Evaluation and Implementation of Green Building in Office Building

(Case Study: Munara 99 Sabilulungan Building)

Rina Marina Masri[1)], Iskandar Muda Purwaamijaya[*1)] ,Veily Vitada[*1)], Alya Sekar Hapsari[1)]

*Corresponding author
*ORCHID IDs: https://orcid.org/0000-0001-5864-0850

[1)]Civil Engineering Study Program, Faculty of Technology and Vocational Education, Universitas Pendidikan Indonesia, Indonesia
*email: ais_imp@upi.edu, veilyv@upi.edu

Abstract

The Green Building concept is a building planning concept to make life better and meet the needs of the next generation. A building can be classified as a green building if it meets the requirements and has green building certification. This paper intends to evaluate, analyze and provide solutions to the application of green building in Munara 99 Sabilulungan building. A descriptive method with an evaluative approach was chosen to describe and compare the existing condition of the building with the greenship assessment tool for new buildings v1.2. The GBCI greenship for new building v1.2 assessment consists of 6 categories, namely land use suitability, energy efficiency and conservation, water conservation, material sources and cycles, space health and comfort, and building environmental management. The assessment results show that the Munara 99 Sabilulungan building received a bronze rating with a score of 44 points. To improve the final rating to a gold rating, the Munara 99 Sabilulungan building is recommended to improve several categories so that it can get a gold rating with 67 points and for the improvement requires a cost of IDR 1,790,085,000, -.

Keywords: *Evaluation, GBCI, Green Building, Greenship for New Building v1.2, Implementation*

1. Introduction

Buildings that are constructed without regard to the surrounding environment can have a negative impact on the environment such as pollution of water, air and soil and climate change [1]. Severe droughts, extreme weather, extremely hot temperatures, rising sea levels and coral bleaching are all impacts of climate change [2].

Office buildings play a role in energy wastage due to their high energy consumption levels [3]. The impact of environmental damage due to development can be prevented by using the concept of green building [4]. Green building is the planning of buildings to make life better

and meet the needs of the next generation. Buildings that use the concept of green building utilize the natural resources around them and each component of the building is interconnected, no part is made in vain.

Green building is regulated in the Regulation of the Minister of Public Works and Housing of the Republic of Indonesia number 02/PRT/M of 2015 concerning green buildings, Regulation of the Minister of Environment number 8 of 2010 concerning criteria and certification of environmentally friendly buildings, and Regulation of the Minister of PUPR No. 21 of 2021 concerning green building performance assessment.

Indonesia has a green building organization called Green Building Council Indonesia (GBCI). GBCI is a non-profit and non-government organization that was established in 2009 and has the authority to provide and certify green buildings in Indonesia. GBCI is an affiliate of the World Green Building Council.

GBCI conducts green building certification assessments based on the Indonesian rating system assessment tool called greenship. The benefits of having greenship certificates are: (i) increase building investment value and selling points, (ii) protect the surrounding environment and participate in reducing the impact of global warming, (iii) can apply for loans to banks and other parties and (iv) get sustainable finance support by the Financial Services Authority (OJK).

Greenship is divided into six categories: (i) appropriate site development, (ii) energy efficiency and conservation, (iii) water conservation, (iv) material resources and cycle, (v) indoor health and comfort, and (vi) building environment management. The ranking levels that can be obtained from the greenship assessment results are divided into three ranks: (i) platinum with a total of at least 86 points, (ii) gold with a total of at least 67 points, (iii) silver with a total of at least 47 points, and (iv) Bronze with a total of at least 35 points.

Munara 99 Sabilulungan Building is a government office with a one-stop service system located at Jl. Al-Fathu, Soreang, West Java. Munara 99 Sabilulungan Building was built by the PUTR Office of Bandung Regency with planning consultant PT. Infra Konsulindo and contractor PT. Amber Hasya. Besides functioning as a public service mall, Munara 99 Sabilulungan Building is also targeted to become an icon of Soreang City.

A building can be said to have implemented the concept of green building if it has successfully gone through an evaluation process and has a green building certification [5]. Munara 99 Sabilulungan Building has not yet conducted and obtained green building certification. Therefore, an evaluation of green building implementation using greenship for new building v1.2 is needed to determine the application of the green building concept in the Munara 99 sabilulungan building.

The objectives of this paper are to show: (i) the level of application of the green building concept in the Munara 99 Sabilulungan Building using greenship for new buildings v1.2, and (ii) create recommendations that can be done to improve the application of the green building concept in the Munara 99 Sabilulungan building.

2. Methodology

Methodology contains about study area and greenship assessment tool for new building v1.2. The study area describes the location of Munara 99 Sabilulungan building. The greenship assessment tool for new building v1.2 is used to evaluate the implementation of green building in Munara 99 Sabilulungan Building. The descriptive method with an evaluative approach was chosen to describe and compare the existing condition of the building with the greenship assessment tool for new building v1.2.

2.1. Study Area

Munara 99 Sabilulungan Building is located in Al-Fathu Street, Soreang City, West Bandung District, West Java, specifically placed in the southern part of West Java Province at coordinates 7° 1'13.82" South Latitude and 107°31'46.51" East Latitude. Munara 99 Sabilulungan building stands on an area of 4200 m2 with 6 floors with a total of 4983 m2 building area. Map of Munara 99 Sabilulungan Building are shown in Fig. 1.

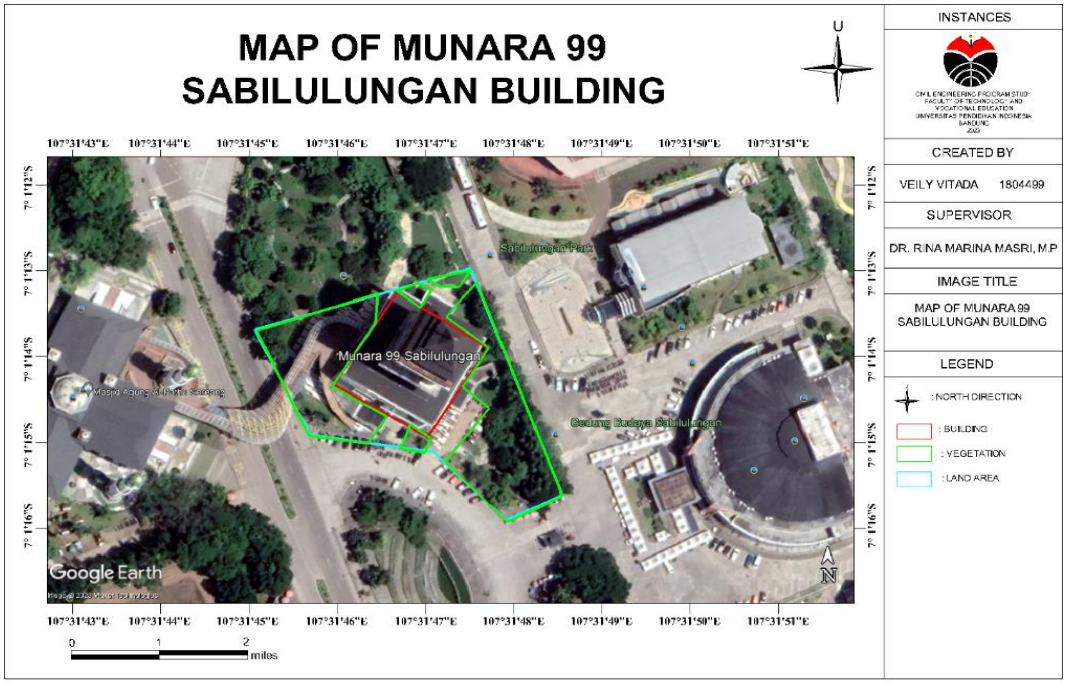

Fig. 1. Map of Munara 99 Sabilulungan Building.

2.2. Greenship for New Building v1.2

Greenship for new building v1.2 is one of the assessment tools from Green Building Council Indonesia (GBCI) that can be used to evaluate the implementation of green building concepts on a building [6]. Greenship for new building v1.2 consist of eligibility, 6 categories, 8 pre-requisite criteria and 37 credit criteria.

2.2.1. Eligibility.

Building eligibility requirements in the greenship for new building v1.2 before the assessment process is carried out [6], are : (1) the minimum area of the building is 2500 m2, (2) the building function is in accordance with the land use based on the local neighbourhood, (3) ownership of environmental impact assessment (AMDAL) and/or environmental management effort (UKL) / environmental monitoring effort (UPL) plan documents, (4) compliance of the building with fire safety standards, (5) compliance of the building with earthquake standards, and (6) compliance of the building with disability accessibility standards.

2.2.2. Apropriate Site Development.

Appropriate site development category consists of 1 pre-requisite criteria and 7 credit criteria with total 17 score. The criteria of appropriate site development category are shown in Table 1.

Table 1. Criteria of Appropriate Site Development-ASD

Criteria	Maximum Criteria Score	Description Per Category
Basic Green Area	P	1 pre-requisite criteria; 7 credit criteria
Site Selection	2	
Community Accessibility	2	
Public Transportation	2	
Bicycle Facility	2	
Site Landscaping	3	
Micro Climate	3	
Stormwater Management	3	
Total Score ASD	**17**	**16.8%**

2.2.3. Energy Efficiency and Conservation.

Energy efficiency and conservation category consists of 2 pre-requisite criteria and 4 credit criteria and 1 bonus criteria with total 26 score. The criteria of energy efficiency and conservation category are shown in Table 2.

Table 2. Criteria of Energy Efficiency and Conservation-EEC

Criteria	Maximum Criteria Score	Description Per Category
Electrical Sub Metering	P	2 pre-requisite criteria; 4 credit criteria; 1 bonus criteria
OTTV Calculation	P	
Energy Efficiency Measures	20	
Natural Lighting	4	
Ventilation	1	
Climate Change Impact	1	
On-Site Renewable Energy - BONUS	5	
Total Score EEC	**26**	**25.7%**

2.2.4. Water Conservation.

Water conservation category consists of 2 pre-requisite criteria and 6 credit criteria with total 21 score. The criteria of water conservation category are shown in Table 3.

Table 3. Criteria of Water Conservation-WAC

Criteria	Maximum Criteria Score	Description Per Category
Water Metering	P	2 pre-requisite criteria; 6 credit criteria
Water Calculation	P	
Water Use Reduction	8	
Water Fixtures	3	
Water Recycling	3	
Alternative Water Resources	2	
Rainwater Harvesting	3	
Water Efficiency Landscaping	2	
Total Score WAC	**21**	**20.8%**

2.2.5. Material Resources and Cycle.

Material resources and cycle category consists of 1 pre-requisite criteria and 6 credit criteria with total 14 score. The criteria of material resources and cycle category are shown in Table 4.

Table 4. Criteria of Material Resources and Cycle-MRC

Criteria	Maximum Criteria Score	Description Per Category
Fundamental Refrigerant	P	1 pre-requisite criteria; 6 credit criteria
Building and Material Reuse	2	
Environmentally Friendly Material	3	
Non-ODS Usage	2	
Certified Wood	2	
Prefab Material	3	
Regional Material	2	
Total Score MRC	**14**	**13.9%**

2.2.6. Indoor Health and Comfort.

Indoor health and comfort category consists of 1 pre-requisite criteria and 7 credit criteria and 1 bonus criteria with total 10 score. The criteria of indoor health and comfort category are shown in Table 5.

Table 5. Criteria of Indoor Health and Comfort-IHC

Criteria	Maximum Criteria Score	Description Per Category
Outdoor Air Introduction	P	1 pre-requisite criteria; 7 credit criteria
CO2 Monitoring	1	
Environmental Tobacco Smoke Control	2	
Chemical Pollutant	3	
Outside View	1	
Visual Comfort	1	
Thermal Comfort	1	
Acoustic Level	1	
Total Score IHC	**10**	**9.9%**

2.2.7. Building Environment Management.

Building environment management category consists of 1 pre-requisite criteria and 6 credit criteria and 1 bonus criteria with total 13 score. The criteria of building environment management category are shown in Table 6.

Table 6. Criteria of Building Environment Management-BEM

Criteria	Maximum Criteria Score	Description Per Category
Basic Waste Management	P	1 pre-requisite criteria; 7 credit criteria
GP as a Member of Project Team	1	
Pollution of Construction Activity	2	
Advanced Waste Management	2	
Proper Commisioning	3	
Green Building Submission Data	2	
Fit Out Agreement	1	
Occupant Survey	1	
Total Score WAC	**13**	**12.9%**

2.2.8. Greenship Rating Level.

Greenship for new building v1.2 rating levels are shown in Table 7 [6].

Table 7. Greenship Rating Level

Rating	Minimum Score	Percentage
Platinum	74	73%
Gold	58	57%
Silver	47	46%
Bronze	35	35%

3. Result and Discussion

3.1. Eligibility

The first step before evaluating a green building using the greenship for new building v1.2 assessment tool is the eligibility requirements. The result of building eligibility requirements Munara 99 Sabilulungan Building based on greenship for new buildings v1.2 are shown in Table 8.

Table 8. Eligibility Results

Criteria	Checklist	
	Met	No
Minimum Building Area is 2500 m^2	✓	
Building Function in accordance with Land Use Based on Local Neighbourhood	✓	
Ownership of Environmental Impact Assessment (AMDAL) and/or Environmental Management Effort (UKL) / Environmental Monitoring Effort (UPL) plan documents	✓	
Compliance of the Building with Fire Safety Standards	✓	
Compliance of the Building with Earthquake Standards	✓	
Compliance of the Building with Disability Accessibility Standards	✓	

3.2. Appropriate Site Development (ASD)

Score earned in the appropriate land use category (ASD) are 8. The result of appropriate site development category are shown in Table 9.

Table 9. Appropriate Site Development Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
ASD P	Basic Green Area	P1	✓		P
		P2	✓		P
ASD 1	Site Selection	*1	✓		1
		*2		✓	-
ASD 2	Community Accesibility	*1	✓		1
		*2	✓		1
		*3	✓		2
		*4	✓		2
ASD 3	Public Transportation	*1		✓	-
		*2		✓	-
ASD 4	Bicycle Facility	*1		✓	-
		*2		✓	-
ASD 5	Site Landscaping	*1A	✓		1
		*1B	✓		2
		*2	✓		1
ASD 6	Micro Climate	*1		✓	-
		*2	✓		1
		*3	✓		1
ASD 7	Stormwater Management	*1		✓	-
		*2		✓	-
		*3		✓	-
Total Score					**8**

3.3. Energy Efficiency and Conservation Results (EEC)

Score earned in the energy efficiency and conservation category (EEC) are 7. The result of energy efficiency and conservation category are shown in Table 10.

Table 10. Energy Efficiency and Conservation Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
EEC P1	Electrical Sub Metering	P1	✓		P
EEC P2	OTTV Calculation	P2	✓		P
EEC 1	Energy Efficiency Measures	C1-1		✓	-
		C1-2		✓	-
		C2-1	✓		1
		C2-2		✓	-
		C2-3	✓		1
		C3-1	✓		1
		C4-1	✓		2

EEC 2	Natural Lighting	*1	✓		-
		*2	✓		-
EEC 3	Ventilation	*1	✓		1
EEC 4	Climate Change Impact	*1	✓		1
EEC 5	On-Site Renewable Energy - BONUS	*1		✓	-
			Total Score		**7**

3.4. Water Conservation (WAC)

Score earned in the water conservation category (WAC) are 11. The result of water conservation category are shown in Table 11.

Table 11. Water Conservation Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
WAC P1	Water Metering	P1	✓		P
WAC P2	Water Calculation	P2	✓		P
WAC 1	Water Use Reduction	*1	✓		1
		*2	✓		7
WAC 2	Water Fixtures	*1	✓		3
WAC 3	Water Recycling	*1		✓	-
WAC 4	Alternative Water Resources	*1		✓	-
WAC 5	Rainwater Harvesting	*1		✓	-
WAC 6	Water Efficiency Landscaping	*1		✓	-
		*2		✓	-
			Total Score		**11**

3.5. Material Resources and Cycle (MRC)

Score earned in the material resources and cycle category (MRC) are 5. The result of material resources and cycle category are shown in Table 12.

Table 12. Material Resources and Cycle Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
MRC P	Fundamental Refrigerant	P1	✓		P
MRC 1	Building and Material Reuse	*1	✓		1
MRC 2	Environmentally Friendly Material	*1		✓	-
		*2		✓	-
		*3		✓	-
MRC 3	Non-ODS Usage	*1	✓		1
MRC 4	Certified Wood	*1	✓		1
		*2		✓	-
MRC 5	Prefab Material	*1		✓	-
MRC 6	Regional Material	*1	✓		1
		*2	✓		1
			Total Score		**5**

3.6. Indoor Health and Comfort (IHC)

Score earned in the indoor health and comfort category (IHC) are 5. The result of indoor health and comfort category are shown in Table 13.

Table 13. Indoor Health and Comfort Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
IHC P	Outdoor Air Introduction	P1	✓		P
IHC 1	CO_2 Monitoring	*1		✓	-
IHC 2	Environmental Tobacco Smoke Control	*1		✓	-
IHC 3	Chemical Pollutant	*1	✓		1
		*2	✓		1
		*3	✓		1
IHC 4	Outside View	*1	✓		1
IHC 5	Visual Comfort	*1	✓		1
IHC 6	Thermal Comfort	*1	✓		1
IHC 7	Acoustic Level	*1		✓	-
			Total Score		**6**

3.7. Building Environment Management (BEM)

Score earned in the building environment management category (BEM) are 7. The result of building environment management category are shown in Table 14.

Table 14. Building Environment Management Results.

Code	Criteria	Indicator	Checklist		Score
			Met	No	
BEM P	Basic Waste Management	P1	✓		P
BEM 1	GP as a Member of Project Team	*1		✓	-
BEM 2	Pollution of Construction Activity	*1	✓		1
		*2	✓		1
BEM 3	Advanced Waste Management	*1	✓		1
		*2	✓		1
BEM 4	Proper Commisioning	*1		✓	-
		*2		✓	-
BEM 5	Green Building Submission Data	*1	✓		1
		*2	✓		1
BEM 6	Fit Out Agreement	*1	✓		1
BEM 7	Occupant Survey	*1		✓	-
			Total Score		**7**

3.8. Greenship for New Building v1.2 Evaluation Results

Evaluation results of green building implementation at Munara 99 Sabilulungan using greenship for new building v1.2 get 44 score with bronze rank. Evaluation results are shown in Table 15.

Table 15. Greenship for New Building v1.2 Evaluation Results.

Category	Evaluation Score	Maximum Score
ASD	8	17
EEC	7	31
WAC	11	21
MRC	5	14
IHC	6	10
BEM	7	13
Total	**44**	**106**

3.9. Recommendations

3.9.1. Bicycle Parking Plan.

Bicycle parking calculations are carried out using a ratio of 1 bicycle parking for every 20 building employees [6]. Munara 99 Sabilulungan building employees consist of 50 employees. Bicycle parking spaces that must be met are 3. These results meet the requirements indicator of the ASD 4 criteria thus get an additional 1 point. The cost required to implement this solution is IDR 1,500,000. Bicycle parking plan of Munara 99 Sabilulungan Building are shown in Fig. 2.

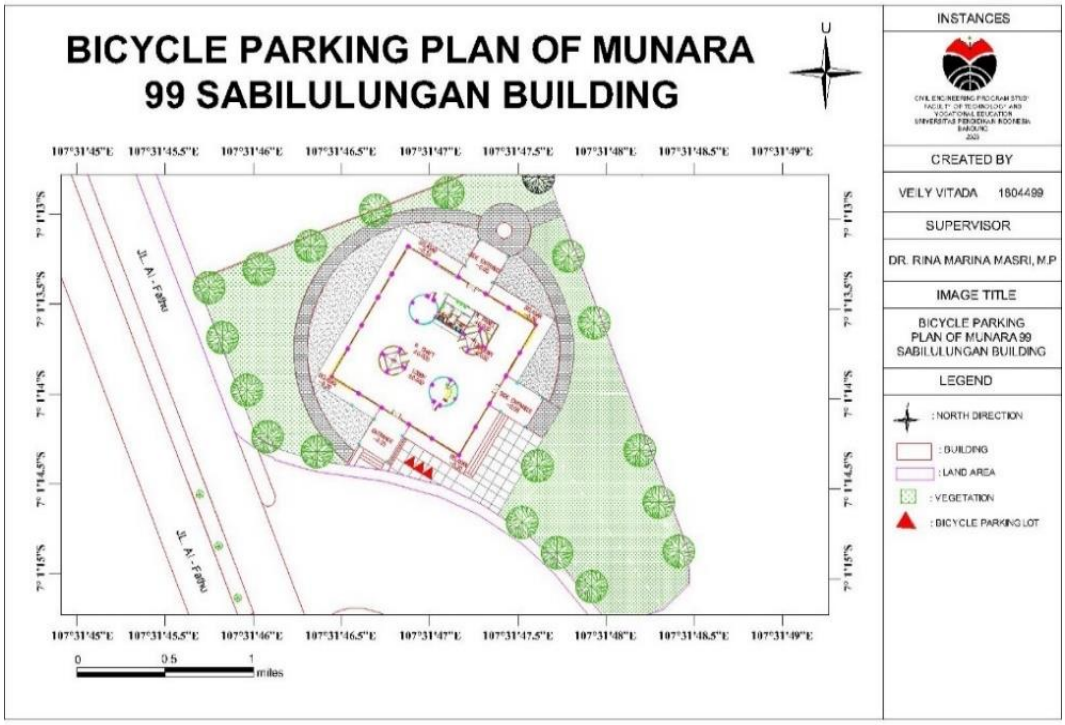

Fig. 2. Bicycle Parking Plan at Munara 99 Sabilulungan Building.

3.9.2. Roof Materials.

The recommendation to use red ceramic roofing material is to get a greater albedo value. Red ceramic roofing has an albedo coefficient of 0.35. The roof area of the building is 1350 m2, so the required red roof tiles are 33750 pieces. These results meet the requirements indicator of the ASD 6 criteria thus get an additional 1 point. The cost required to implement this solution is IDR 118,125,000. Recommended albedo value of building roof area using red ceramic roofing are shown in Table 16.

Table 18. Recommended Albedo Value of Building Roof Area.

Material	Cover Area (m2)	Albedo Coefficient	Albedo Value
Red Ceramic Roof	1350	0.35	0.31
Concrete	168	0.7	0.08
Total	**1518**	**11**	**0.39**

3.9.3. Roof Tank and Infiltration Wells.

The recommendations to use of 2 roof tanks with a capacity of 30 m3 and 3 infiltration wells with a diameter of 1 m and a depth of 2.5 m are solution to reduce rainwater runoff from the roof and building grounds to the surrounding drainage network. The percentage of rainfall runoff water handling to the surrounding drainage is 53.91%. These results meet the requirements indicator of the ASD 7, WAC 4, WAC 5 and WAC 6 criteria thus get an additional 1 point for each criteria. The cost required to implement this solution is IDR 190,500,000.

3.9.4. OTTV.

The recommendations to use of low-e solar control glass (Stopray Vision 31T) is to get the OTTV value of 32.87 watt/m2. Comparison of OTTV value of glass types used in Munara 99 Sabilulungan Building with recommended glass types are shown in Fig. 2.

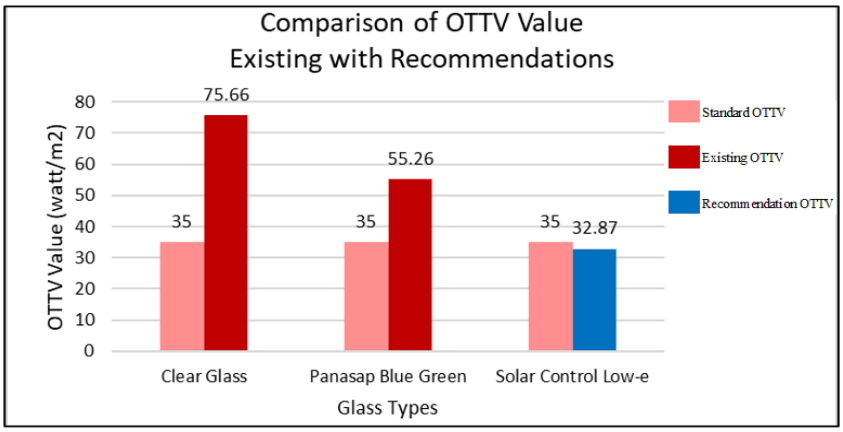

Fig. 3. Comparison Chart of Existing OTTV Value with Recommendation.

The type of glass used is solar control low-e (stopray vision 31T) with supplier PT. Asahimas. The area of glass to be replaced is 744 m2. These results meet the requirements indicator of the EEC 1 criteria thus get an additional 3 point. The cost required to implement this solution is IDR 930,000,000.

3.9.5. Solar Panel.

The recommendation to use solar panels is to reduce electricity consumption in the Munara 99 Sabilulungan Building. Munara 99 Sabilulungan Building can save energy consumption by 3% or 12.264 MWh annually by using Solterra 550 watt peak solar panels with total 36 units. These results meet the requirements indicator of the EEC 5 criteria thus get an additional 5 point. The cost required to implement this solution is IDR 400,000,000.

3.9.6. CO_2 Sensor.

The CO_2 sensor ensures the amount of fresh air in the room and maintains the CO_2 concentration below 600 ppm. The CO_2 sensor is placed 30cm above the floor surface with a coverage radius of 78m2. These results meet the requirements indicator of the IHC 1 criteria thus get an additional 1 point. The cost required to implement this solution is IDR 149,500,000.

3.9.7. No Smoking Sign.

Recommendation to put 4 no smoking signs at each building entrance. These results meet the requirements indicator of the IHC 2 criteria thus get an additional 2 point. The cost required to implement this solution is IDR 160,000.

3.9.8. Lux Meter and Sound Level Meter Tools.

Recommendation to use lux meter tool to measure the intensity of light in a room and sound level meter tool to measure the noise level in a room. These results meet the requirements indicator of the IHC 7 criteria thus get an additional 1 point and indicator of the EEC 2 criteria thus get an additional 2 point. The cost required to implement this solution is IDR 300,000.

3.9.9. Recommendations Result.

Categories that received additional score are: (1) ASD with additional 4 points, (2) EEC with additional 10 points, (3) WAC with additional 5 points and (4) IHC with additional 4 points. The final ranking of the recommendation results that can be obtained is gold with 64 points requires a cost of IDR 1,790,085,000.

4. Conclusions

We conclude that the evaluation of implementation green building in Munara 99 Sabilulungan Building using greenship for new building v1.2 received bronze rank with 44 points. Implementing the recommendations can increase the ranking to gold with 67 points requires a cost of IDR 1,790,085,000.

References

[1] L. Warlina, Manajemen Pembangunan dan Lingkungan, Tangerang Selatan: Universitas Terbuka, 2017.

[2] E. Aldrian, M. Karmini and Budiman, Adaptasi dan Mitigasi Perubahan Iklim di Indonesia, Jakarta: Pusat Perubahan Iklim dan Kualitas Udara, Kedeputian Bidang Klimatologi Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), 2011.

[3] A. Ardiansyah, "Monitoring Daya Listrik Berbasis IoT (Internet of Things)," *Journal of Electrical Electronic Control and Automotive Engineering*, vol. 3, no. 2, pp. 205-208, 2018.

[4] F. Y. Massie, A. K. T. Dundu and J. Tjakra, "Penerapan Konsep Green Building Pada Industri Jasa Konstruksi di Manado," *Jurnal Sipil Statik*, vol. 6, no. 8, pp. 553-558, 2018.

[5] A. E. Atmanto, A. D. Koesdaryanto, G. Gupita, M. Sindyartha, T. Y. Iswati and W. Setyaningsih, "Penilaian Kategori Green Building Pada Desain Bangunan Co-Working Space dan Serviced Office di Jakarta Selatan," *SENTHONG*, vol. 3, no. 2, pp. 519-528, 2020.

[6] GBCI, Greenship for New Building v1.2, Jakarta: Green Building Council Indonesia: Divisi Rating dan Teknologi, 2016.