Assessment of Green Building Score Based on Green-ship rating of The Green Building Council Indonesia

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Assessment of Green Building Score Based on Green-ship rating of The Green Building Council Indonesia

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Abstract. University building should have good environment qualities. This research aimed to (1) identify Industrial Engineering Department building at Diponegoro University based on green building green-ship rating published by Green Building Council of Indonesia, (2) recommendation formulation to improve the green building score. The assessment was conducted by comparing existing condition of building with green-ship rating version 1.1. There are six assessment aspects: (1) appropriate site development, (2) energy efficiency and conservation, (3) water conservation, (4) material resource and cycle, (5) indoor health and comfort, and (6) building environment management. Each aspect consists of some green building indicators. Primary data collected through interviews and direct observation. The result of data processing shows that Industrial Engineering Department building obtained 52 score point from 114 maximum points, and categorize as a green building with bronze ranking. Recommendation to increase sustainability score are: provides special bicycle parking, adding the vegetation area on the building area of 705m^2, conducting installation of renewable energy with photovoltaic technology about 492.5 watts, build an installation for water treatment, Perform air quality measurements, organize sustainability-themed training regularly.

Keywords: *Sustainability assessment, Green Building score, recommendation formulation*

INTRODUCTION

Many aspects involve to be considering in the process of design of a green building. Aspect of built environment must consider site, design, construction, operation and maintenance of the building. Then, the construction process and operational process of the building will need consumption of energy, water, materials, and natural resources. The building give some environmental effect such as waste, air pollution, water pollution, indoor pollution, heat islands, Storm-water run-off, and noise. Also, that effect will influence the human health, environmental degradation and loss of resources. The building sector used 42 % more electricity than any other sector. We spend more than 90 % of our time in the buildings. The number and size of buildings in urban areas had increased due to urbanization and resulting in an increased demand for electricity and other forms of energy (UNIDO, 2009). Energy consumed in the buildings sector is 20.1% of the total of worldwide energy consumed. It consists of residential and commercial end users, that also includes the energy used to generate and deliver electricity to individual sites such as homes, offices, or industrial plants (EIA, 2017). According to the South East Asia Energy Outlook 2013, Indonesia is South East Asia's largest energy consumer, consuming 36% of the total primary energy consumed in South East Asia in 2011, (Eang, 2015).

Buildings sector consume 40% energy, 25% water, and 40% of resources in the world (EPA, 2013). The building is called the biggest energy eater. The design of the building should give priority to the user's comfort while remaining environmentally friendly. The function of buildings for humans is to protect from the threat of the surrounding natural

environment such as weather conditions or other threats. However, today the sustainability of the environment must also be preserved and protected from the impact of a building. Then, a building must be designed as a green building.

Measurements that refer to a certain standard needed to measure of how environmentally friendly a building. Therefore, an instrument is needed to measure the greenness of a building or area. There are many institutions and standards in green building assessments, such as BREEAM (BRE Environmental Assessment Method) in United Kingdom, LEED (Leadership in Energy and Environmental Design) in United States, NABERS and GREEN STAR in Australia, and GREEN MARK in Singapore (Komalasari, 2014). The measurement of green building score at Indonesia use the Green-ship standard (GBCI, 2010). This standard is under the authority of the National Certification Body of Green Building Council Indonesia (GBCI) as an independent institution that has been established since 2009. GBC Indonesia is an Emerging Member of the World Green Building Council (World-GBC) based in Toronto, Canada.

Currently, the green building measurement is not only applied to commercial buildings but also applied in campus buildings. It is necessary to study on measurement of campus Green Building. The building of Industrial Engineering department, Diponegoro University is a new building with the concept of green building. The building walls are composed mostly of glass and bright enough. However, if outside building air temperature was heat; the building will needed a lot of Air Conditioning machine to cool the room. Also, the area around the building is quite lack of trees. This study aims are: (1) to conduct green building measurements at the Industrial Engineering Building of Diponegoro University based on green building criteria of Green Building Council of Indonesia, (2) to provide recommendations and solutions related to the improvement of the greenish level of the building.

LITERATURE REVIEW

Green building define as "The practice of creating structures and using processes that are environmentally - responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction". This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as "a sustainable or 'high performance' building" (EPA, 2013).The components of green building according to EPA are (1) Sustainable Sites and Responsible Land Use Development, (2) Materials and Resource Conservation, (3) Energy Conservation and Atmospheric Quality, (4) Water Efficiency, Conservation, and Management, (5) Indoor Environmental Air Quality.

Another definition of Green Building is "a green approach to building an environment that includes a holistic approach to designing a building which requires consideration for all resources used in materials, fuel or contributions of its users" (Wolley et al, 2001). Indonesian Minister of Environment define the green building on its regulation no. 08/2010, the criteria and certification of Green Building, which states green building is a building that applies environmental principles in designing, developing, operating and managing them and important aspects of handling climate change impact (Indonesia Ministry of Environment, 2010).

Green Building Council Indonesia developed Green-ship standard assessment factor which has 6 categories. There are two types of criteria, first are criteria classified as prerequisite-criteria and second are classified as assessment-criteria. The prerequisite-criteria must be exists in each category and must be fulfill before further appraisal. Assessment-criteria are the criteria that exist in each category and the fulfillment of these criteria must be adjusted to the ability of the building. Criteria consisted of one or more than one indicator. Score of indicator are different between one to another. The number of assessment factors or categories, the criteria and the indicator of green building are given on table 1.

TABLE 1. Categories in Green-ship Measurement of GBCI

Categories	Number of Criteria		Number of Indicator	
	Prerequisite	Assessment	indicators	Scores
1. Appropriate Site Development/ASD	2	7	18	16
2. Energy Efficiency and Conservation/EEC	2	7	15	36
3. Water Conservation/WAC	0	9	11	20
5 Material Resource and Cycle/MRC	3	5	9	12
5. Indoor Health and Comfort/IHC	1	7	14	20
6. Building Environment Management/BEM	1	5	9	13
Total	9	40	76	117

RESEARCH METHOD

There are several requirements for the feasibility of a building for a green building assessment with a Green-ship rating from the Green Building Council of Indonesia. Before certification process, the project must meet certain requirements such as (1) Minimum building area must be 2500m2, (2) Building function in accordance with its designation according to local government planning, (3) Building must have environmental management plan and environmental monitoring (4) Building specifications compliance to earthquake resistance standards, (5) Building compliance to fire safety standards, (6) Conformity of buildings to disability accessibility standards, (7) Availability of building data to be accessed by GBCI related to certification.

There are four stages on green building measurement. The first stage is analysis of the prerequisite criteria. If the analysis result concluded that criteria requirement haven not met the standard yet, then the score of the criteria cannot be evaluated. In real assessment, the green building assessment process cannot proceed further. But, in this study, if there are prerequisites criteria that have not been met the requirement, then it is assumed to be fulfilled later. The prerequisite criteria on each category are given on table 2.

TABLE 2. Prerequisite Criteria for Green Building Assessment

Category	Prerequisite Criteria	Assessment Indicators
I	Site Management Policy	Commitment of top management to maintenance building exterior, integrated pest management (IPM), on habitat around the site using non-toxic materials.
	Motor Vehicle Reduction Policy	Commitment of top management to do various program in order to reduced using of private vehicle.
II	Policy and Energy Management Plan	Commitment of top management on monitoring target savings and action to encourage energy savings and permanent written energy savings campaigns on every floor
	Minimum Building Energy Performance	Show energy savings of 5% or more from last year,Optimized Efficiency Building Energy Performance, Testing, Re-commissioning or Retro-commissioning.
IV	Fundamental Refrigerant	Using non-CFC Refrigerants and Fire Extinguishers that have ozone values depleting Potential (ODP), <1
	Material Purchasing Policy	A policy of top management that prioritizes spending on environmentally friendly on all materials usage.
	Waste Management Policy	Commitment of top management on waste management, campaigns to encourage waste sorting behavior
V	No Smoking Campaign	Commitment of top management to encourage minimization of indoor smoking activities.
VI	Operation & Maintenance Policy	Existence of operation and maintenance plan on mechanical and electrical systems, plumbing systems and water quality, exterior & interior, purchasing and waste management.

The second stage is to conduct an assessment to the building used Green-ship Building for existing building Ver. 1.1 (GBCI, 2016). Data collection was done by conduct interviews with some Industrial Engineering department lecturer, employees, student, and the building designer who are perceived to understand about the design and operational management of the building. The result of interviews then perceived as a score. It is done for all assessment indicator. The result then will be analyzed by gap analysis to know how far the score of building compare to green-ship standard.

The third stage is the determination the category of the building on the green-ship rating. There are 4 categories; bronze, silver, gold and Platinum. The building get bronze category if the score of assessment reach 41 points, silver category 53 points, gold category 66 points, and Platinum category 83 points. The maximum score is 117 points. The fourth stage is evaluation the result to formulate some recommendation. Recommendations are based on research finding and deep interviews with green building experts.

RESULT AND DISCUSSION

Result of prerequisite criteria analysis shows that almost all of prerequisites in the category have not been fulfilled yet. Some documents or programs in the prerequisite criteria has not owned or created yet by the management of the building. It means that the building is not ready for the green building assessment process. Second step is to assess the building due to 6 categorizes, each categorize consist of some aspect shown on table 1.

Appropriate Site Development/ASD

The Industrial Engineering Diponegoro University building reach 11 scores from 16 score in Appropriate Site Development/ASD categorize which consist of 7 criteria. The building got 5 score on Community Accessibility, 3 score on Site Landscaping and, and 3 score on Building Neighborhood. Community accessibility required access and facilities on the public transportation vehicle. Some criteria that the building must provide are: reduction in the use of private motor vehicles, more landscape area of vegetation, using the green roof to reduce heat effect, water management by reduction of the volume of rainfall runoff from the land area, apply Standard Operating Procedures (SPO) for pest control diseases and build some social programs for local people.

TABLE 3. Assessment result of Appropriate Site Development/ASD

	Assessment Criteria	Requirement	Score
1	Community Accessibility	– There are at least 5 types of public facilities within 500 meters of the main road – The presence of a bus stop or public transport station within 300 m from the location gate – Provide pedestrian path facilities to get to the bus stop	5
2	Motor Vehicle Reduction	– Reduction in the use of private motor vehicles by preserve car-pooling, feeder bus, reserved parking – The availability of secure bicycle parking as much as 1 unit of parking per 30 users	0
3	Site Landscaping	– The existence of a landscape area of vegetation that is free of garden buildings, at least 30% of the total land area, 60% use of local plants originating from local nurseries	3
4	Heat Island Effect	– Using materials that have an average albedo value of at least 0.3 according to the calculations on the roof area of a building covered by pavement or Using green roof 30% from roof area	0
5	Storm Water Management	– Reduction of the volume of rainfall runoff from the land area to the city drainage network of 50% total average daily rainfall volume	0
6	Site Management	– Own and apply Standard Operating Procedures (SPO) for pest control diseases and weeds of plants using non-toxic materials – Provision of non- pet habitats at least 5% of the total area of the building site	0
7	Building Neighborhood	– Building community has social programs for local people. – The building has a path for pedestrian connects to other buildings – Located near the sources of electricity and street lighting. – Revitalization of cultural heritage buildings	3

Assessment Result of Energy Efficiency and Conservation/EEC

Second category is Energy Efficiency and Conservation. The building got 24 score from 36 score available for this category. 16 score from Optimized Efficiency Building Energy Performance because the building management already has control on electricity consumption for the last 6 months to be smaller than the standard (Office 250 kWh / m2/yr). Also got 8 score on System Energy Performance from saving energy consumption on room lighting power

which is more efficient 20% of the illumination power. Some categorize need to be provide are Energy Monitoring & Control, Using Renewable Energy, and try to reduce energy emission.

TABLE 4. Assessment result of Energy Efficiency and Conservation/EEC

No	Assessment Criteria	Requirement	Score
1	Optimized Efficiency Energy Performance	– Control of electricity consumption for the last 6 months to be smaller than the standard Office 250 kWh/m^2/yr (SNI, 2000)	16
2	Testing, Recommisioning or Retrocommisioning	– Control and maintenance of MVAC (Mechanical Ventilation and Air Conditioning) – Continuous commissioning within a maximum of 3 years	0
3	System Energy Performance	– Save energy consumption on room lighting power, more efficient 20% of the illumination power – This benchmark can only be obtained, when it meets IHC 6 Visual Comfort	8
4	Energy Monitoring & Control	– The monthly routine recording of monitored results and data collection at kWh meter (done over the last 6 months) – Apply EMS (Energy Management System) technology	0
5	Operation and Maintenance	– Guidance for operation and maintenance of all AC systems (chiller, Air Handling Unit, cooling tower) – Monthly report for the last 6 months for the operating activities and maintenance of the building system	0
6	On Site Renewable Energy	– Percentage of maximum power demand is generated by renewable energy	0
7	Less Energy Emission	– Result of CO2 Emission Reduction Measures	0

Assessment Result of Water Conservation/WAC

Third category is Water Conservation which consists of 9 criteria and provided 20 score. The IE building only got 9 score, 1 score from Water Sub-Metering criteria and 8 score from Fresh Water Efficiency criteria. Fresh water efficiency requires a program to decrease of water consumption. Some program should be provide to increase the score of green building are Indicates laboratory evidence of the last 6 months of primary source water corresponding to water criteria, Using alternative water recycling, Using a filtration system that produces drinking water, Deep Well Reduction, and Water Tap Efficiency.

TABLE 4. Assessment Result of Water Conservation/WAC

No	Assessment Criteria	Requirement	Score
1	Water Management Policy	The existence of sub-meters of water consumption in public area systems, commercial areas and building utilities	0
2	Water Sub-Metering	The existence of sub-meters of water consumption in public area systems, commercial areas and building utilities	1
3	Water Monitoring Control	The existence of standard operating procedures and their implementation of maintenance and checking the plumbing system regularly to prevent leakage and waste of water	0
4	Fresh Water Efficiency	Decrease point for every increase of water consumption from SNI standard	8
5	Water Quality	Indicates laboratory evidence of the last 6 months of primary source water corresponding to water criteria	0
6	Recycled And Alternative Water	Using alternative water recycling and / or water for make-up water cooling tower	0
7	Potable Water	Using a filtration system that produces drinking water in accordance with Minister of Health Decree on Water Quality Requirements (2000)	0
8	Deep Well Reduction	Consumption of water using deep well with maximum 10% of whole water consumption	0

9	Water Tap Efficiency	Percentage of the total water faucet units in public areas use the auto stop feature	0

Assessment Result of Material Resource and Cycle/MRC

The fourth category is Material Resource and Cycle, which has 5 criteria and provide 12 scores, but IE building only got 2 scores from Waste Management Practice criteria. These scores gained from organic and inorganic waste sorting, and undertake inorganic waste processing independently or cooperate with official body of inorganic waste processing which has principle of 3R (Reduce Reuse Recycle). Other criteria on Material Resource and Cycle are not yet implemented such as (1) Using Non-CFC Refrigerants, (2) Training and Report on management for waste of lamps, batteries, printer ink and used packaging cleaning materials, and (3) Standard operating procedures and reports on the distribution of material that can still be reused in the form of furniture, electronics and spare parts. The building management also asked to prioritizing the use (1) environmentally friendly materials, (2) local production, (3) certified SNI, (4) recycled, reused and renewable, (5) product of wood has to be certified, (6) Products that produce minimal environmental. There is a purchase documentation proving the purchase in environmentally friendly materials.

TABLE 5. Assessment Result of Material Resource and Cycle/MRC

No	Assessment Criteria	Requirement	Score
1	Fundamental Refrigerant	Using Non-CFC Refrigerants and Fire Extinguishers that have Ozone values Depleting Potential (ODP)<1	0
2	Material Purchasing Policy	Prioritizing the use of (1) environmentally friendly materials, (2) local production, (3) certified SNI, (4) recycled, reused and renewable, (5) product of wood has to be certified, (6) Products that produce minimal environmental. There is a purchase documentation proving the purchase in environmentally friendly materials.	0
3	Waste Management Practice	waste separation of organic and inorganic , organic waste processing independently or in cooperation with the official body waste processing with the principle of reuse, recycle and renewable	2
4	Hazardous Waste Management	Training and Report on management for waste of lamps, batteries, printer ink and used packaging cleaning materials	0
5	Management of Used Good	Standard operating procedures and reports on the distribution of material that can still be reused in the form of furniture, electronics and spare parts	0

Types of materials that meet suitability for use in green building preferably materials that are local production, have certificates of SNI / ISO / Eco-label, can be recycled. Selection of preferred materials that can be re-used, renewable. Selection of lighting materials preferably lamps that do not contain mercury. The use of asbestos-free ceiling. Use of wood material using composite wood products and low formaldehyde emission agrifiber. Use of selected paint and carpet products with low VOC emission.

Assessment Result of Indoor Health and Comfort/IHC

The fifth category is Indoor Health and Comfort. The category is consisted of 7 criteria of environment indicator on air quality, thermal, visual and acoustic. The IE building got 5 score from 20 available for this category. 2 score from air quality of the room which indicating the presence of air intake accordance with SNI 03-6572-2001 (SNI, 2001) on Ventilation Procedures and Air Conditioning System in Buildings. 1 score from thermal comfort (thermal conditions of the room are generally at a temperature of 24 ° C - 27 ° C and Humidity relative 60%). 1 score from visual comfort accordance to level of illumination in each workspace based on SNI on Energy Conservation in the Lighting System. The last score, 1 point from Acoustic Level accordance to sounds level in the work space based on SNI on Specifications of Sound Level and Buzzing Time in Buildings and Housing. Some facilities need to provide in the building are CO2 and CO monitoring, measurements of Physical, Chemical and Biological Pollutants. Also, all areas of the building should be no smoking area, providing a special area of smoking must located at least 5 m from the entrance.

TABLE 6. Assessment Result of Indoor Health and Comfort/IHC

No	Assessment Criteria	Requirement	Score
1	Outdoor Air Introduction	The air quality of the room indicating the presence of air intake accordance with SNI 03-6572-2001 on Ventilation Procedures and Air Conditioning System in Buildings.	2
2	Environmental Tobacco Smoke Control	All areas of the building are no smoking area. When providing a special area of smoking must located at least 5 m from the entrance.	0
3	CO2 and CO Monitoring	For high-density rooms equipped with installation CO2 sensor that has a mechanism for regulating so the CO2 concentration in the room is not more than 1,000 ppm. For enclosed indoor parking spaces equipped with the installation of carbon gas sensors monoxide (CO)	0
4	Physical, Chemical and Biological Pollutants	Bacterial counts with a maximum number of germs of 700 colonies / m3 of air and pathogen-free germs in the room based on Minister of Health Decree (2001)	0
5	Thermal Comfort	The thermal conditions of the room are generally at a temperature of 24 ° C - 27 ° C and Humidity relative 60% + 5%	1
6	Visual Comfort	The level of illumination in each workspace based on SNI on Energy Conservation in the Lighting System (2011)	1
7	Acoustic Level	Sound level in the work space based on SNI on Specifications of Sound Level and Buzzing Time in Buildings and Housing	1

Assessment Result of Building Environment Management/BEM

The sixth category is Building Environment Management which consisted of 5 criteria and provided 13 score. Unfortunately, the IE building only got two score from this category for Application of innovation to improve the quality of buildings and encourage change behavior to increased efficiency. Other criteria still did not give point because unavailable such as Design Intent & Owner's Project Requirement, Green Operational & Maintenance Team, Green Occupancy, and Operation and Maintenance Training.

TABLE 7.Assessment Result of Building Environment Management/BEM

No	Assessment Criteria	Requirement	Score
1	Innovations	Application of innovation to improve the quality of buildings and courage change behavior to increased efficiency.	1
2	Design Intent & Owner's Project Requirement	Availability of Design Intent and Owner's Project Requirement documents and document As Built Drawing	0
3	Green Operational & Maintenance Team	The existence of a structure that is integrated in the operational structure and maintenance of the building which is responsible for maintaining the application of sustainability / green building principles	0
4	Green Occupancy/Lease	For commercial buildings have Lease Agreement, for non-commercial buildings have SPO and Training covering the efforts to meet the criteria in Green-ship	0
5	Operation and Maintenance Training	The existence training programs in operation and maintenance for tread, energy, water, materials and HSES (Health Safety Environmental and Security) periodical schedule (every 6 months).	0

Final Result of Green Building for Industrial Engineering building

The result of assessment of Green Building for Industrial Engineering building of Diponegoro University is given on table 8. With a total value of 52 Points, the Industrial Engineering Building is included in the criteria of green

building with bronze rank (bronze). The comparison between maximum value and assessment result given on figure 1.

TABLE 8. Result of Green Building Assessment

Categories	Number of Criteria		IE building score	
	Assessment	Max Score	Score	(%) of Max
1. Appropriate Site Development/ASD	7	16	11	69%
2. Energy Efficiency and Conservation/EEC	7	36	24	67%
3. Water Conservation/WAC	9	20	9	45%
4. Material Resource and Cycle/MRC	5	12	2	17%
5. Indoor Health and Comfort/IHC	7	20	5	25%
6. Building Environment Management/BEM	5	13	1	8%
Total	40	117	51	44%

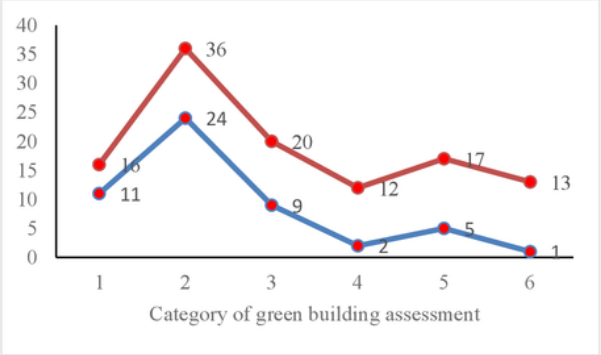

FIGURE 1. Graph of Comparison of Maximum Values and Assessment Results

Formulation of the recommendation to increase green-ship rating, expert opinion collecting by distributing questionnaires to 10 respondents consisting of building management and architects in the university. Some recommendations based on green building assessment are:

a) Motor vehicle reduction efforts
b) Provide Bicycle Facilities
c) Adding Vegetation to Land Landscape
d) Improving Energy Control and Monitoring
e) Make efforts to save energy and use renewable energy
f) Utilizing alternative water sources other than ground water
g) Improve waste management
h) Efforts to improve thermal comfort with indoor vegetation

The direction of building development other than green building is smart building. The concept of a smart building where the concept uses an automation system called Building Automation System (BAS). Smart Building automation system refers to the use of information technology and computers to control the equipment inside the building.

CONCLUSION

Measurement results shows that Industrial Engineering Building got a score of 52 of a total of 121 points categorized as a bronze rating of green. This score only 44 % of total score.

Recommendations to increase the green-ship ranking of Industrial Engineering Building are focus on Material Resource and Cycle/MRC and Building Environment Management/BEM such as:

a. Adding the area of vegetation as much as 705 on the area around the parking lot, the roof of the building, and the empty part of the building by making terrace garden or vertical garden.
b. Installing renewable energy with photo-voltaic (PV) technology to supply 492.5 watts of electricity.

c. Making the installation to utilize alternative water sources used comes from water used in condensing air conditioners and rainwater.

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