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Towards achieving Platinum standards for Green Building certification: a case study using Jakarta International Stadium (JIS) design

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Abstract. Jakarta International Stadium (JIS) will be the largest FIFA-standard stadium in Indonesia equipped with 82,000 seating capacities, two training pitches, and retractable roof on its top. Parking lots will be limited in numbers; however, many modern public transportation systems will pass over the area to encourage people not to use private vehicles. As the Project Owner, PT. Jakarta Propertindo (Perseroda) has set the target to achieve Platinum-standard in Green Building. As of mid-July 2021, JIS was still under construction with the actual progress of around 64 %, however, its design has met the sustainability's highest requirements as Green Building Council Indonesia (GBCI) has awarded Greenship platinum to JIS' design with the score of 81.8%. The final assessment (FA), which includes on-site measurement and verification, will be performed after the construction is completed. This research is aimed to measure the efficacy of Greenship grade in Indonesia's sustainable building design by comparing it with another international rating system. LEED (Leadership in Energy and Environmental Design) from U.S. Green Building Council (USGBC) which is famous to its stringency in energy performance assessment, was chosen to be another benchmark for this project. The result shows that if LEED criteria were applied at JIS, the design could score up to 77.4% which meet the conditions for platinum level.

Keywords: JIS, Greenship, LEED, sustainability, platinum

1. Introduction

Jakarta, the capital of Indonesia, is the second-most populated urban area in the world [1]. It consists of five administrative cities and an administrative regency, they are Jakarta Pusat (Central Jakarta), Jakarta Utara (North Jakarta), Jakarta Timur (East Jakarta), Jakarta Selatan (South Jakarta), Jakarta Barat (West Jakarta), and Kepulauan Seribu (the thousand islands) regency [2]. North Jakarta which was once the famous central business district for hundreds of years [3], becomes the city that has the largest number of populations living under poverty line in Jakarta [4]. To improve people's quality of life and economic sector, sustainable development that people-oriented and accessible must be provided [5].

To accelerate the urban development of North Jakarta, The Government of the Province of Jakarta has mandated its Province-owned company (Badan Usaha Milik Daerah) PT. Jakarta Propertindo (Perseroda) or Jakpro to build Jakarta International Stadium (JIS), a FIFA-standard compliance stadium that will be integrated with intermodal modern public transport services to ease urban mobility and connectivity so that it could be a catalyst in generating new economic sectors and enhancing the existing



ones. Described as the smart and futuristic stadium, it is also expected to be a center of attraction for international tourism and hospitality that provides positive impacts on sustainable economic growth. The roof main truss structure, which has weight of 3,900 tons with the diameter of around 270 m, was lifted at once up to the height of 70 m using the strand jacks located on its 16 lifting points. This lifting method has not only made a new record in the construction world, but also constructive contribution to the national pride and spirit, especially during the global pandemic.

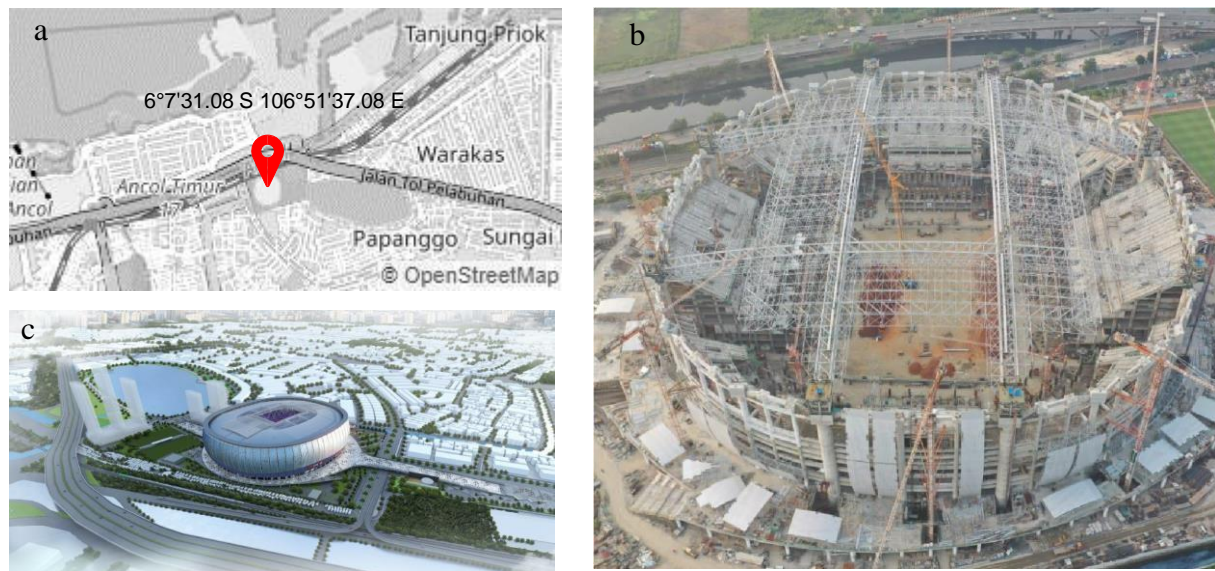


Figure 1. (a) Location of JIS (courtesy of openstreetmap.org).
(b) JIS' progress as of mid-July 2021 [9]. (c) 3D image illustration of JIS [9].

Climate changes and global pandemic might be correlated from cause-and-effect perspective. The greater global warming effect, the higher risk of getting transmitted according to mathematical models [6]. Fortunately, a strict commitment to reduce the effect of global warming has been pledged by the

Indonesia's Capital, almost a decade before the virus spread. Jakarta has set a target to reduce 30% of GHG (greenhouse gas) emissions and conserve 30% of energy and water [7]. As of March 2021, Jakarta has successfully 26% of GHG emission, and it is replanned to reduce 50% of GHG emission by 2030, then becomes net-zero emission by 2050 [8]. To in line with the Government focus on sustainable development, JIS is designed to reach the highest level (platinum grade) in green building requirements. In April 2021, JIS has successfully passed the design recognition (DR) evaluation with the score of 81.8% (63 out of 77) and achieved Greenship Platinum level according to Green Building Council (GBCI). The final assessment (FA) is planned to be performed in 2022 after the construction is completed and the stadium is in operational. JIS' annual energy consumption is calculated at around 2,300 MWh [10] which is much lower than that of Allianz Arena in Munich that is over than 14,500 MWh (electricity only, without heating fuel) [11]. But how well JIS design will perform in other international rating system, such as LEED (Leadership in Energy and Environmental Design) which is famous to its stringency in energy efficiency?

2. Literature review and methodology

Previous investigation to compare rating systems was performed among LEED (US), BREEAM (Building Research Establishment Environmental Assessment Method - UK), and Green Star (Australia) for eight-story building in Dubai which has hot desert climate. Based on the presented simulation results, the energy performance of a building and the corresponding energy rating obtained are strongly dependent on the assessment scheme used, and in that case, LEED is the most stringent rating system

among the others when it comes to energy efficiency [12]. However, when a study was carried out between LEED and BREEAM for the actual buildings in two different countries in the cooler regions (UK and Denmark) which have temperate climate, BREEAM was found to be more demanding than LEED [13].

Comparison between two green building rating systems (Greenship and LEED) for JIS project is the focus in this paper to better understand which assessment method give more impact in sustainability. As briefs, LEED is more focus on energy efficiency, indoor well-being, and site location compared to Greenship, however Greenship weighs water conservation more than LEED (see Figure 2). It is understandable since Jakarta has major problem with flood due to the rise of sea level caused by climate change, and land subsidence caused by extreme ground water extraction [14] [15]. It should be noted that this paper is not trying to compare which rating system is more suitable for Jakarta, but rather measuring the sustainability level of the Stadium from other perspective.

It is well-known that the green building full assessment for new construction category cannot be performed until the project is completed and the building is fully operational because it needs to verify the ventilation and air conditioning systems and all construction materials (including finishes). As of September 2021, the construction progress has reached 70%, and the soft opening ceremony is planned by the end of 2021. It means that the final green building evaluation on JIS, using any rating type, could not be performed right now. This stage limitation does not mean that the design part cannot be verified. By evaluating the design stage and grading it, the design engineer would be challenged and motivated to do better without waiting the project completion stage. Therefore, the evaluation will be concentrated only on the design part, and some points that related to on-site verification and measurement would be omitted.

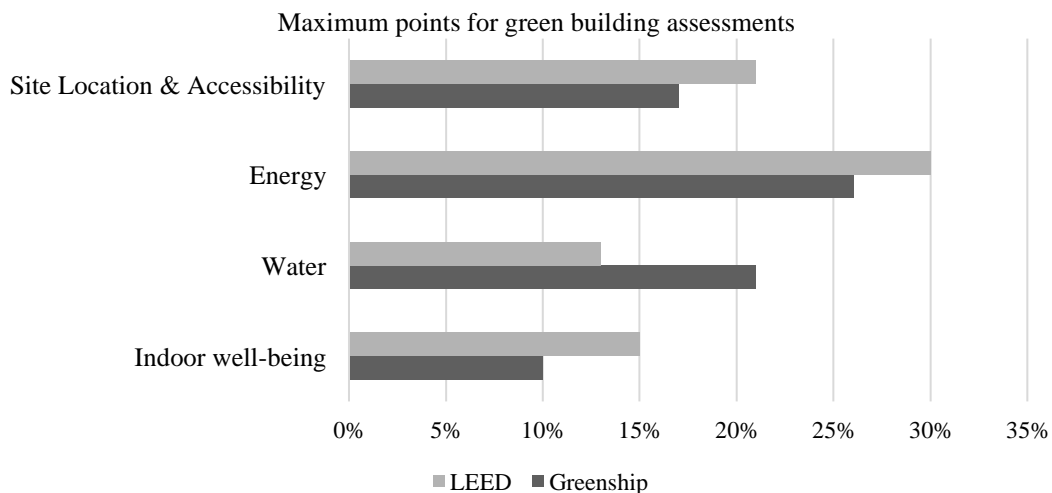


Figure 2. Comparison between LEED and Greenship rating systems.

2.1. Greenship rating tool

Greenship was firstly introduced in 2010 by GBCI [16], a non-profit NGO and an established member of World Green Building Council (WGBC), whose mission is to transform construction and property sectors in Indonesia to be more responsible and sustainable [17]. It comprises six (6) categories in which energy efficiency is the largest portion followed by water management that could be interpreted as two major sustainability issues to solve in Indonesia is energy and water. Greenship has four (4) ranks for certification level, the highest one is platinum with the minimum score of 73%, the other three levels are gold, silver, and bronze that can be reached if the building has the score at least 57%, 46%, and 35%, respectively [16].

2.1.1. Design Recognition. Unlike any other rating system, Greenship has two stages of evaluations, the first one is design recognition (DR) to verify how the design complies with the green building principles, and final assessment (FA) as the overall evaluation of building performance in terms of sustainability. As a rating tool in an emerging market, DR is an appreciation to the effort that has been spent to provide such design that complies with green building concept and to encourage all stakeholders to contribute more to sustainability. The ratio of DR to FA is around 77% which provides a figure that the Greenship weighs around 23% on on-the-spot evaluation to verify whether the actual result during operational follows the engineering design. The maximum score for each category [16] and JIS' result for DR [18] are shown in Table 1. JIS' lowest DR points on Building & Environmental Management (BEM) category could be increased during the final assessment when testing and commissioning procedures and results are in accordance with the standards.

Table 1. Greenship rating tool for new building [16] with JIS' score on each category [18].

Greenship Category for New Building	Max. score (FA)	Max. score (DR)	JIS' score (DR)	
Appropriate Site Development (ASD)	17	17	12	70.6%
Energy Efficiency and Conservation (EEC)	26	26	24	92.3%
Water Conservation (WAC)	21	21	18	85.7%
Material Resource and Cycle (MRC)	14	2	2	100.0%
Indoor Health and Comfort (IHC)	10	5	4	80.0%
Building & Environmental Management (BEM)	13	6	3	50.0%
Total	101	77	63	81.8%

2.2. LEED certification system

LEED is an international sustainability certification from U.S. Green Building Council (USGBC) that widely used in 167 countries and territories, especially in China where the certified project space is even more than in the U.S itself [19]. It is more rigid in term of energy efficiency but provides less points in water efficiency compared to Greenship, but it does not mean that LEED less care in water management because both LEED and Greenship agree to provide maximum points of three (3) for rainwater management. The maximum points can be achieved is 110 in which the last 10 points are more like bonus points because they are used for innovations (4 points) and regional priority (6 points). LEED grade is divided into four (4) levels depends on the approved points during the assessment, they are platinum (80+ points), gold (60-79 points), silver (50-59 points), and certified (40-49 points) [20] and interestingly that the minimum scores to achieve the specific level are similar to Greenship's (see Figure 3).

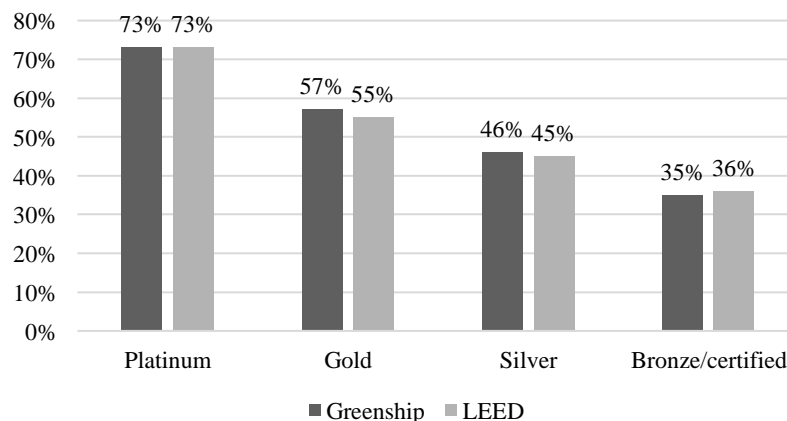


Figure 3. Similarity between LEED dan Greenship in certification's minimum score.

2.2.1. Assumed points for LEED design. There is no design recognition assessment in LEED, however in this paper, by using the same principle as Greenship's, it was assumed that the maximum points for the design stage is 93, as the other points are related with commissioning and on-site verification when the construction process is completed (i.e., supporting documents for non-toxic finishing materials, acoustic level measurement during building operational, etc.).

3. Analysis

The analysis was performed only on LEED v4.1 (the latest one) criteria as JIS has already outstanding performance in Greenship. LEED has nine different criteria and the maximum points for each criterion in the design phase are assumed as shown in Table 4. The details of JIS features that meet LEED criteria are described below.

3.1. Integrative Process (IP)

Integrative Process is like an executive summary, that explaining how the green team makes impact and what the contributions they make [20], before explaining the detail process of each criterion. This criterion is a low-hanging fruit that should not be overlooked by any LEED project.

3.2. Location and Transportation (LT)

JIS is built on a location in Tanjung Priok District in North Jakarta city. The northern part of the project site was home to informal settlement, known as Kampung Bayam, even though the site itself could be categorized as a brownfield because the ground water contains a very high total of dissolved solids and low pH [21]. Due to the project development, the Kampung Bayam's (former) inhabitants were then profitably compensated (*ganti untung*) so that they could move to a better place and improve their life condition. It is a part of RAP (resettlement action plan) program of Jakpro on JIS project [22].

Furthermore, to support local economy, people from surrounding areas are also employed in the project. Urban revitalization would not be achieved without implementing net-zero carbon emission program. Jakarta is very concern about this, so that the development of JIS area means the integration of modern mass transportation system with the stadium complex so that the public transit stop could be reached within the short walking distance (lesser than 400 m). Apart from that, electric vehicle charging stations and bicycle facilities are also provided even though these cannot be claimed for LEED points as the number are still lesser compared to the requirements (5% of total parking spaces). Still, the number of available parking lots at JIS is very less [23] compared to the number of expected spectators because JIS encourages everyone to maximize the use of public transports which are conveniently accessible.



Figure 4. Masterplan of public transit stops at JIS area [24].

In short, JIS still has high possibility to entitle high points in this category because JIS development is not only focusing on sport facility as a building but also enhancing quality of life, especially who lives in North Jakarta, a city who currently has the highest number of people living under poverty line in Jakarta Province [4], by improving community-based economy and creating international-standard tourism service. It fits with the motto of Jakarta that is a city of collaboration.

3.3. Sustainable Sites (SS)

A project study concluded that Jakarta has been experiencing severe land subsidence due to overabstraction of groundwater by industry, building and even household use [25]. This subsidence creates major annual floods that damages infrastructure, housings, and many others. Tokyo's success story to control the land subsidence by enforcing strict rule in groundwater extraction regulation [26] could be set up as an example on how to Jakarta should deal with the problem. To be a pioneer and a part of solution, instead of using groundwater, JIS collects some rainwater and then process it into the treatment facility prior to use it as source of clean water. Of course, it will not cover the total annual need, therefore the remaining part is supplied by the water company. Furthermore, the zero-surface-runoff concept on the drainage design is applied by providing hundreds of deep infiltration wells, rainwater tanks, modular tanks, and infiltration ponds with the total capacity of more than 240% of the design runoff annual volume [10] to ensure the effectivity in reduction the effects of extreme groundwater extraction, especially in North Jakarta. The precaution due to the flood hazard is also considered in the design by increasing the ground level to almost 2.5 m from the annual flood level [10] and it still within safety range even after 30 years (see Figure 5).

As an integrated sport hub that follows Governor regulation [28], JIS has dedicated itself to create more public space to increase social cohesion among various social backgrounds. It covers more than 70% of the total area, in which 30% of them are green space (see Figure 5). Almost half of the green area are well-shaded with large trees, while the pavement uses high solar reflectance (SR) values to avoid heat island effect. Additionally, JIS uses natural insecticides (pied stilt / *Himantopus leucocephalus*) as part of football pitch maintenance team [29]. The presence of JIS along with its large park will increase the area of urban space in Jakarta that vital for the sustainable urban living.

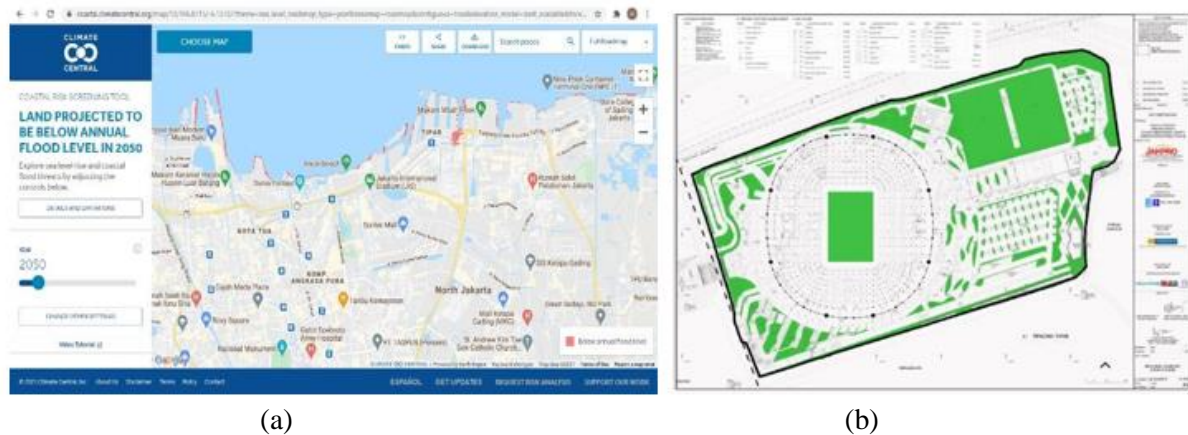


Figure 5. (a) Projection of flood level in JIS area in 2050 [27], (b) JIS' green area [10]

3.4. Water efficiency (WE)

Compared to Greenship, LEED has higher efficiency in water-saving baseline when it comes to public infrastructure. The public lavatory faucet shall not flow water over than 0.5 gpm (≈ 1.9 lpm) according to LEED, which is more demanding compared to only 8 lpm in GBCI's standard. However, still the water reduction for indoor use is over 80% because JIS uses alternative water sources from recycled water and rainwater. These alternative water sources also serve the plants so that no irrigation is required during the rainy season which lasts for 6 months every year. Rain plays vital role at JIS as it also supplies 100% of clean water needs, including cooling towers, for the whole wet season. Main source of clean water (supplied by water company) is only used during summer. Furthermore, instead of extracting groundwater, JIS will inject rainwater into it to reduce the effect of land subsidence [10].

Table 2. Baseline and design of water consumption of fixtures [10] [16] [20].

Water Fixture	Baseline		JIS' design
	LEED	Greenship	
Toilet	6 lpf ^a	6 lpf	3 to 4.5 lpf
Urinal	3.8 lpf	4 lpf	2.5 lpf
Public lavatory faucet	1.9 lpm ^b	8 lpm	4 to 7 lpm
Private lavatory faucet	8.3 lpm	8 lpm	7 lpm
Kitchen faucet	8.3 lpm	8 lpm	7 lpm
Showerhead	9.5 lpm	9 lpm	5 to 6 lpm

^a liter per flush
^b liter per minute

3.5. Energy and Atmosphere (EA)

JIS is built in the tropical country so that the design has is unique compared to that of European Stadium. To deal with high humidity and warm temperature, the facade is designed with the 50% perforation so that fresh air can flow freely into the stadium and at the same time provide natural lighting inside. The facade pattern itself resemblances the stripes of Kemayoran tiger (a nickname for Jakarta's football club, Persija) and gives positive impact on the overall thermal transfer value (OTTV) as low as 16.21 W/m² [10], which is much lower than the one specified in the Standard [30].

Another energy-saving features can be found in the lighting system which provide lighting power density (LPD) as low as 1.8 W/m². The design annual energy consumption is calculated at 181.46 kWh/m²a which is lesser than half of the baseline (374 kWh/m²a) and even more economical compared with the Government's lower limit on energy consumption index. In total, JIS is designed to consume 2,342 MWh of energy annually.

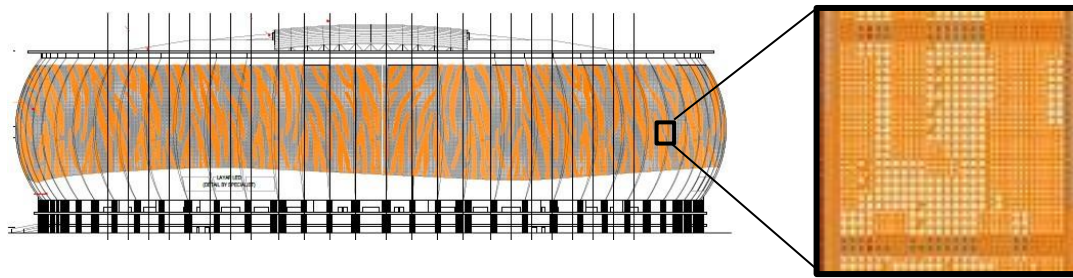


Figure 6. Facade's perforated pattern at JIS (courtesy of Jakpro & KSO).

Compared with many Stadiums in the Western countries, JIS with 82,000 seating capacities, has the lowest energy demand compared to those of in Europe that has lesser seating capacities (see Figure 7). It also should be noted that the comparison among JIS and other stadiums do not consider heating energy demand because JIS do not experience winter season as it is located in a tropical country. JIS' low energy consumption in a 24-hour event-day (10.86 MWh / day) is even lesser than Qatar's Lusail Stadium's in a single match (45 MWh / match) [32].

Table 3. Energy Consumption index in accordance with the Jakarta's government regulation [31].

Building type	Energy Consumption Index (kwh/m ²)			Benchmark
	lower limit	reference	upper limit	operating hours
Office	210	250	285	2600 hours/year
Hotel	290	350	400	8736 hours/year
Apartment	300	350	400	8736 hours/year
School	195	235	265	2080 hours/year
Hospital	320	400	450	8736 hours/year
Shops	350	450	500	4368 hours/year

This JIS' low energy design is expected to reduce 2,300 of CO₂-emission annually. Additionally, JIS also do not use any ozone depletion material (ODP) in the refrigerant as both CO₂ and ODP are two main greenhouse gases (GHG) that create global warming. Energy conservation involves renewable energy, and at JIS it is represented by Photovoltaic system which available on the roof top. It supplies more than 5% of annual energy needs and is expected that in the future the amount of renewable power sources will be increased gradually to support zero-emission global program.

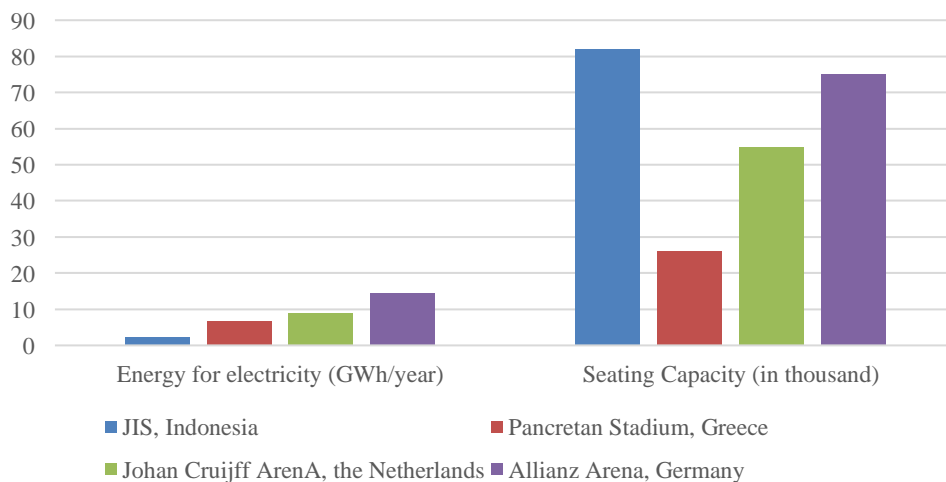


Figure 7. Stadiums' seating capacities and energy (electricity only) demand [10] [11] [33] [34].

3.6. Materials and Resources (MR)

In this criterion, some criteria require many documents that can only be provided when the construction is completed that means not available during the design stage. However, there is one measure that JIS could claim an easy-reward point, that is performing cradle-to-grave life-cycle assessment. Moreover, there are many additional positive points on JIS eco-friendly design, they are: reduction tons of CO₂e, low-energy consumption, utilization of non-CFC refrigerant, and preservation of freshwater at Cincin lake (*Danau Cincin*) by applying zero runoff concept and zero ground-and-surface-water abstraction.



Figure 8. Cincin Lake (*Danau Cincin*) and JIS map location (courtesy of Google map).

3.7. Indoor Environment Quality (IEQ)

The ventilation rates were calculated in accordance with ASHRAE 62.1, and it shows that the results are very satisfactory as they are four times higher than those specified in the Standard. CO₂ control devices are also installed in peak area to monitor its concentration of no more than 800 ppm. If the CO₂ concentration is more than 800 ppm, then the controller will automatically send a signal to turn the fan on and then close the AVD Return AHU. The AVD return AHU will be opened and the fan will be automatically off if the CO₂ concentration is less than 20 ppm. [10]

JIS is a smoke-free stadium so that many no-smoking sign would be installed in many spots inside the stadium, meeting points, and within 5 m from all entrances. The design has also specified that all materials should be environmental-friendly by using low-VOC (volatile organic compounds) for painting, low-mercury lighting, and formaldehyde-free composite wood. Thermal comfort and indoor lighting requirements follow Indonesian Standards (SNI) that are similar to ASHRAE's.

3.8. Innovation (IN) and Regional Priority (RP)

Innovation and Regional Priority are regarded as bonus points in LEED system. The concept of innovation category is that the project has outperformed LEED's requirements in green building system. JIS design has satisfied some of those in LEED innovation catalog and pilot credit libraries. JIS' remarkable design on zero runoff concept and low-energy consumption could lead into exemplary performance in accordance with LEED's. Furthermore, as a government-financed project and part of national pride in the term of sustainable integrated sport facility, JIS always prioritizes local manpower and materials to accelerate economic growth.

4. Result and discussion

The analysis shows that if LEED were used as certification standard, JIS might be able to claim for 72 points out of 93, which is around 77.4% for the design phase. It is lower than the result in Greenship, but the grade is still within the range of platinum level. JIS design concept on zero-runoff, water recycles, efficient water fixtures potentially tops LEED's requirement.

Table 4. LEED criteria for rating tools [20] with JIS potential points on each category

LEED Criteria for New Construction	Max. points	Assumed max. points for design	Potential points for JIS design	
Integrative Process (IP)	1	1	1	100.00%
Location and Transportation (LT)	16	16	13	81.30%
Sustainable Sites (SS)	10	10	8	80.00%
Water Efficiency (WE)	11	11	10	90.90%
Energy and Atmosphere (EA)	33	27	19	70.40%
Materials and Resources (MR)	13	5	3	60.00%
Indoor Environment Quality (IEQ)	16	13	8	61.50%
Innovation (IN)	6	6	6	100.00%
Regional Priority (RP)	4	4	4	100.00%
Total	110	93	72	77.40%

JIS' low score on materials and resources and indoor environment quality category does not necessarily could be translated that JIS compromises indoor comfort and uses non-environmentalfriendly building materials. Besides, potential higher points could be achieved after the commissioning and the verification of all final construction documents. The stringency of LEED compared to Greenship is reflected on JIS' declined score as shown in Figure 9. However, Greenship strictness still win in water efficiency category. The widest gap of Greenship and LEED score on JIS' design is not on energy efficiency matters, but on the construction material compositions.

During the assessment, normally, not all claimed points would be approved by the Board. There is no rule of thumb how many points would not be considered by the Board. It depends on how the Engineer and Architect could convince them based on the logical analyses and proper documentations. However, to prepare for the worst-case scenario, we could use three-point equation analysis to forecast the achievable result. If we assume pessimistically that one point from each category would be reducible during the evaluation, then the total point would be only 63, and the condition of most-likely point are same as optimistic point, then:

$$E = \frac{a + 4m + b}{6}$$

where a is pessimistic value, m is most-likely value, and b is optimistic value, then the expected score would be decreased to 70 or equal to 75.2% which is still higher than the required percentage to achieve platinum level.

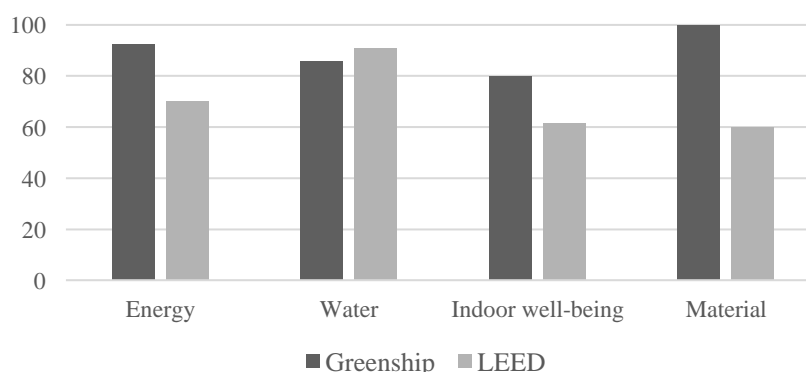


Figure 9. JIS' design score on Greenship (DR) and LEED (proposed) for specific categories

Apart from JIS' outstanding design that, based on the above analysis, shows consistent results in achieving platinum in two rating systems; sustainable building criteria should not only be considered in the material selections, thermal comfort for the occupants, and efficient building performance during operational, but also in the emission because of the design and construction methodology. The overdesigned building will definitely need more resources and energy to construct than that of follows the standard. In other words, emission from embodied energy in the construction material should also be calculated and taken into account in the green building rating systems.

5. Conclusion and outlook

Even though, in general, LEED is stricter than Greenship, JIS still has high prospective to reach platinum certification. Additionally, improvement on energy efficiency and broader use of renewable energy in JIS would lead to better sustainability outcomes. The future research and study to improve energy efficiency, especially to reach nearly-zero emission in sport facilities, which normally have been characterized as energy-hunger architecture, in Southeast Asia region would be interesting as it lies on tropical zone that has high humidity and warm climate. Jakarta itself has been categorized as the world's riskiest city to the environmental hazard according to a report [35], and in the other hand buildings highly have contributions to the total global greenhouse emissions [36] that forge climate changes, therefore extra efforts toward green construction and operation to maintain urban sustainability against global warming's threat shall be the priority for everyone.

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