Implementation of Green Building Concept in Office Building Jakarta

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Abstract. Green Building Concept has become popular in Indonesia. The purpose of this study was to determine the extent to which the implementation of green building principles in Office Buildings. Research Method using a GREENSHIP Rating Tools for existing building which consists of six categories; Appropriate Site Development (ASD), Energy Efficiency & Conservation (EEC), Water Conservation (WAC), Material Resources & Cycle (MRC), Indoor Air Health & Comfort (IHC) and Building & Environments Management (BEM). The results show that implementation the Green Building Concept could also made energy performance more efficient, after Implementing through Retrofitting of the Chiller System, Recycle Waste Water, Replacement of Conventional lamp to Energy Saving LED and also Training and Education to all employees and tenants. From comparing Data research before implementation of Green Building concept in 2014 and after Implementation and retrofitting in 2017 & 2018, found that Savings Cost from electricity bill payments is IDR 466,803,325.67/month (18%) and roughly will Break Event Point (BEP) for 3.86 Years and Energy Efficiency Index (EEI) from 238.8 kwh/m²/Years to 123.65 kwh/m²/Year

1. Introduction

The concept of Green Building is become popular in the world; there are several institutions that issue certifications including USGBC LEED [1] [2], Singapore BCA-Green Mark [3] and GBCI [4], this research using tool rating from green building council Indonesia (GBCI) for existing buildings. Green Building Council Indonesia (GBC Indonesia) is an independent (non-government) institution that is fully committed to educate of community in applying environmental best practices and facilitating the transformation of a sustainable global building industry [3]. GBCIndonesia has now issued 5 types of GREENSHIP, namely: GREENSHIP New Building, GREENSHIP existing building, interior green space, GREENSHIP homes and GREENSHIP neighbourhoods. GREENSHIP for existing Buildings is applied to a building that has been operating at least one year after construction. The implementation of green buildings in existing buildings is mostly related to the management and maintenance of buildings. This study took a case study of an office building in Jakarta Indonesia that has two towers; each Tower has 32 floors and 3 basements. The majority of electricity consumption is from the Ventilating Air Conditioning system 51%, Lighting System 20%, Sewage Treatment Plant 9%, Elevator 8%, Pumps 7%, Computer and others 5%. GREENSHIP Rating Tools for existing Building is grouped into six categories: Appropriate Site Development (ASD), Energy Efficiency & Conservation (EEC), Water Conservation (WAC), Resources & Cycle Materials (MRC), Indoor Air Health & Comfort (IHC), and Building & Environment Management (BEM). The award for the existing building can be seen in Table 1.
This research took a case study of an office tower in Jakarta, which in 2012 received a Gold award and planned to get a Platinum award, the achievement point in 2012 was 72 points. Detail points achieved can be seen in table 2.

Table 2. Ratings obtained by buildings in 2012 [4]

| Category                                      | Point Achieved | Available Point |
|-----------------------------------------------|----------------|-----------------|
| Appropriate Site Development                  | 8              | 16              |
| Energy Efficiency & Conservation              | 17             | 36              |
| Water Conservation                            | 19             | 20              |
| Material Resources & Cycle                    | 6              | 12              |
| Indoor Air Health & Comfort                   | 14             | 20              |
| Building & Environment Management             | 8              | 13              |
| Point Achieved                                | 72             | 117             |

Detail of Rating Tools and point available developed by GBCI for Existing Building can be seen in table 2, table 3, table 4, Table 5, table 6, table 7 and table 8.
### Table 5. Point Available for Water Conservation (WAC)

| No’s | Code | Criteria                          | Point Available |
|------|------|-----------------------------------|-----------------|
| 1    | WAC P1 | Water Management Policy          | P               |
| 2    | WAC 1  | Water Sub-Metering               | 1               |
| 3    | WAC 2  | Water Monitoring Control         | 2               |
| 4    | WAC 3  | Fresh Water Efficiency           | 8               |
| 5    | WAC 4  | Water Quality                    | 1               |
| 6    | WAC 5  | Recycled Water                   | 5               |
| 7    | WAC 6  | Potable Water                    | 1               |
| 8    | WAC 7  | Deep Well Reduction              | 2               |
| 9    | WAC 8  | Water Tap Efficiency             | 2 (bonus)       |
|      |       | **Sub Total**                    | **20**          |

### Table 6. Point Available for Resources & Cycle Materials (MRC)

| No’s | Code | CRITERIA               | Point Available |
|------|------|------------------------|-----------------|
| 1    | MRC P1 | Fundamental Refrigerant | P               |
| 2    | MRC P2 | Material Purchasing Policy | P             |
| 3    | MRC P3 | Waste Management Policy | P               |
| 4    | MRC 1  | Non ODS Usage          | 2               |
| 5    | MRC 2  | Material Purchasing Practice | 3               |
| 6    | MRC 3  | Waste Management Practice | 4               |
| 7    | MRC 4  | Hazardous Waste Management | 2               |
| 8    | MRC 5  | Management of Used Good   | 1               |
|      |       | **Sub Total**           | **12**          |

### Table 7. Point Available for Indoor Health Comfort (IHC)

| No’s | Code | CRITERIA                             | MAX POIN |
|------|------|--------------------------------------|----------|
| 1    | IHC P | No Smoking Campaign                  | P        |
| 2    | IHC 1 | Outdoor Air Introduction             | 2        |
| 3    | IHC 2 | Environmental Tobacco Smoke          | 2        |
| 4    | IHC 3 | CO2 and CO Monitoring                | 2        |
| 5    | IHC 4 | Physical and Chemical Pollutants     | 6        |
| 6    | IHC 5 | Biological Pollutant                 | 3        |
| 7    | IHC 6 | Visual Comfort                       | 1        |
| 8    | IHC 7 | Acoustic Level                       | 1        |
| 9    | IHC 8 | Building User Survey                 | 3        |
|      |       | **Sub Total**                        | **20**   |

### Table 8. Point Available for Building Environment Management (BEM)

| No’s | Code | Criteria                           | Point Available |
|------|------|------------------------------------|-----------------|
| 1    | BEM P | Operation & Maintenance Policy     | P               |
| 2    | BEM 1 | Innovations                        | 5               |
3 BEM 2 Design Intent & Owner’s Project Requirement 2
4 BEM 3 Green Operational & Maintenance 2
5 BEM 4 Green Occupancy/ Lease 2
6 BEM 5 Operation and Maintenance Training 2
Sub Total 13

Electricity Bill per month in 2014 before retrofitting can be seen in Table 9 below.

| Months      | LWBP kWh | WBP kWh | TOTAL kWh | Bills IDR       |
|-------------|----------|---------|-----------|----------------|
| January     | 1,892.760| 307.800 | 2,200.560 | 2,796,413.194  |
| February    | 1,912.320| 294.480 | 2,206.800 | 2,459,192.381  |
| March       | 2,059.440| 325.920 | 2,385.360 | 2,458,753.699  |
| April       | 2,046.600| 289.320 | 2,335.920 | 2,590,922.198  |
| May         | 2,040.120| 310.440 | 2,350.560 | 2,661,675.274  |
| June        | 2,087.400| 306.240 | 2,393.640 | 2,960,947.907  |
| July        | 1,902.480| 306.240 | 2,208.720 | 3,007,494.036  |
| August      | 2,113.680| 321.480 | 2,435.160 | 2,732,377.851  |
| September   | 2,117.760| 315.000 | 2,432.760 | 3,150,719.192  |
| October     | 2,190.000| 327.600 | 2,517.600 | 3,065,388.481  |
| November    | 2,056.080| 320.520 | 2,376.600 | 3,140,022.359  |
| December    | 2,059.440| 300.360 | 2,359.800 | 2,966,604.401  |
| **TOTAL**   | 24,478.080| 3,725.400| 28,203.480| 33,990,510.973 |
| **Average** | 2,039.840| 310.450 | 2,350.290 | 2,832,542.581  |

Researcher use Table 9 as a Base line Energy Consumption is 28,203,480 kWh / Year and the Average Electricity Payment is IDR 2,832,542,581 / month

| Sources                          | EEI (kWh/m²/year) | Years |
|----------------------------------|-------------------|-------|
| ASEAN – USAID                    | 240               | 1987  |
| ESDM & JICA Electric Power Development Co Ltd | 198.2              | 2008  |
| GBC Indonesia                    | 250               | 2010  |
| Governor's regulation / Pergub DKI Jakarta No.38 tahun 2012 Tentang Bangunan Gedung Hijau | 210-285           | 2012  |

Building’s EEI before retrofitting was 238.8 kWh/m²/year

2. Methodology
The Methods of this research can be seen on figure 1, the researcher was using Greenship rating tool developed by Green Building Council Indonesia [4] and by collection of data from January 2016 to December 2018 from an office’s building when they awarded by a Greenship’s silver rating and then made an efforts to repair (retrofit) the Ventilation Air Conditioning (VAC), Energy Management System, Water Recycle and Improving indoor air quality, utility report, electricity bill, operational expenses and capital expenditure. The research method used is qualitative and quantitative. Qualitative methods were carried out through interviews with the Building Management, literature studies, observation, and documentation. While the quantitative method aims to find relationships or explain the causes of change based on measurable facts based on numerical data, can be observed and measured. The data used in this study are primary data and secondary data. Primary data is building planning data from the consultant building planner, GREENSHIP assessment data from GBC Indonesia, and data from direct research obtained by researchers through surveys, interviews, and field
measurements. Secondary data is data collected by other parties that have been documented so that it can be used by other parties (researchers)

![Methodology Diagram](image)

### 3. Result and Discussion

#### 3.1 Repair / Retrofit

3.1.1 **Physical / infrastructure improvements by retrofitting**

Improvements are made to improve the Energy Efficiency Index (EEI) [5], water consumption index [5] and air circulation system

Item Repair & Retrofit and its costs can be seen in table 11 below

| Item Retrofit                                                                 | Category                      | Cost (IDR)    |
|------------------------------------------------------------------------------|-------------------------------|---------------|
| Replacement of 4 Chiller Units (3 1000 TR Units and 1 Unit 500 TR) Type Screw Compressor with more energy-efficient centrifugal type | Energy Efficiency & Conservation | 16,577,000,000 |
| Improvements to the wastewater system so that it can be                      | Water Conservation            | 1,800,000,000  |

Figure 1. Methodology
used for cooling tower's make up water

| Replacement of conventional lights with energy-efficient LEDs [6] | Energy Efficiency & Conservation | 3.250.000.000 |
|---------------------------------------------------------------|--------------------------------|---------------|
| TOTAL COST                                                   |                                 | 21.627.000.000 |

### 3.1.2 Energy Efficiency Index (EEI)

Result of EEI can be seen in table 11 below

| Area (m²) | kWh/Years | EEI (kW/m²/Year) | Remark |
|-----------|-----------|------------------|--------|
|           | 2014      | 2018             |        |
| 203.195   | 28,203,480| 25,125,360       |        |
|           | 238.8     | 123.65           |        |

From table 12 EEI can be reduce from 238.8 kWh/m²/year to 123 kWh/m²/year, it means building has more efficient in energy consumption

### 3.1.3 Chiller Performances

Retrofit results can be seen from the performance of the chiller efficiency which can be seen in Figure 1 below, from the picture it is found that the old COP chiller is 3.8 and the new COP chiller is 5.0 or there was an improvement of about 25%

![Comparison of Coefficient Of Performance (COP) Old Chiller & New Chiller](image)

Chiller Efficiency Comparison can be seen in table 13 below, from the table it is known that the old Chiller to get a cooling of 1 Ton of Refrigeration (TR) requires energy of 1.63 kW, while for the new Chiller to get a cooling of 1 Ton of Refrigeration (TR) energy is needed at 0.89 kW, meaning that with the new chiller we get savings of around 50% compared to the old chiller.

| Chiller Plant     | Efficiency |
|-------------------|------------|
|                   | Old Chiller (kW/TR) | New Chiller (kW/TR) |
| Chiller (A)       | 0,95       | 0,53          |
| Pump CHWP (B)     | 0,3        | 0,15          |
| Pump CWP (C)      | 0,3        | 0,15          |
| Cooling Tower (D) | 0,08       | 0,04          |
| Sistem Effisiensi | 1,63       | 0,89          |
| (A+B+C+D)         |            |               |
3.1.4 Waste Water Recycle and Water Balances
Recycling results of wastewater can be seen in the building water balance, where an average of 71% of waste water is reused for Make-up water cooling Tower and gardening.

![Building Water Balance Diagram]

3.2 Electricity Bill after Retrofit
Electricity bills can be compared before and after retrofit, electricity bills after retrofit in 2017 can be seen in Figure 5 and figure 5, electricity bills continue to decline due to continued retrofit of conventional lamp replacements with energy-saving lamps (LED). Researcher using electricity bill to calculate Return on Investment (ROI).
Figure 4. Average Electricity Consumption kilowatt Hour (kWh)/month

Figure 5. Average Electricity Bill (Rp)/month

Table 14. Electricity bills in 2018

| Months    | kWh     | TOTAL kWh | Bills (IDR)  |
|-----------|---------|-----------|--------------|
|           | LWBP    | WBP       |              |
| January   | 1,932,360.00 | 283,200.00 | 2,215,560.00 | 2,500,101,165.00 |
| February  | 1,688,400.00 | 252,840.00 | 1,941,240.00 | 2,193,040,256.00 |
By comparing Payment of Electricity bills before and after Retrofit, we can compare it from table 9 and table 14, it can be seen that the difference in electricity payments = IDR. 2,832,542,581 - IDR. 2.365,739,255, 33 = IDR. 466,803,325,67 / month, From Table 11 it is found that the retrofit Cost is IDR 21,627,000,000.00 so Estimated Return of Investment = (IDR 21,627,000,000 / IDR 466,803,325,67) = 46,33 months or 3.86 Years

3.3 **GREENSHIP Rating**

| No’s | Category                              | Point 2012 | Point Plus | Point 2017 |
|------|---------------------------------------|------------|------------|------------|
| 1    | Appropriate Site Development           | 8          | -1         | 7          |
| 2    | Energy Efficiency & Conservation       | 17         | 13         | 30         |
| 3    | Water Conservation                     | 19         | 0          | 19         |
| 4    | Material Resources & Cycle             | 6          | -1         | 5          |
| 5    | Indoor Air Health & Comfort            | 14         | 2          | 16         |
| 6    | Building & Environment Management      | 8          | 2          | 10         |

|                   | Point Achieved | Award   |
|-------------------|----------------|---------|
|                   | 72             | GOLD    |
|                   | 15             |         |
|                   | 87             | PLATINUM|

After retrofitting, GREENSHIP Rating increased and received the Platinum Awards with 87 Points.

4. **Conclusions**

Implementing of the building concept not only strengthen the brand image of the building by achieving platinum award but also saving operational costs for building management, in the case study of an office building in Jakarta, after retrofitting the VAC system by replacing the chiller, Recycle waste water, Replacing less efficient light with Energy Saving lights and also training to all employees and tenants can reduce the electricity bills average Rp. 466,803,325,67/month (or around 18% from building consumption) and roughly Return on Investment (ROI) is 3.86 Years.

**Future Research**

High-rise buildings still have a lot of potential for further research by installing renewable energy plants such as the installation of solar power plants (solar panels) [7] by utilizing the roofs or facades of buildings and also utilizing the gravitational potential of clean water systems and VAC systems (micro hydro).
References

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