

# Development of Information Systems for Increasing Time Performance in the Construction of Green Buildings in Indonesia

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The problem raised in this research is the current use of energy continues to increase along with technological developments and distributed in the world. Therefore, the Government issued Minister of Public Works and Public Housing Regulation No. 02 / PRT / M / 2015 concerning Green Building which regulates permits to build office buildings in office buildings so that more offices can be developed in Indonesia. In addition, Indonesia also has a system for Green Buildings called Green Buildings which is a standard in Green Buildings issued by the Green Building Council of Indonesia. To overcome this, a pre-green building appraisal system in Indonesia has been created so that companies that do not understand the criteria and assessment criteria will know about it. The application system is made to be able to load building applications in Indonesia, reducing the design time and automation of the counting system is easier and more effective than using manuals, while also reducing the percentage increase in the time of the final assessment. This application makes it easy for users to determine the expected building requirements in accordance with the system requirements and green building requirements in Indonesia.

**Keywords:** Green building, Approval and requirements system, Pre-assessment, Automation

**Article History****Article Received:** 11August 2019**Revised:** 18November 2019**Accepted:** 23January 2020**Publication:** 10 May2020

## I. INTRODUCTION

The Government issued the Minister of Public Works and Public Housing Regulation No. 02 / PRT / M / 2015 concerning Green Buildings which are intended as guidelines for building operators in carrying out green building construction or the so-called green building. Energy Saving Building or known as the Green Building continues to be promoted as one of the anticipatory steps to global climate change <sup>[1]</sup>. The fact that buildings and buildings built in Indonesia are the third largest energy users, with a portion of about 30% of the total national energy consumption. If not managed properly, energy consumption from buildings and buildings has the potential to increase to 40% of total energy consumption by 2030 <sup>[2]</sup>. In building buildings, many other countries have adopted the following green buildings, several countries that have implemented green building<sup>[3]</sup>:

Country Name	Year	Number of Green Building
USA	1998-2002	13.000
ISRAEL	2005-2013	45
CHINA	2005-2014	1.500
SOUTH KOREA	2008-2012	53
MALAYSIA	2009-2013	61
INDONESIA	2009-2015	18

So, it can be seen in table 1 that Indonesia is still lagging behind other countries in building green buildings as their function can reduce the use of energy consumption and other functions:

According to Ervianto (2009), the benefits of green building ownership:

1. Low operational costs, as a result of efficiency in the utilization of energy and water.
2. More comfortable, because the temperature and humidity of the room is maintained.

**Table I. Green Buildings in several World Countries**

3. Development must pay attention to the choice of materials which contain relatively few chemicals.
4. Air circulation system that is able to create an environment in a healthy space.
5. Easy and inexpensive to replace various building components
6. The maintenance and care costs are relatively low [4].

With the existence of a green building can reduce national energy consumption and bring many other benefits, besides that green building maintenance is also not too expensive compared to conventional buildings although construction costs are more expensive 5-7% but building maintenance will be cheaper and easier to care for. Each country has a different Green Building evaluation system, for example there are countries:

1. Amerika Serikat, Leadership in Energy and Environmental Design (LEED).
2. Inggris, Building Research Establishment Environmental Assessment Method (BREEAM).
3. Jepang, Comprehensive Assessment system for Built Environment Efficiency (CASBEE).
4. Australia, Green Star
5. Singapura, Green Mark
6. Malaysia, GB Index
7. Indonesia, Green Building Council Indonesia (GBCI).

In Indonesia, the rating system is called Greenship which, Greenship is a rating system that can be used as a guide for construction industry players to achieve a measurable green building standard that can be understood by building users. The standard to be achieved in implementing Greenship is the realization of an environmentally friendly green building from the planning, construction, to the day-to-day operations and maintenance. Greenship was only published in 2010 and to date there are two assessment systems namely valuation for new buildings and existing buildings. The Greenship assessment category also has various rating ratings consisting of 6 types of classifications including:

1. Appropriate site development /ASD
2. Energi efficiency and conservation/EEC
3. Water conservation/WAC
4. Material Resources and Cycle/MRC
5. Indoor air health and comfort/IHC
6. Building and environment management/BEM) [5].

Departing from the philosophy of sustainable design, green building is a building concept that focuses on saving land, materials, energy, water, air quality and waste management. Green building elements include:

- a. Land: Appropriate land development does not use all available land for building but provides 30% of the total land for catchment areas.
- b. Material: Material is obtained locally to reduce transportation costs. Materials are used using green specifications that are included in the life cycle analysis list such as energy produced, material durability, waste minimization, use of certified wood, and the ability to be recycled.
- c. Energy: Planning for optimal air circulation management to reduce the use of air conditioning by optimizing sunlight for daytime lighting. Green buildings also use solar power and wind turbines as alternative electricity producers.
- d. Water: Green building reduces water use by using STP (Sewerage Treatment Plant) to recycle water from household waste so that it can be used again for toilets, watering plants and others. Green buildings also use water-saving equipment such as low-pressure showers, automatic faucets (self-closing or spray tubs), and low-flush toilet tank tanks that can basically regulate the use of water in buildings as economically as possible.
- e. Air: Green building uses materials and non-toxic products that will improve indoor air quality and reduce the level of asthma, allergies and sick building syndrome. Green building uses emission-free and resistant materials to prevent moisture from producing spores and other microbes. Air quality in the room also has to be supported by using an effective ventilation system and moisture control materials that allow the building to breathe.
- f. Waste and Environmental Management: Green building also includes aspects of environmental management and local waste management. Some of the design criteria include the use of certified wood material to support forest maintenance management, the use of material designed to be disassembled and reassembled and recycled / reused in its final function, the use of materials from renewable resources and waste management, both solid and liquid friendly environment [2].

In the latest Greenship version 2.0, the author focuses more on the category of new buildings, how to get a green building through the requirements stated in the Green Building Council Indonesia and there are also

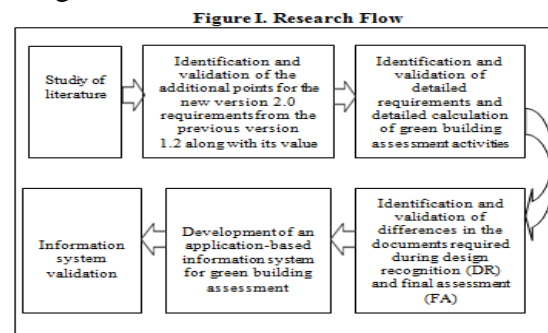
points in the requirements, therefore Building owners who want the building to be The green building must first register the building with the Green Building Council Indonesia before entering the construction stage. If the building owner does not register the building in advance, but wants the building to become a green building, then it is unlikely that the building that the building owner is building is a green building that is environmentally friendly, because there are many requirements and points that are not yet known to the building owner or the general public in build green buildings that are environmentally friendly. Therefore the author focuses more on building new buildings so that many building owners are interested in building their buildings into green buildings that are more energy efficient, environmentally friendly and easy to maintain. This is the author's attraction, because in registering the building the building owner needs to register the building and consult the Green Building Council Indonesia at a fixed price.

The purpose of the author about Green Building research is because there is no application system in the assessment and requirements of this Green Building, especially in Indonesia, then there is no system that accelerates and facilitates the assessment system in the Indonesian green building council, especially at the pre-assessment stage where the stage before the final assessment, because This assessment is important to assess the extent to which the requirements that we have met whether or not have met the points that must be achieved in the Green Building Council of Indonesia. In addition this application will also help the building owner in designing the building into a green building because the application is equipped with requirements, points then explanations so that users can understand the purpose of these requirements in addition there is also equipped with a calculation formula and then some required indicators and how to calculate it to meet the desired points.

## II. METHOD

This study consists of several validations, first determining the components of work to be discussed in the application, then the next step is determining what documents must be uploaded along with the points, then in the calculation section using the formula, the formula will be included along with calculating it with the indicator tables if needed and other explanations that have not been explained in

detail before. The next step is to develop an application-based information system for the assessment system in the green building. The following is a research flowchart:



## III. RESULT AND DISCUSSION

The first validation is to validate the new points of version 2.0 which were not previously in the previous version which is version 1.2 where there are additional other requirements. To fulfill these points there are also documents that must be uploaded besides there are also calculations that must be calculated, here is an example of an upgrade from version 1.2 to version 2.0:

**Table II. Example of upgrading requirements from version 1.2 to 2.0**

Appropriate site development		
ASD P1	Site Development Resilience	
<b>Aim</b>		
	Reducing the burden on environmental drainage systems from the quantity of rainwater runoff with an integrated rainwater management system.	
<b>Benchmarks</b>		
1A	Reduction of rainwater runoff volume load to the city drainage network from the building location up to 85%, which is calculated using the rainfall intensity value	1

From the table above it is known that reducing the volume of rainwater runoff to the city drainage network from the building location up to 85%, in the previous version of 1.2 only 50% of these things needed validation in terms of calculations and what documents needed to be uploaded. In addition there are requirements in the previous version that did not exist then added to the latest version 2.0, here are examples of requirements that do not yet exist:




**Table III. Example of upgrading requirements from version 1.2 to 2.0**



Building and environment management		
BEM 5	Submission of Green Building Data	
Aim	Completing the database of green building implementation in Indonesia for Sharpen research standards and materials.	
Benchmarks		
1	Give a statement that the building owner will submit data on the implementation of green building (energy, water and waste) from the building within 12 months after the date of certification to GBC Indonesia.	2

From the statement of table 3. That these requirements are not yet in the Green Building Council Indonesia requirements in version 1.2, therefore the author needs to validate the new requirements in version 2.0. The next stage is the identification and validation of the detailed requirements and calculation examples so that users or developers who use this application understand their use and do not need to ask questions or open a guidebook, therefore an example calculation is needed along with the indicator tables needed in the calculation. The following sample calculations are included in the Green Building application:

**Figure II. Example problems and formulas**

Tipe Tanaman	Luas Tajuk Tanaman berdasarkan		Keterangan
	Tampak Atas	Tampak Depan	
Pohon			Luas tajuk tanaman = $(\frac{1}{4}\pi D^2)$
			Luas tajuk tanaman = $(\frac{1}{4}\pi D^2)$

Contoh perhitungan

Suatu proyek bangunan baru (konstruksi baru) dibangun pada lahan 10000 m<sup>2</sup>. Footprint bangunan 7000 m<sup>2</sup> dengan letak basement tepat persis di bawah gedung. Luas lahan hijau sebesar 2000 m<sup>2</sup> dan sisanya perkerasan jalan. Pada lahan hijau tersebut ditanam 20 pohon kamboja Bali dan 15 pohon ketapang kencana.

Untuk memenuhi tolok ukur 1, perlu dilakukan perhitungan apakah area lansekap berupa vegetasi (*softscape*) yang bebas dari struktur bangunan dan struktur sederhana bangunan taman (*hardscape*) di atas permukaan tanah atau di bawah tanah memenuhi 10 % dari luas total lahan (10 % × 10000 m<sup>2</sup> = 1000 m<sup>2</sup>). Luas lahan hijau proyek 2000 m<sup>2</sup> > 1000 m<sup>2</sup>, maka dari perhitungan didapatkan bahwa proyek **memenuhi** prasyarat ASD tolok ukur 1.

Selanjutnya untuk memenuhi tolok ukur 2, dilakukan perhitungan komposisi tanaman. Dari luas lahan hijau yang dipersyaratkan pada tolok ukur 1, dihitung apakah komposisi tanaman yang disediakan memenuhi 50 % dari lahan hijau tersebut (50 % × 2000 m<sup>2</sup> = 1000 m<sup>2</sup>). Perhitungan komposisi tanaman dilakukan dengan menjumlahkan luas tajuk tanaman yang terdapat di lahan hijau. Rincian perhitungan komposisi tanaman dapat dilihat pada Tabel 5 dibawah ini:

Tabel 5. Contoh Perhitungan Komposisi Tanaman

Nama Tanaman	Jumlah Tanaman	Diameter (m)	Luas Tajuk (m <sup>2</sup> )	Jumlah Luas Tajuk (m <sup>2</sup> )
Kamboja Bali	20	7	38.47	769.4
Ketapang Kencana	15	4.5	15.9	238.5
Total luas tajuk tanaman				1007.9

Dari perhitungan diatas didapatkan total luas tajuk tanaman 1007.9 m<sup>2</sup> > 1000 m<sup>2</sup>, maka komposisi tanaman pada area lansekap tolok ukur 1 mencapai lebih dari 50% dan proyek **memenuhi** prasyarat ASD P tolok ukur 2.

The first validation result is determining the Green Building Council Indonesia assessment indicators by validating the Green Building experts by stages:

1. Determine what requirements must be fulfilled in the Green building council in Indonesia
2. Determine what documents must be submitted or uploaded to qualify for the Green House either for Design Recognition or for Final Assessment
3. Determine the Formulas and Table coefficient requirements for calculating calculations

Then after the validation of the next stage experts determine the application-based information system model, the development of this application makes it easier for users to create buildings that are environmentally friendly and based on green buildings. This application uses unity software, unity 3D application is a game engine is a software processing images, graphics, sound, input, and others intended to create a game, although it does not always have to be for games. The advantage of this game engine is that it can make 3D and 2D based games, and is very easy to use. With Unity3D, you can create 3D games, FPS and 2D games and even Online Games, other features about Unity are as follows:

1. Create 2D / 3D Games
2. Making FPS Games
3. Making Online Games.
4. Conversion Support: Mobile Android, Iphone, Blackberry, Windows, Linux, Flash, Webplayer
5. Online Publish Google Play, Android market
6. Support code: C #, Javascript and Boo
7. Support file extensions, 3ds, obj, fbx

Background why using the Unity3D application Because Unity3D is a popular negine game to date, Unity3D users very much make programmers able to work together to solve a problem, this application can be in 3D form and therefore it matches the application concept that will be created using 3D animation later This application is lighter than other game engines and can be installed on a computer, laptop or smartphone in its use the user does not need to bother running the application. This application system is also made offline because if it is made online then a data server is required and in opening documents, another program is needed to open it, besides that, the data security system of the uploaded Building must also be safe so that it is not abused so

this application uses an offline system. users want to use this application can be downloaded on the website [Gedunghijau.com](http://Gedunghijau.com) for free on the website will contain an explanation of the green building requirements and knowledge about green buildings, especially in Indonesia. Following is an example of the initial appearance of the green Building Simulation application:

**Figure III. The initial appearance of the Green Building Simulator**

At the start screen there are several options that must be filled by the user, as follows:

1. Select the type of assessment

There are types of assessment options namely design recognition and final assessment, users can choose both.

A. Design Recognition

The project team had the opportunity to get a temporary award for the project at the design and planning finalization stage based on the Greenship assessment tool. This stage is passed as long as the building is still in the planning stage. This stage can provide benefits for the project including:

- Give awards at the design stage that can function as part of marketing the property you have.
- Provide a temporary assessment of the performance of the building at the design and planning stage which serves as an evaluation both for improvement and maturation in the next process and
- Projects will become more targeted and more secure in achieving the Green Building predicate for the final assessment stage

B. Final Assessment

At this stage, the project is assessed as a whole both in terms of design and construction and is the final stage that determines the overall building performance.

1. Project Name

Filled by the user with the name of the project being worked on

2. Project Location

Project location at work

3. Building Owner

The owner of the building in the project is owned by individuals or companies

4. Building Function

Function of building designation

5. Number of Floors

Filled The number of floors and basements consists of several levels

6. Land Area

Land area owned to build buildings and other facilities

7. Gross Floor Area

Is the total floor area of the entire building calculated from the structure of the outer wall without reducing openings, including balconies and mezzanines. But in the calculation does not include the carpark area.

8. Net Floor Area

The internal unit area includes a balcony inside the unit and a private lobby elevator inside the unit.

9. AC system

AC system used in buildings.

The next step after filling in the personal data and data about the project, the building eligibility is required as follows:

1. Minimum building area is 2500 m<sup>2</sup>
2. Willingness of building data to be accessed by GBC Indonesia related to the certification process
3. The function of the building is in accordance with the allotment of land based on the local RTRW
4. AMDAL ownership and / or environmental management effort plan (UKL) / environmental monitoring effort (UPL)
5. Building compatibility with fire safety standards
6. Compatibility of buildings with earthquake resistance standards
7. Conformity of the building to the accessibility standard of the disabled <sup>[7]</sup>.

The following is a sample drawing of the detailed requirements to fill in the building's eligibility

**Figure IV. Building Eligibility Display**

**Data Proyek**

Nama Proyek : South Jakarta Mall  
Lokasi : South Jakarta

Pemilik Bangunan : Mr.Rifaldi  
Fungsi Gedung : Mall and apartment  
Jumlah Lantai : 10 Lantai 2 Basement  
Luas Lahan : 7500 m2  
GFA : 3000 m2  
NLA : 4500 m2  
Sistem AC : Centrifugal water cooled chiller

**1. Kelayakan (Eligibility)**

Sebelum melalui proses sertifikasi, proyek harus memenuhi kelayakan yang ditetapkan oleh GBC Indonesia. Kelayakan tersebut antara lain:

1. Minimum luas gedung adalah 2500 m2

Pada tahap registrasi dokumen yang dibutuhkan adalah:

Dokumen perencanaan ( minimal tahap desain skematik ) yang menunjukkan denah gedung yang disertai dengan rincian luasan per lantai.

2. Kesiapan data gedung untuk diakses GBC Indonesia terkait proses sertifikasi

Pada tahap registrasi dokumen yang dibutuhkan adalah:

Dokumen pernyataan bahwa data gedung yang akan disertifikasi akan dapat diakses oleh gbc indonesia.

In the building eligibility requirements there are documents that must be uploaded to be able to fill the next requirements whether the building's eligibility meets the Green Building Council Indonesia standards and the uploaded documents can be all files starting from word, excel, pdf, jpg or others. Following is an example of uploading a building eligibility document file:

Figure V. Sample Upload of Eligibility Documents

After completing the eligibility documents there will be a next stage which is filling the requirements

1. Appropriate Site Development = 21 points
  2. Energy Efficiency and Conservation = 31 points
  3. Water Conservation = 23 points
  4. Material Resources and Cycle = 13 points
  5. Indoor Health and Comfort = 14 points
  6. Building Environment Management = 19 points
- The total of 121 points

The translation of values in each category according to stages can be seen in the following table:

Table IV. Example of upgrading requirements from version 1.2 to 2.0

Category	Total Value for DR			Total Value for FA		
	Precondition	Credit	Bonus	Precondition	Credit	Bonus
ASD	--	17		--	17	
EEC	--	26	5	--	26	5
WAC	--	21		--	21	
MRC	--	2		--	14	
IHC	--	5		--	10	
BEM	--	6		--	13	
Number of Criteria and Bench marks	--	77	5	--	101	5

Each category contains several criteria that have different types, namely:

**The prerequisite criteria** are the criteria that exist in each category and must be met before further assessments are based on credit criteria and bonus criteria. The prerequisite criteria represent the minimum standard for environmentally friendly buildings. If one of the requirements is not met, the credit criteria and bonus criteria in all categories cannot be assessed. These prerequisite criteria don't have values like other criteria.

**Credit criteria** are criteria that exist in each category and do not have to be met. Fulfillment of these criteria is certainly adjusted to the capabilities of the building. If this criterion is met, the building in question is rated and if not met, the building in question will not be scored.

**Bonus criteria** are criteria that allow giving added value. Aside from not having to be fulfilled, its achievements are considered quite difficult and rarely occur in the field. The bonus value does not affect the Greenship's maximum value, but it still counts as an achievement value. Therefore, buildings that can meet the bonus criteria are considered to have their own achievements. In the requirements that are met there are score points that accumulate when filling in all required documents and questions asked, the green building is divided into several levels as follows:

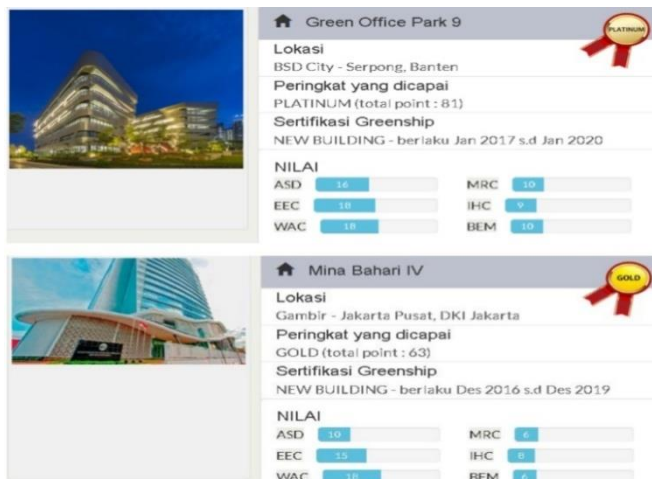
Table V. Green Building Points Level

LEVEL	POINT	
	MINIMUM	PERCENTAGE (%)
PLATINUM	86	73



GOLD	67	57
SILVER	54	46
BRONZE	41	35

At the end after completing the documents and answering questions around the green building, the user will get a certificate for the building category, there is a platinum for the highest score, gold, silver and bronze, the greater the points obtained the better the green building because it has completed several important documents related to the green building.



Gambar VI. ContohSertifikat Gedung Baru

#### IV. CONCLUSION

From the results of the validation produced several components of green building requirements for new buildings by using an application-based information system that can improve time performance and facilitate users in using the application and increase knowledge about green buildings. The existence of this green building application is an application that can be used to measure self-assessment before heading to the assessment conducted by the Green Building Council Indonesia in order to reduce the percentage of failures in green building certification, besides it is expected that there will be an application development after this if this application is deemed incomplete.

#### REFERENCES

- [1] General. PUPR Minister Regulation Number 02 / PRT / M / 2015 concerning Green Building, Jakarta. 2015
- [2] AlaydrusHadijah, (2019). "Green buildings in Jakarta can save energy up to 80%". Indonesia
- [3] Shi, Q, et. Al (2015). "Objective conflicts in green building projects: A critical analysis: Journal of Building and Environment 96, 107-117".
- [4] Ervianto. Wulfram I. 2009. Construction Project Management. Jakarta: GrahaIlmu Publisher
- [5] GBCI. (2010). Guide to Implementing Green Building Appraisal Tool GREENSHIP Version 1.0, Jakarta: PT Pembangunan Perumahan.
- [6] Abduh, M., and Fauzi, R.T. (2012). The Contribution of Green Construction to the Creation of Green Buildings, Proceedings of the Seminar: "The Concept of Green Buildings and Earthquake Resistant Buildings in Indonesia". IPR, July 11, 2012.
- [7] GBCI. (2013). Guide to Implementing GREENSHIP Green Building Appraisal Version 1.2, Jakarta: PT Pembangunan Perumahan.