Lesson learned from implementation of green building concepts towards sustainable development: a case study of a state-owned enterprises (BUMN) head office in Cilacap

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Abstract. The building sector has a role in contributing to climate change, which occurs by 37%, so the transition to sustainable development is carried out. Green building, which is one of the manifestations of sustainable development, is a planning concept that is still voluntary, and in Indonesia, only 4% has been recorded. This research was conducted to study the implementation of the green building concept specifically so that the main building of BUMN in Cilacap, Central Java, was determined. From observations and interviews, the benefits and challenges of implementing the green building concept were obtained, which serves as an illustration for other businesses in implementing the idea. The benefits include the potential for decarbonization with the use of renewable energy, comfort for occupants, and operational cost savings. In contrast, future challenges include maintaining the commitment of each building user to continue to conserve and the implementation of feasibility provisions at the beginning. Recommendation to improve: it is necessary to routinely monitor and evaluate or audit the commitments made, implement appreciation measures for employees and sanctions for violators, involve certified experts in building management in the operational stage, and integrate supporting data in the system as a form of good internal communication.

1 Introduction

Development continues in the world as a form of economic growth. However, significant climate change due to the phenomenon of global warming has raised awareness of the need to transition to a sustainable built environment. Some facts in 2023 show that the building sector consumes 34% of global energy, the infrastructure needed in 2050 and not yet built reaches 75%, and the building and construction sector is a greenhouse gas contributor of 37% of total global emissions [1]. Towards the zero carbon target by 2050, efforts to decarbonize

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the global building stock are being made, including various steps such as improving energy efficiency, increasing the use of renewable energy, and adopting environmentally friendly technologies. There are 2 (two) indicators of decarbonization impact in the form of energy intensity of the building sector (kWh/m^2) and the share of renewable energy in buildings (%). Building decarbonization efforts in Indonesia are only partially mandatory, and the rest are voluntary [2].

Along with the development of the Golden Indonesia 2045, the Government of Indonesia also has 4 (four) development pillars, one of which is sustainable economic development. This is in accordance with the mandate of the 1945 Constitution of the Republic of Indonesia, which stated that national economic growth is organized based on various principles, including sustainable and environmentally oriented. In realizing sustainable development, environmental protection and management, which has a definition of systematic and integrated efforts carried out to preserve environmental functions and prevent pollution and damage to the environment, which includes planning, utilization, control, maintenance, supervision, and law enforcement [3], must also be carried out. In addition to playing a role in climate change action, business actors, as part of the Penta helix agent, need to pay attention to environmental protection and management efforts that have become their commitment.

The implementation of green buildings as a form of support for other sustainable development currently in Indonesia is only 4% of the total building area that has been certified to reach 55 million m^2 during 2015-2022 globally [4]. Green buildings are buildings that prioritize environmental sustainability pay attention to negative impacts and create positive impacts on climate and the environment throughout the life cycle starting from the planning, construction, operation, maintenance, renovation, to demolition stages [5]. Green buildings are also one of the innovations that can increase the effectiveness and efficiency of energy use and the use of eco-friendly materials [6]. The concept of green building focuses on efficiency, human health, and the natural environment [7,8]. Green buildings, also known as sustainable or high-performance buildings, are facilities that are designed, constructed, operated, renovated, and disposed of using ecological principles to improve occupant health and resource efficiency and minimize the impact of the built environment on the natural environment [9]. Another definition is that a green building is a building that uses very minimal natural resources, so it is more energy efficient and can reduce the impact of damage to the environment [10,11]. Green building is the practice of creating structures and using environmentally responsible and resource-efficient processes throughout a building's life cycle, from location, design, construction, operation, maintenance, renovation, and deconstruction [12]. From the various definitions and concepts above, green building is not only the practice of planning that is realized at the construction stage but also throughout the life cycle of the building, which has been overlooked.

2 Research Methods

The research was conducted with a case study on one of the GBCI-certified green buildings, namely the main building of BUMN in Cilacap, with the consideration of selection because the location is around the production area with a high level of risk. Primary data collection was carried out by direct observation of the field and in-depth interviews with the person in charge of building management.

Green Building Council Indonesia (GBCI) which was formed in 2009 as an independent organization and is a permanent member of the World Green Building Council has a Greenship certification program with 6 (six) categories, namely New Building (NB), Existing Building (EB), Interior Space (IS), Homes, Neighborhood (NH), and Net Zero Healthy (NZH) with 4 ratings owned from the highest order, namely Platinum, Gold, Silver, and

Bronze [13]. Greenship certification for New Building - Final Assessment (FA) and Existing Building have the same 6 (six) assessment categories but with different maximum point totals and rating ranges. Here are the details of the assessment categories in Table 1.

Table 1. Detailed Scoring for Greenship NB & EB

Categories	Maximum Value	
	NB (FA) Ver. 1.2	**EB Ver. 1.1**
Appropriate Site Development/ ASD	17	16
Energy Efficiency & Conservation/ EEC	26	36
Water Conservation/ WAC	21	20
Material Resource and Cycle/ MRC	14	12
Indoor Health and Comfort/ IHC	10	20
Building Environment Management/ BEM	13	13
Total	**101**	**117**
Predicate	Platinum: > 74 Gold: 58-73 Silver: 47-57 Bronze: 35-46	Platinum: > 83 Gold: 66-82 Silver: 53-65 Bronze: 41-52

Since the BUMN head office in Cilacap is an existing building, the data collected was analyzed qualitatively with the benchmarks of the 2016 Greenship EB assessment summary Version 1.1.

3 Results and Discussion

3.1 Overview of Green Building in BUMN Head Office in Cilacap

The BUMN head office in Cilacap (Fig.1), which was initiated in 2016, was completed and operational in mid-2019 with a green building concept. The management of this head office is under the responsibility of the Area Manager of Asset Operation. The head office is built on an area of 7,257 m^2 with a total of 5 floors. It received a Gold certificate for the New Building Greenship in 2019 and received an upgrade to Platinum in 2022, with Platinum certificate No. 025/RP/EB/XII-2022 for the Greenship Existing Building.

Fig. 1. An aerial view of the BUMN head office

The six assessment categories are: 1) Appropriate Site Development (ASD); 2) Energy Efficiency and Conservation (EEC); 3) Water Conservation (WAC); 4) Material Source and

Cycle (MRC); 5) Indoor Health and Comfort (IHC); and Building Environmental Management (BEM). Each of these six categories has prerequisite criteria that represent the minimum standards for green buildings, credit criteria that have a value if met, and bonus criteria that add value but do not affect the maximum value of Greenship. The following is the maximum score for each category, with an overall score of 117 points (100%) and the achievement of a total score by the BUMN head office in Cilacap of 85 points (73%). The score as Fig. 2 shown.

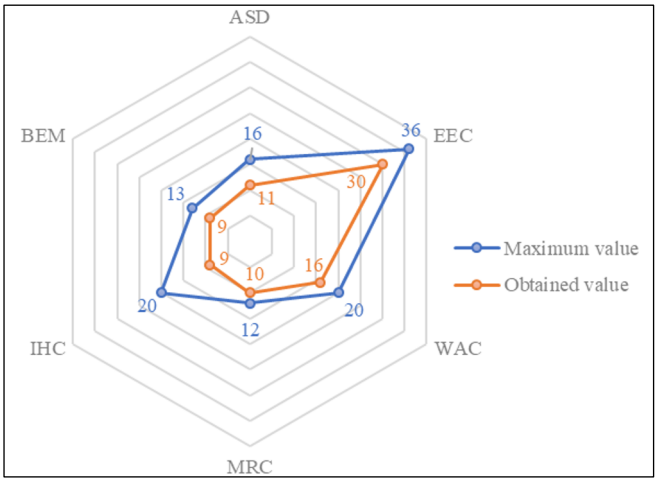

Fig. 2. Chart of maximum and obtained value for Greenship EB

Before following the certification process for existing buildings, the BUMN head office must meet the eligibility requirements set by GBC Indonesia, with results found on site as follows in Table 2.

Table 2. Feasibility result on the BUMN head office

No.	Feasibility	Meet		Description
		Yes	No	
1	A minimum building area of 2.500 m^2.	✓		Building area (NLA) = 11.665 m^2.
2	Willingness to sign an agreement letter that allows all building data to be studied by GBC Indonesia in a case study.	✓		-
3	Possess the Environmental Management Implementation Report (UKL/UPL) endorsed by BAPEDAL.	✓		Has an AMDAL with Environmental Permit No. 660/529/30/Year 2016, issued by Cilacap Regent on June 13, 2016.
4	Possess a Certificate of Acceptability to Function (SLF) issued by the Local Government.		✓	It cannot be shown/ proved.

From the eligibility points above, the Certificate of Acceptability to Function is not fulfilled because it cannot be shown. In accordance with the Regulation of the Minister of Public Works and Housing No. 27/PRT/M/2018 concerning Certificate of Acceptability to Function, it shows the fulfilment of administrative requirements and technical requirements

(building procedures and reliability) of the Building. Building reliability requirements include safety, health, comfort, and convenience requirements, which are also in line with green building principles. This finding shows poor file administration by the asset division as the building manager.

In addition, the existence of the building's environmental documents is also difficult to find. In fact, commitments in environmental documents are important to be paid attention to their implementation in realizing sustainable development as mandated [3]. From observation, the communication aspect between divisions is not going well.

3.2 Implementation of Green Building Concept in BUMN Head Office in Cilacap

3.2.1 Appropriate Site Development

In this category, there are 2 (two) prerequisite criteria, namely the existence of a land management policy and a policy to reduce the use of private motorized vehicles, as evidenced by a statement of commitment. For credit criteria, there are 7 (seven) things related to community accessibility, reduction of motorized vehicles, land landscape, heat island impact, rainwater management, land management, and the surrounding environment.

Community accessibility at the main BUMN building in Cilacap can reach at least 5 types of public facilities within 500 m of the site, such as a minimarket 51 m away, a multipurpose building 150 m away, a security post 50 m away, a place of worship 210 m away, and a sports field 3 m away. There is also an employee bus stop within ± 62 m. In the criteria of reducing motorized vehicles, the main BUMN building in Cilacap has 2 (two) secure bicycle parking units with a total installed rack that can accommodate 72 units and 10 showers for bicycle users spread throughout the building floor. For the landscaping criteria, the vegetation area is 22.8%, not reaching 30% of the total land area. However, the local vegetation criterion has reached 100% of the 60% requirement. In reducing the heat island effect, materials with an average albedo value of at least 0.3 on the roof area of the building have been used. By having 3 infiltration ponds and 1 rainwater tank, a reduction in the volume load of rainwater runoff can be made. In land management, the ownership and implementation of SOP to control plant pests and weeds without the use of toxic materials and the provision of non-pet animal habitats at least 5% of the total building footprint area are assessment criteria. The BUMN head office meets the assessment criteria of ownership and implementation of SOP to control plant pests and weeds without the use of toxic materials. In the requirements of the surrounding environment, activities to improve the quality of life of the community around the building are carried out by making public toilets at least 5 units and providing community development training.

In the appropriate land use category, community accessibility and landscaping have the highest points compared to other criteria. Fulfilment in this category is carried out during the construction phase.

3.2.2 Energy Efficiency and Conservation

In this category, there are also 2 (two) prerequisite criteria, namely the existence of energy management policies and plans and the fulfilment of minimum building energy performance with IKE benchmarks. For credit criteria, there are 7 (seven) things, namely optimized building energy performance efficiency, testing and recommissioning, system energy performance, energy monitoring & control, operation and maintenance, on-site renewable energy, and clean energy.

With a standard office electricity IKE of 250 kWh/m^2.year, the 2019-2022 electricity IKE data shows below the standard. Since the BUMN head office uses VRV air conditioning systems, the criteria for testing and recommissioning do not apply. For system energy performance, 100% LED is used for lighting. In energy monitoring and control, a BAS (Building Automatic System) system is used, which is monitored through the system and manually on the PTUR and transformer displays. In operation and maintenance, operation and maintenance guidelines for air conditioning systems and other equipment systems, as well as monthly reports on building system operation and maintenance activities according to SOP, are evidence of assessment. The BUMN head office has added value in this category because it has a renewable energy source with the use of a Solar Power Plant with a power of 18 kWp, which reaches 1.3% of the maximum energy consumption of the building. That way, the reduction in CO_2 emissions can achieve the same percentage of the use of PLN electricity as a clean energy criteria.

In this category, it is necessary to pay attention to its implementation until the operational stage, which is the longest stage in the building cycle [14,15] because energy needs continue to exist and affect the action to deal with climate change which is SDG No. 13. Indonesia as one of the countries participating in the Paris Agreement (COP-21) is committed to reducing greenhouse gas emissions unconditionally by 2030 by 29% to 31.89% recorded in the 2022 Enhanced Nationally Determined Contribution (ENDC) document based on the BaU (business as usual) scenario.

3.2.3 Water Conservation

In this category, there is 1 (one) prerequisite criteria, namely the existence of a water management policy in the context of water conservation. For credit criteria, there are 8 (eight) in the form of water sub-meters, water monitoring controls, clean water efficiency, water quality, alternative water and recycled water, drinking water, deep well reduction, and water tap efficiency as bonus criteria.

In the BUMN head office, there are PDAM and regional inlet water sub-meters and recycled water outlets. In water monitoring control, there is an SOP for maintenance and inspection of the piping system with a water balance report. It is known that the average water consumption in the head office is 13.4 L/person/day below the office standard of 50 L/person/day. For clean water quality, laboratory test results have not been verified by an accredited laboratory. The need for clean water in the BUMN head office also comes from recycled water. Still, the results of laboratory tests of the recycled water used for toilet and garden needs have also not been proven by an accredited laboratory. In meeting drinking water needs, refillable bottled water is still used, so there is no filtration system in drinking water management. In water tap efficiency, 83% of the total water tap units are sensor faucets located in each bathroom/WC.

Water conservation is also a concern during the building's life cycle. The sustainable use of water will support SDG No. 6: Clean Water and Sanitation.

3.2.4 Material Resource and Cycle

In this category, there are 3 (three) prerequisite criteria, namely the use of non-CFC refrigerants, the existence of an environmentally friendly material purchasing policy, and the existence of a waste management policy. In the credit criteria, there are 5 (five) things, namely the use of materials without ozone-depleting substances, material purchasing practices, waste management practices, hazardous waste management, and used goods management.

The BUMN head office has used non-CFC refrigerants that support ozone protection. However, in the practice of purchasing environmentally friendly materials, 3 types are claimed to be proven by the required supporting documents. In waste management, an SOP is owned, and efforts are made to manage organic and inorganic waste and reduce plastic packaging waste. The SOP also manages hazardous waste and used goods.

3.2.5 Indoor Health and Comfort

In this category, there is 1 (one) prerequisite criteria, namely the existence of a no-smoking campaign. The credit criteria include 8 (eight) things, namely outside air introduction, smoking control, CO_2 and CO monitoring, measurement of physical, chemical, and biological pollutants, temperature levels, lighting levels, noise levels, and building user comfort surveys.

In this category, the BUMN head office has measured room airflow, indicating the introduction of outside air with provisions by the specified SNI. However, monitoring of smoking along with CO_2 and CO has not been done. In the measurement of pollutants, the BUMN head office routinely cleans air conditioners to prevent the development of microorganisms. The room temperature level is in the range of 24-27°C, and the relative humidity is 60% ± 5% according to SNI 6390:2011. The lighting level around the workspace reached an average of 350 lux, while the noise level in the workspace was in the range of 40-45 dB. In the building comfort survey, 80% of the total respondents felt comfortable.

3.2.6 Building Environment Management

In this category, there is 1 (one) prerequisite criteria, namely the existence of an operations and maintenance policy. The credit criteria include 5 (five) things: innovation, the availability of Design Intent and Owner's Project Requirement documents, the existence of a building operational and maintenance team structure, green occupancy, and operational and maintenance training.

In this category, the BUMN head office has innovated to improve energy and water efficiency. A subsidiary conducts a separate building operations and maintenance team and has a regular building operations and maintenance training schedule.

3.3 Lessons Learned from Implementation of Green Building Concepts

The results of interviews with building managers show that the understanding of green buildings is environmentally friendly buildings that pay attention to environmental aspects, from architecture to construction to maintenance. The motivation for implementing green buildings is a form of environmentally and sustainable action, which realizes that pollution and emissions are currently increasing. The government's commitment to reducing emissions also contributes to encouraging BUMN owners to participate.

In the maintenance phase, efforts are still being made to utilize nature, such as solar panels to meet part of the electricity supply and rainwater to meet water needs. A policy for the use of lights and air conditioning from 6 a.m. to 8 p.m. is implemented, and if there are no employees working overtime, the system will turn them off automatically. Electronic devices, such as dispensers, TVs, and refrigerators, which are not in use, will be inspected every Friday and unplugged. The use of recycled water from toilets for flushing, plant watering, and car washing has also been implemented. The method for M&E of green building implementation is currently just through certification, which is renewed every 3 years.

It is realized that the benefits of implementing green buildings are an effort to reduce emissions and can support the continuity of work. When tired of working, visuals of a shady environment with plants can relieve fatigue and obtain fresh air. In addition, the potential benefit of implementing green buildings is that it can save operational costs. Research [16] that calculates the life cycle cost of buildings with a projected building life of 5 years and 20 years shows benefits even though the initial and replacement costs in green buildings are greater than the operational costs and green buildings spend lower operational and maintenance costs compared to conventional buildings [17]. However, in this case, the costs saved are unknown because the owner manages them. With the principle of sustainable waste management, grass clippings are used as compost to provide fertilizer for plants.

The challenge faced by the manager is that there are building users who are opposed to it. These attitudes include areas where parking is prohibited because part of the green space is used, smoking activities outside the designated area, employees working overtime, and a lack of awareness of waste sorting even though the facilities are sufficient. Increasing the use of electric bicycles and motorcycles also needs to be done because it is currently still minimal. The use of environmentally friendly and domestic materials by TKDN standards needs to be increased. In addition, based on observations, the filing system and communication between human resources need to be improved. Regular monitoring and evaluation or audits are required so that green building management can be enhanced, and certified experts need to be involved in building management in the operational stage [18].

In the green building concept above, the existence of policies that support the six categories with proof of supporting documents becomes a benchmark. Of the six categories, policies that require monitoring during implementation are the EEC, WAC, and MRC categories because they take place during the operational stage of the building. Therefore, these three categories contribute to the SDGs. In addition, the eligibility provisions at the beginning also need to be monitored, namely the implementation of the obligations in the environmental documents owned, which support the protection and management of the environment as a form of sustainable development.

4 Conclusion

The green building concept should contribute to sustainable development throughout the building's lifetime. Energy efficiency, water conservation, and material resources and cycles are continuous aspects of its implementation. All commitments made to support the green building concept are expected to be implemented and monitored, which is a challenge for those responsible for businesses, including those responsible for implementing the required eligibility provisions.

To improve the implementation of the green building concept, it is necessary to routinely monitor and evaluate or audit the commitments made, implement appreciation measures for employees and sanctions for violators, involve certified experts in building management in the operational stage, and integrate supporting data in the system as a form of good internal communication.

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