EPI International Journal of Engineering
Volume 7, Number 1, February 2024, pp. 24-32
DOI: 10.25042/epi-ije.022024.04

*p*ISSN 2615-5109
*e*ISSN 2621-0541

Assessment of MICE Green Building Score Utilizing GREENSHIP Rating System: Value Engineering Approach

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Abstract

The building industry used for meetings, incentives, conventions, and exhibitions (MICE) is one of the industries that has high economic attractiveness for investors. Regulations and user requests for new buildings must meet environmentally friendly building standards. The GREENSHIP green building certification system is issued by the Green Building Council Indonesia. To obtain a platinum rating, a minimum total of 56 points requires additional investment costs but will result in operational cost savings. This paper aims to find out what factors influence the optimization of construction costs through value engineering to achieve a green building rating tool with optimum costs in MICE green building design. The findings show that energy is the most influential factor in obtaining platinum rating certification, so it requires value engineering to achieve optimal investment costs. The novelty of this research is that the selection of materials/machines and work methods for environmentally friendly concepts that save energy needs to be done from the start of design to achieve a payback period for the additional cost that can be returned in 3 years and 2 months that is feasible for new investments, which can be a commitment for company owners to build MICE green buildings.

Keywords: Green building; MICE; value engineering

1. Introduction

MICE (Meeting, Incentive, Convention, Exhibition) is a place for meetings and exhibitions in a broad sense, which includes various types of meetings, incentives, conventions, exhibitions, event venues, and other meeting places as shown in Fig. 1 [1]. The meeting, incentive travel, convention, and exhibition (MICE) industry is considered one of the industries with strong economic attractiveness, which has developed rapidly in China in recent years [2].

Tourism with visitors intended for business (MICE/business visitors) is different in terms of needs, handling tourism with the aim of recreational visitors (leisure visitors). In terms of foreign exchange earnings that affect the economic sector, this is the reason, that MICE expenses/business visitors are greater than visitors for recreational purposes, plus the supply of buildings used for MICE currently available, both in Singapore and in Indonesia, are old and not integrated with other supporting facilities such as hotels, restaurants, and malls which will reduce the comfort of visitors, making it attractive for capital owners to build buildings that can be used for MICE activities [3]. The tourism sector is growing steadily in Indonesia is the second largest foreign exchange earner and is the main driver of the Indonesian economy. According to the World Travel & Tourism Council, Indonesia's tourism industry is the twentieth largest in the world, smaller than Thailand and Australia [4].

Numerous factors must be considered during the design phase of a green building. The building's environmental aspect necessitates consideration of site selection, design features, construction practices, and ongoing maintenance. Significant quantities of energy, water, materials, and natural resources are consumed throughout the construction and operational phases. Buildings exert various environmental impacts, including waste generation, air and water pollution, indoor air quality issues, heat island effects, stormwater runoff, and noise pollution. These impacts can adversely affect human

Figure 1. Building design concept for MICE

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health, contribute to environmental degradation, and deplete natural resources.

The increase in costs for the construction of a Green Building concept building has been studied to increase construction costs ranging from 4.5% to 7% compared to conventional buildings, but results in rental prices that have premiums that can be higher between 5% to 10% [5].

Based on a case study of Green Building in Poland whereby following Green Building standards, the trend has been to increase profits by 26% per year, and good application of green technology can save energy between 30% to 80%, as stated by the United Nations Environment Program [6].

To evaluate a building's environmental friendliness, standardized measurements are essential. Various institutions and standards exist for green building assessments globally, including BREEAM in the UK, LEED in the US, NABERS and GREEN STAR in Australia, and GREEN MARK in Singapore. In Indonesia, the GREENSHIP standard, overseen by the Green Building Council Indonesia (GBCI), serves as the benchmark for green building assessments [7].

The current research concentrates on the expenses of MICE activities required to achieve a GREENSHIP certification with a platinum rating, specifically reducing initial costs without compromising quality and functionality. The cost reduction method employed is Value Engineering, a crucial tool in the civil engineering construction industry. Value Engineering offers significant benefits in terms of cost savings and project enhancements. By implementing Value Engineering, it is anticipated that costs will rise as conventional buildings are optimized to meet green building standards. The Value Engineering process involves several stages, making it essential to identify which stage's indicators most significantly impact cost performance [8].

2. Literature Review

2.1. Green building rating standard

Most countries have developed green building rating tools that are based on social, environmental, and economic dimensions [7]. What is meant by green buildings can be in stages as the design, construction, and operation of buildings with maximum conservation of resources (energy, land, water, and materials), pollution reduction, environmental protection, and providing a place for healthy and comfortable people indoor space [7]–[9].

2.2. GREENSHIP

There are several GREENSHIP rating tools, new building, existing building, interior, home, and neighborhood. The building certification system in Indonesia for new buildings can be carried out in the design stage and the building construction stage called the GREENSHIP New Building. The project team can create a comprehensive green building with innovative and creative approaches and ideas from the design to the operational stages of obtaining certification.

GREENSHIP New Building Certification, there are 2 (two) stages of assessment: are 2 (two) stages of assessment:

a. Stages of Design Recognition (DR), a maximum score of 77 points. If the building is still in the design phase, the performance of the final design and planning will be assessed against the GREENSHIP assessment tool.
b. Stages of Final Assessment (FA), a maximum score of 101 points. In the final stage, the overall performance of the building is assessed thoroughly both from the design and construction aspects based on the GREENSHIP assessment tool.

The rating from Design Recognition (DR) and Final Assessment (FA) is shown in Table 1.

2.3. Factors affecting green building

There are Eligibility provisions and six assessment categories to get the GREENSHIP New Building certification. Each category consists of several criteria containing Prerequisites, Credit Points, and Bonus Points. The six categories are as follows Appropriate Site Development (Table 2), Energy Efficiency and Conservation (Table 3), Water Conservation (Table 4), Material Resources and Cycle (Table 5), Indoor Health and Comfort (Table 6), and Building and Environmental Management (Table 7).

Table 1. Rating Design Recognition (DR) and Final Assessment (FA)

Rating	Percentage	Score Minimum DR	Score Minimum FA
Platinum	73%	56	74
Gold	57%	43	58
Silver	46%	35	46
Bronze	35%	27	35

Source: [10]

Table 2. Appropriate site development

Factor	Indicator	Point
Basic Green Area	E.1.1	Prerequisite
Site Selection	E.1.2.	2
Community Accessibility	E.1.3.	2
Public Transportation	E.1.4.	2
Bicycle Facility	E.1.5.	2
Site Landscaping	E.1.6	3
Microclimate	E.1.7	3
Stormwater Management	E.1.8	3
Total Category		17

Table 3. Energy efficiency and conservation

Factor	Indicator	Point
Electrical Sub Metering	E.2.1.	Prerequisite
OTTV Calculation	E.2.2.	Prerequisite
Energy Efficiency Measures	E.2.3.	20
Natural Lighting	E.2.4	4
Ventilation	E.2.5	1
Climate Change Impact	E.2.6	1
On-Site Renewable Energy	E.2.7	5 (Bonus)
Electrical Sub Metering	E.2.1.	Prerequisite
Total Category		26

Table 4. Water conservation

Factor	Indicator	Point
Water Metering	E.3.1.	Prerequisite
Water Calculation	E.3.2	Prerequisite
Water Use Reduction	E.3.3.	8
Water Fixtures	E.3.4.	3
Water Recycling	E.3.5	3
Alternative Water Resources	E.3.6	2
Rainwater Harvesting	E.3.7	3
Water Efficiency Landscaping	E.3.8	2
Total Category		21

Table 5. Material resources and cycle

Factor	Indicator	Point
Fundamental Refrigerant	E.4.1	Prerequisite
Building and Material Reuse	E.4.2	2
Environmentally Friendly Material	E.4.3	3
Non-ODS Usage	E.4.4	2
Certified Wood	E.4.5	2
Prefab Material	E.4.6	3
Regional Material	E.4.7	2
Fundamental Refrigerant	E.4.1	Prerequisite
Total Category		14

Table 6. Indoor health and comfort

Factor	Indicator	Point
Outdoor Air Introduction	E.5.1	Prerequisite
CO_2 Monitoring	E.5.2	1
Environmental Tobacco Smoke Control	E.5.3	2
Chemical Pollutant	E.5.4	3
Outside View	E.5.5	1
Visual Comfort	E.5.6	1
Thermal Comfort	E.5.7	1
Acoustic Level	E.5.8	1
Total Category		10

Table 7. Building and environmental management

Factor	Indicator	Point
Basic Waste Management	E.6.1	Prerequisite
GP as a Member of the Project Team	E.6.2	1
Pollution of Construction Activity	E.6.3	2
Advanced Waste Management	E.6.4	2
Proper Commissioning	E.6.5	3
Green Building Submission Data	E. 6.6	2
Fit Out Agreement	E.6.7	1
Occupant Survey	E.6.8	1
Total Category		26

2.4. Building under study

The Mata Elang International Stadium MICE building is located on Jalan Jenderal Sudirman Kav C 11 PIK2, Tangerang Regency, Banten Province. It is one of the buildings in the PIK2 Complex which was developed by the Agung Sedayu Group and Mata Elang Group, which is an independent city area on the edge of Jakarta with a land area of 183,579 M^2 and a building area of 573,674 M^2 which is designed to be a MICE Green Building.

2.5. Value engineering

Building stages can be evaluated in three stages design (architectural, structural, mechanical, electrical, and other works), construction (architectural, structural, mechanical, electrical, and other works), and operation (maintenance, energy, worker/employee, and other work) [11].

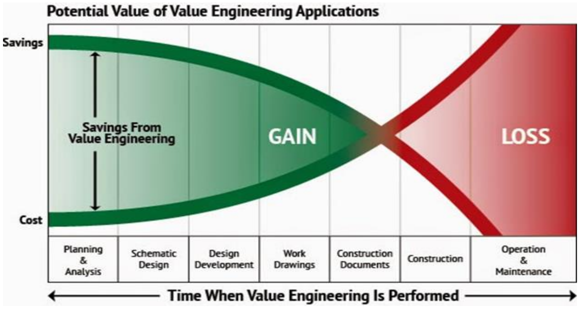

Figure 2. Cost-saving value engineering

These are the phases in value engineering [12] as follows: Preparation, Information, Function Analysis, Creative, Evaluation, Development, Presentation, Implementation and Follow-up [13], [14].

Applying the Value Engineering method to construction projects is particularly effective at the initial stages of construction activities. Conducting a value engineering process is most beneficial during the planning phase, as it allows for the early identification and optimization of cost elements. Performing value engineering analysis during the construction phase can lead to increased work time, additional consultation costs, and various other losses. This concept is illustrated in Fig. 2.

3. Research Methods

The Green Building Council Indonesia has developed a GREENSHIP standard assessment framework, divided into six distinct categories. These criteria encompass two types: prerequisite criteria and assessment criteria. Prerequisite criteria are mandatory within each category and must be met before further evaluation. On the other hand, assessment criteria are also present in each category, and their fulfillment must be tailored to the building's capabilities. Each criterion comprises one or more indicators, each with varying scoring systems. The number of assessment factors, categories, criteria, and indicators for green building evaluation are detailed in Tables 2 to 7.

To qualify for a green building designation assessed by a GREENSHIP rating from the GCBI, several prerequisites must be met. Before the certification process, the project must satisfy specific conditions, including (1) a minimum building area of 2500 m2, (2) adherence to local government planning regarding the building's designated function, (3) implementation of an environmental management plan, and monitoring system, (4) compliance with earthquake resistance standards in building specifications, (5) adherence to fire safety standards, (6) conformity with disability accessibility standards, and (7) provision of building data accessible to the GBCI for certification purposes.

The green building measurement process comprises four stages, outlined in Figure 1. The initial stage involves analyzing prerequisite criteria. If the analysis reveals that these criteria have not yet met the required standards, the criteria cannot be scored, halting the assessment process. However, in this study, if any prerequisite criteria were found to be unmet, they were assumed to be fulfilled subsequently. Details of the prerequisite criteria for each category are provided in Table 8.

The second phase involved evaluating the building against the GREENSHIP criteria for new buildings version 1.2. Data gathering was conducted through interviews with selected individuals including the experts in green building, and the building designer, all of whom were considered knowledgeable about the building's design and operational management. Interview results were translated into scores for each assessment indicator. Subsequently, a comprehensive gap analysis was performed to ascertain the building's score and compare it against the GREENSHIP standard.

Moving to the third stage, the building's category on the GREENSHIP rating scale was determined. This rating system comprises four categories: bronze, silver, gold, and platinum. A building wants to get a platinum rating at a reasonable cost. In the fourth phase, the obtained results were evaluated to formulate recommendations. These recommendations were derived from research findings and in-depth interviews conducted with green building experts based on value engineering.

4. Results and Discussion

The analysis of prerequisite criteria revealed that nearly all prerequisites within this category had yet to be fulfilled. Some required documents or programs were either unavailable or not yet developed by the building management, indicating a lack of readiness for the green building assessment process. The subsequent step involved assessing the building across six categories, each encompassing various aspects detailed in Table 8.

In the category of Appropriate Site Development (ASD) MICE green building attained a score of 8 out of a possible 17. This category comprises seven criteria. The building design achieved a score of 2 for Site Selection, 2 for Community Accessibility, 1 for Public Transportation, 1 for Bicycle Facilities, 1 for Site Landscaping, and 1 for Microclimate.

Community Accessibility necessitates provisions for access and amenities for public vehicles. Key criteria include reducing reliance on private motor vehicles, enhancing greenery through increased vegetation coverage, employing green roofs to mitigate heat effects, managing water through runoff volume reduction, implementing standard operating procedures (SOPs) for pest control, and establishing social programs for local communities. Details of the scores obtained in the ASD category are presented in Table 9.

Table 8. Categories in GREENSHIP Measurement V1.2

Categories	Number of Criteria		Number of Indicators	
	Prerequisite	Assessment	Indicators	Scores
Appropriate Site Development/ASD	1	7	18	17
Energy Efficiency &Conservation /EEC -Incl. Bonus	2	5	13	26
Water Conservation/WAC	2	6	11	21
Material Resource and Cycle/MRC	1	6	9	14
Indoor Health and Comfort/IHC	1	7	14	10
Building Environment Management/BEM	1	7	9	13
Total	8	38	76	101

4.1. Energy Efficiency and Conservation (EEC)

The subsequent category examined was Energy Efficiency and Conservation (EEC). Within this category, the building received a score of 21 out of a total of 26 points available. A significant portion of this score, 15 points, was attributed to optimized efficiency in building energy performance. This achievement was utilizing calculations in a worksheet, every 2% decrease in energy usage compared to the baseline design earns one point. These savings are computed starting from a 10% reduction in energy consumption compared to the baseline building. The worksheet is supplied by GBCI. Additionally, the building secured 4 points for Natural Lighting, achieved through energy-saving practices in room lighting power, resulting in illumination power that is 20% more efficient. Key requirements for this category include Energy Monitoring & Control, 1 for ventilation, and 1 effects of climate change. Details of the scores obtained within the EEC category are outlined in Table 10.

Table 9. Appropriate Site Development (ASD**)**

Assessment Criteria	Prerequisite Criteria	Score
Site Selection	- Select a development area with the building floor coefficient (KLB) >3 - Carrying out revitalization and development on land that has a negative value and is unused due to former development or negative impacts.	2
Community Accessibility	- Open pedestrian access other than the main road outside the site which connects it with secondary roads and land owned by other people so that access is available at a minimum of 3 public facilities for 300 m for pedestrians. - Open the ground floor of the building so that it can provide safe and comfortable pedestrian access for a minimum of 10 hours a day	2
Public Transportation	- Provide pedestrian path facilities within the building area to get to the nearest public transport stop or station that is safe and comfortable by considering Minister of Public Works Regulation 30/PRT/M/2006	1
Bicycle Facilities	- There is a safe bicycle parking area of 1 parking unit per 20 building users up to a maximum of 100 bicycle parking units	1
Site Landscaping	- Use of plants that have been cultivated locally on a provincial scale, amounting to 60% of the mature canopy area of the landscape area	1
Microclimate	- Use various materials to avoid the heat island effect on the roof area of the building so that the albedo value (solar heat reflection power) is a minimum of 0.3 according to calculations.	1

Table 10. Energy Efficiency and Conservation (EEC)

Assessment Criteria	Requirement	Score
GBCI Standard Worksheet	- By utilizing calculations in a worksheet, every 2% decrease in energy usage compared to the baseline design earns one point. These savings are computed starting from a 10% reduction in energy consumption compared to the baseline building. The worksheet is supplied by GBCI.	15
Natural Lighting	- Efficient utilization of natural light ensures that a minimum of 30% of the working floor area receives a natural light intensity of at least 300 lux. - a lux sensor is installed to automatically adjust artificial lighting when natural light falls below 300 lux.	4
Ventilation	- Do not provide air conditioning in toilet rooms, stairs, corridors, and lift lobbies, and equip these rooms with natural or mechanical ventilation.	1
Effects of Climate Change	- Assessing the effects of energy conservation involves calculating the reduction in CO2 emissions. This reduction is determined by comparing the energy needs of the building's design to those of the baseline, using the grid emission factor. This factor, which converts between CO2 emissions and electrical energy consumption, was established in the DNA decision B/277/Dep III/LH/01/2009.	1

4.2. Water Conservation (WAC)

The third assessment category addressed Water Conservation (WAC), encompassing seven criteria and resulting in a total score of 21 points. Within this category, the MICE Building received a score of 17 points. Freshwater efficiency entails the implementation of programs aimed at reducing water consumption. Details of the scores obtained within the WAC category are presented in Table 11.

Table 11. Water Conservation (WAC**)**

Assessment Criteria	Requirement	Score
Water Use Reduction	- The consumption of clean water should primarily be sourced from primary sources, with up to 80% coming from these sources, while still meeting the per capita water demand as specified in SNI 03-7065-2005.	1
	- There has been a 30% reduction in the consumption of clean water from primary sources.	6
Water Fixture	- Water features must comply with the discharge capacity below the maximum standard capacity of the water output device as specified in the attachment. At least 50% of the total procurement of water feature products should meet this requirement.	2
Water Recycling	- Utilize all recycled grey water for flushing and cooling tower systems.	3
Alternative Water Resources	- Rainwater is used for alternative water resources	1
Rainwater Harvesting	-Using alternative water recycling and or water for make-up water cooling tower	3
Water Efficiency Landscaping	-Implementing innovative irrigation technology to manage water requirements for landscaping based on the specific needs of plants	1

4.3. Material Resource and Cycle (MRC)

The fourth category under assessment focused on Material Resource and Cycle (MRC), comprising 6 (six) criteria and yielding a score of 14 points. MICE achieved a score of 12 points, primarily attributed to material management practices.

Building management is encouraged to prioritize the utilization of environmentally friendly materials, locally sourced products, certified SNI (Indonesian National Standards) materials, recycled, reused, and renewable products, certified wood products, and products with minimal environmental impact. Furthermore, procurement documentation demonstrating the purchase of environmentally friendly materials is required. Details of the scores obtained within the MRC category are provided in Table 12.

Table 12. Material Resource and Cycle (MRC)

Assessment Criteria	Requirement	Score
Environmentally Friendly Material	- Using materials with environmental management system certification in production is worth a minimum of 30% of total material costs. The certification is valid if it remains so during the purchase process.	1
	- Utilizing materials derived from a recycling process accounts for at least 5% of the total material costs.	1
	- Using materials predominantly sourced from a renewable resource	1
Non-ODS Usage	- AC refrigerant used by Suva ex Dupont (HFC-134[a])	2
Certified Wood	- Using materials predominantly sourced from renewable resources (such as processed wood transport invoices/FAKO, company certificates) and Forest Stewardship Council (FSC)	2
Prefab Material	- More than 30% of designs use modular or prefabricated materials	3
Regional Material	- Utilizing materials with the main raw materials sourced and manufactured within the territory of the Republic of Indonesia constitutes at least 80% of the total material costs.	2

4.4. Indoor Health and Comfort (IHC)

The fifth category addressed in the assessment pertained to Indoor Health and Comfort (IHC), encompassing seven criteria related to environmental indicators for air quality, thermal conditions, visual comfort, and acoustic qualities. Within this category, MICE achieved a score of 10 out of a possible 10 points. A score of 2 was obtained for air quality, indicating compliance with SNI 03-6572-2001 standards for Ventilation Procedures and Air Conditioning Systems in Buildings, ensuring adequate air intake. Thermal comfort received a score of 1, reflecting generally satisfactory thermal conditions within the room, maintaining a temperature range of 24-27 °C and relative humidity of 60%. Visual comfort earned 1 point, aligning with illumination standards specified in SNI for Energy Conservation in Lighting Systems. The final point, attributed to acoustic comfort, was based on adherence to sound level regulations outlined in SNI for Specifications of Sound Level and Buzzing Time in Buildings and Housing.

To further enhance indoor health and comfort, certain facilities should be provided within the building, including monitoring for CO2 and CO levels, as well as measurements of physical, chemical, and biological pollutants. Additionally, the establishment of non-smoking areas throughout the building is recommended, with designated smoking areas positioned at least 5 meters away from entrances. Details of the scores obtained within the IHC category are illustrated in Table 13 Indoor Health and Comfort (IHC).

4.5. Building Environment Management (BEM)

The sixth category addressed in the assessment pertained to Building Environment Management (BEM), comprising five criteria and yielding a score of 13 points. MICE achieved a score of 9 out of a possible 13 points. The BEM category is detailed in Table 14.

Table 13. Material Resource and Cycle (MRC)

Assessment Criteria	Requirement	Score
Outside View	- 75% of the active space area is oriented towards an exterior view, constrained by transparent openings along a straight line. - Utilizing materials derived from a recycling process accounts for at least 5% of the total material costs.	1
Environmental Tobacco Smoke Control	- Display signs stating, "No Smoking in all building areas" and prohibit the provision of designated smoking buildings or areas within the premises. If applicable, smoking areas outside the building should be located at least 5 meters away from entrances, outdoor air intakes, and window openings.	2
CO2 and CO Monitoring	- Rooms with a density exceeding 2.3 square meters per person are fitted with a CO2 sensor. This sensor regulates outdoor air ventilation to maintain CO2 concentrations below 1,000 ppm. It is positioned 1.5 meters above the floor near the return air grille or duct.	1
Chemical Pollutants	- Utilizing paints and coatings labeled or certified by GBC Indonesia for their low Volatile Organic Compounds (VOCs) content. - Utilizing composite wood products and laminating adhesive while avoiding the use of asbestos.	3
Thermal Comfort	- Set the general room thermal conditions to a temperature of 25^{0}C and a relative humidity of 60%.	1
Visual Comfort	- Utilizing lamps that provide room illumination levels in compliance with SNI 6197:2011 on Energy Conservation in Lighting Systems.	1
Acoustic Level	- Sound Level in the workspace based on SNI on Specifications of Sound Level and Buzzing Time in Buildings and Housing	1

Table 14. Building Environment Management (BEM)

Assessment Criteria	Requirement	Score
GP as a member of the project team	- Requires involvement of at least one GREENSHIP Professional (GP) certified expert, responsible for guiding the project until it receives a GREENSHIP certificate	1
Pollution of Construction Activity	-Implement a construction waste management plan that includes: -Establishing collection areas, separation, and recording systems for solid waste. -Differentiating records based on whether solid waste is disposed of in landfills, reused and recycled by third parties, or poses no risk of polluting drainage	2
Advanced Waste Management	- Processing building waste, both organic and non-organic, either independently or in partnership with third parties, to enhance value and minimize environmental impact.	2
Proper Commissioning	- Conducting testing and commissioning procedures as per GBCI instructions, which includes providing relevant training to enhance the functionality and performance of equipment and systems by plans and references.	3
Fit Out agreement	- Ensure a letter of agreement with the building tenant includes: (a) Utilization of certified wood for fit-out materials; (b) Execution of training conducted by the building management; and (c) Enforcement of indoor air quality (IAQ) management post-fit-out construction, implemented through a lease agreement.	1

4.6. Overall outcome of green building evaluation for MICE building

The outcomes of the green building evaluation for MICE Building at Mata Elang International Stadium are outlined in Table 15.

Table 15. Results of green building evaluation for MICE Building at Mata Elang International Stadium

Categories	Number of Criteria		Number of Indicators	
	Assessment	Max Score	Score	(%) of Max
1. Appropriate Site Development/ASD	8	17	8	47%
2. Energy Efficiency &Conservation /EEC -Incl. Bonus	7	26	21	81%
3. Water Conservation/WAC	8	21	17	81%
4. Material Resource and Cycle/MRC	7	14	12	86%
5. Indoor Health and Comfort/IHC	8	10	10	100%
6. Building Environment Management/BEM	8	13	9	69%
Total	46	101	77	76%

Scoring a total of 77 points, the MICE Building for the platinum level designation within the green building criteria. A comparison between the maximum attainable score and the assessment results is illustrated in Fig. 2.

Recommendations for enhancing the GREENSHIP rating were formulated through expert opinion collection. A set of questionnaires was distributed to 10 respondents, including building management and university architects. Based on the outcomes of the green building assessment, several recommendations were proposed:

a) Enhance energy control and monitoring systems.
b) Establish bicycle facilities to encourage non-motorized transportation.
c) Introduce additional vegetation to enhance the landscape.
d) Promote energy conservation practices and explore renewable energy sources.
e) Investigate the use of alternative water sources beyond groundwater.
f) Improve waste management practices.
g) Enhance thermal comfort through the integration of indoor vegetation.

Furthermore, aside from green building initiatives, the direction of building development is shifting towards smart buildings. Smart buildings employ Building Automation Systems (BAS) to automate various functions within the building, leveraging information technology and computer systems for control.

In summary, the Industrial Engineering Building attained a score of 77 out of a total of 101 points in the GREENSHIP assessment, earning a platinum rating.

4.7. Value engineering

Based on the 46 criteria in GREENSHIP, these criteria can be grouped into 5 groups as shown in Fig. 3 and Fig. 4, which are

1. Requirement Group
2. Given designs group
3. Energy Group
4. Passive design group
5. Create a design group

The initial cost of the building for MICE activities is IDR 5,057,670,000,000 with the details as shown in Table 16 and based on Pareto law where there is work that exceeds 20%, value engineering can be done.

Based on the price details in Table 16, mechanical and electrical work as well as structural work collectively exceed 20%. Given that mechanical and electrical work will primarily evolve as the building becomes operational, the focus of the author is on this aspect.

Based on Table 16, the initial costs from the breakdown of the largest costs are mechanical and electrical work of 30.6%, above 20% can be done by value engineering, and the most influential factor E 23 = Energy Efficiency Measures = 15 points so that the focus is on internal energy earned a platinum rating of GREENSHIP as green costs.

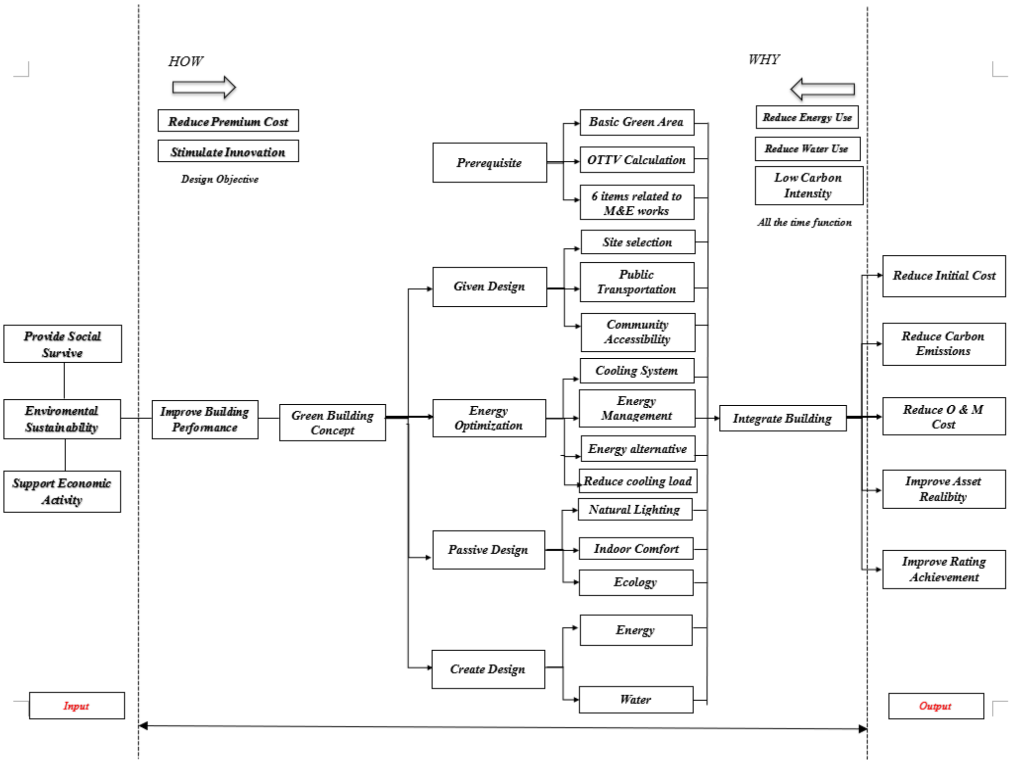

Figure 3. FAST Diagram before value engineering

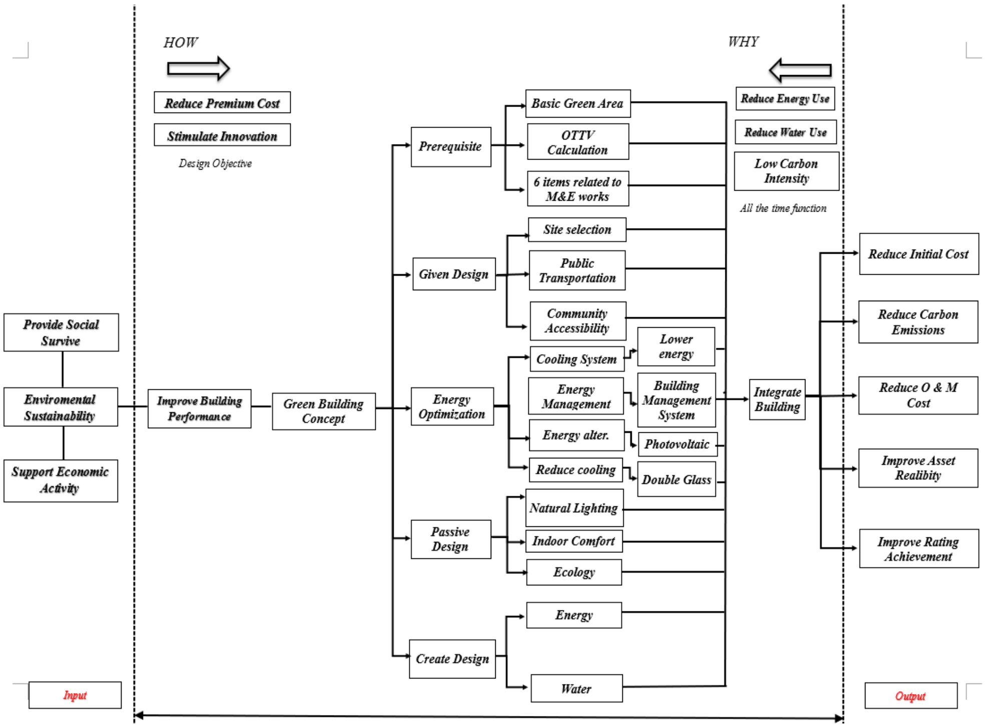

Figure 4. FAST Diagram after value engineering

Table 16. Initial Cost of MICE Building

Works Description	Initial Cost IDR	%
Preliminaries	536,964,000,000	10.6%
Project Site Preparation & Vacuuming System	46,000,000,000	0.9%
Basement Foundation & Piling Works	575,470,000,000	11.4%
Structural Works	1,338,265,000,000	26.5%
Architectural Works & Finishes	800,208,000,000	15.8%
MEP Services	1,546,565,000,000	30.6%
External & Infrastructure Works	178,043,000,000	3.5%
Other Packages	36,155,000,000	0.7%
Total	5,057,670,000,000	100.0%

The total additional cost to make the energy-related green costs IDR 379,036,191,458 = 7.494% as shown in Table 17 with cost breakdown as shown in Table 18.

Table 17. Total additional green costs

Work Description	Initial Cost IDR	Worth to Green Building IDR
Preliminaries	536,964,000,000	536,964,000,000
Project Site Preparation & Vacuuming System	46,000,000,000	46,000,000,000
Basement Foundation & Piling Works	575,470,000,000	575,470,000,000
Structural Works	1,338,265,000,000	1,338,265,000,000
Architectural Works & Finishes	800,208,000,000	907,953,638,400
MEP Services	1,546,565,000,000	1,817,855,553,058
External & Infrastructure Works	178,043,000,000	178,043,000,000
Other Packages	36,155,000,000	36,155,000,000
Total Investment	5,057,670,000,000	5,436,706,191,458
Total Additional Cost		7.494%

Table 18. Cost breakdown of additional cost before value engineering

Work Description	Initial Cost IDR	Worth to Green Building IDR
Preliminaries	536,964,000,000	536,964,000,000
Project Site Preparation & Vacuuming System	46,000,000,000	46,000,000,000
Basement Foundation & Piling Works	575,470,000,000	575,470,000,000
Structural Works	1,338,265,000,000	1,338,265,000,000
Architectural Works & Finishes	800,208,000,000	800,208,000,000
Glass replacement on Building Envelope		107,745,638,400
MEP Services	1,546,565,000,000	1,546,565,000,000
Additional cost on Chiller		60,522,553,058
Additional cost on BMS		154,224,000,000
Additional Cost on PV		56,544,000,000
External & Infrastructure Works	178,043,000,000	178,043,000,000
Other Packages	36,155,000,000	36,155,000,000
Total Investment	5,057,670,000,000	5,436,706,191,458

From the value engineering stage, this research uses the Function Analysis System in analyzing energy optimization. Energy optimization is carried out on a) the air conditioning system that will be used because the energy cost of a building is the highest from the air conditioning machine, b) the AC load which will be evaluated from the load of the glass envelope building as Overall Thermal Transfer Value (OTTV), c) other energy besides AC which requires energy management d) alternative energy sources as renewable energy.

Regarding energy optimization, an analysis was carried out on the causes of the cooling load, capacity, and partial load of the chiller used to cool the room, building management systems, and alternative energy sources to reduce additional costs. with details of additional cost reductions to IDR 237,173,388,379 as shown in Table 19.

Table 19. Cost breakdown of additional cost after value engineering

Work Descriptions	Initial Cost IDR	Worth to Green Building IDR
Preliminaries	536,964,000,000	536,964,000,000
Project Site Preparation & Vacuuming System	46,000,000,000	46,000,000,000
Basement Foundation & Piling Works	575,470,000,000	575,470,000,000
Structural Works	1,338,265,000,000	1,338,265,000,000
Architectural Works & Finishes	800,208,000,000	800,208,000,000
Glass replacement on Building Envelope		107,745,638,400
MEP Services	1,546,565,000,000	1,546,565,000,000
Additional cost on Chiller		33,073,749,979
Additional cost on BMS		61,200,000,000
Additional Cost on PV		35,154,000,000
External & Infrastructure Works	178,043,000,000	178,043,000,000
Other Packages	36,155,000,000	36,155,000,000
Total Investment	5,057,670,000,000	5,294,843,388,379
Total additional cost		4.689%

Economic benefits, According to Knight Frank 2023, rental prices for green buildings are 34% higher than those for conventional buildings. This increase leads to higher profits for green building companies, subsequently raising the value of these buildings.

Environmental benefits include reducing energy consumption, conserving resources to expand availability, preventing energy crises, lowering CO2 emissions, mitigating global warming, and combatting the effects of climate change.

5. Conclusion

The most influential factor in getting green certification is energy. The design of this building must be improved to meet EEC2 prerequisites with improvements to the OTTV, cooling loads from the air conditioning, and lighting installations. Decreasing the value of OTTV from the national standard of 35 W/M² to 21.06 W/M² there is an additional cost of IDR 107,745,638,400, - by modifying the building envelope as in Table 17. The total energy consumption of buildings decreased from Kwh/year from 43,222,692.07 to 29,110,483.10 or energy-saving 14,112,208.96. The points achieved because of savings from the total energy consumption of 11 points, 32.65% of energy-saving minus 10% = 22.65% divided by 2%. With the additional point achieved because of savings from the total energy consumption of 11 points the total points criteria achieved will be 77 or platinum rating and with the conversion of 1 kwh = 0.891 kg and energy savings of 14,112,208.96 kwh/year, there is a reduction in CO2 emissions of 12,573,978.82 kg. With Pareto's law, mechanical and electrical work that is more than 20% of the weight of the initial budget is feasible for value engineering. With FAST diagrams for energy optimization, the total additional cost to make the energy-related green costs IDR 379,036,191,458 = 7.494% can be reduced to IDR 237,173,388,379 = 4.689%. The additional cost can be returned in 3 years and 2 months.

Recommendations for future research on the Green Building Score utilizing the GREENSHIP Rating System and the Value Engineering approach include:

a) Exploring additional aspects of green building certification beyond the current focus.
b) Applying the Value Engineering method to other case studies to evaluate its effectiveness and benefits in different contexts.
c) Investigating the long-term impacts of Value Engineering on the performance and sustainability of green buildings.
d) Assessing the cost-benefit analysis of Value Engineering in various phases of construction projects.
e) Comparing the GREENSHIP Rating System with other green building certification systems to identify potential improvements and best practices.

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