Green building assessment tools in Indonesia: a systematic literature review and comparative analysis

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Abstract. This study reviews the utilization and effectiveness of green building assessment tools in Indonesia by systematically analyzing four primary tools: EDGE, Greenship Existing Building, Greenship New Building, and MAGC. Using the PRISMA methodology, articles published between 2019 and 2024 were selected, and a bibliometric analysis was conducted with VOSviewer. Analyzing 34 case studies reveals a predominant focus on the operational phase of green building implementation, which accounts for 47% of the research, highlighting the importance of energy efficiency and resource management. The comparative analysis identifies that while Greenship tools dominate the planning and construction phases, EDGE excels in operational energy efficiency for educational and medical buildings, whereas MAGC is preferred for commercial buildings and public facilities. These findings suggest that no single tool is universally applicable across all contexts, emphasizing the need for tailored assessments based on specific project types. For policymakers, it is crucial to promote these assessment tools through incentives and resources. Developers and practitioners should enhance their understanding and training on these tools. Additionally, significant research gaps remain in underrepresented sectors, such as transportation and sports facilities, indicating that future studies should explore these areas for a comprehensive integration of the building lifecycle phases.

1 Introduction

The integration of green building concepts across the entire building life cycle, from planning to demolition, plays a crucial role in promoting sustainable development. These concepts are operationalized through various green building assessment tools designed to evaluate and enhance environmental sustainability at each phase [1]. In Indonesia, the adoption of green building practices has been growing, with several studies applying different assessment tools. For instance, the Greenship New Building Version 1.2 was used to assess the Rectorate Office Building [2], while the Greenship Existing Building Version 1.1 was implemented for

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a Catholic Church [3]. Additionally, the Model Assessment Green Construction (MAGC) was applied in a hotel project [4], and the EDGE (Excellence in Design for Greater Efficiencies) was utilized in assessing the Bugis Vernacular House [5]. Despite these applications, green building development in Indonesia faces several challenges, particularly in terms of regulatory alignment and the low annual certification rates for tools like Greenship and BGH [6]. Moreover, existing research on these tools is relatively limited, especially concerning their effectiveness and applicability in Indonesia's unique environmental and regulatory context. The absence of a comprehensive comparative analysis further highlights the need for a deeper investigation into how these tools perform relative to one another.

This research conducts a systematic literature review and comparative analysis of four green building assessment tools in Indonesia: EDGE, Greenship Existing Building, Greenship New Building, and MAGC. The study aims to evaluate their effectiveness in Indonesian applications, addressing: (1) strengths and limitations of each tool, (2) alignment with Indonesian regulations, and (3) research gaps and optimization opportunities.

2 Research Method

This study employed Publish or Perish version 8 to search literature from Google Scholar and Crossref databases, chosen for their comprehensive coverage of national and international publications on Indonesian green building assessment tools. These databases index various scholarly works and provide robust metadata while accommodating both Indonesian and English publications. The search strategy utilized specific keywords including "Model Assessment Green Construction MAGC Indonesia," "Excellence in Design for Greater Efficiencies EDGE Green Building Indonesia," "Greenship Existing Building assessment," and "Greenship New Building assessment." Publications were limited to 2019-2024 to capture current trends in the field.

2.1 Paper Selecting

The retrieved articles were processed using PRISMA methodology, chosen for its systematic framework in identifying, selecting, and synthesizing evidence [7]. This structured approach enhances transparency and reproducibility while minimizing oversight of significant literature, particularly crucial in the evolving field of green building assessment. The methodology followed PRISMA's comprehensive reporting guidelines [8], applying specific exclusion criteria (no author, no source, no abstract, data discrepancy, duplicates) and inclusion criteria (Indonesian/English publications, Indonesian case studies, use of EDGE, Greenship Existing Building, Greenship New Building, or MAGC assessment tools). This systematic approach ensures relevance and rigor in the article selection process.

2.2 Bibliometric Research

The The bibliometric analysis was conducted using VOSviewer 1.6.20 to analyze keyword patterns and relationships from article titles and abstracts. The methodology utilized Google Scholar and Crossref databases, focusing on Indonesian/English publications and recognized assessment tools to ensure research quality. The structured approach to article selection, combined with well-defined inclusion and exclusion criteria, significantly reduces potential bias while maintaining scholarly rigor. Through systematic filtering and PRISMA methodology, this analysis maps keyword relationships to identify research trends, themes, and gaps in Indonesian green building assessment studies [9,10]. The visualization of

interconnected keywords reveals heavily explored areas and underexplored topics, providing critical insights into the field's development and future research directions.

3 Research Results

3.1 PRISMA Result

The article screening process using PRISMA methodology with Publish or Perish version 8 application, as shown in Figure 1, identified 34 articles from an initial 4,045 publications retrieved from Google Scholar and Crossref databases. The selection process applied exclusion criteria (no author, no source, no abstract, data discrepancy, and duplicates) and inclusion criteria (Indonesian or English publications, Indonesian case studies, and use of at least one assessment tool: EDGE, Greenship Existing Building, Greenship New Building, or MAGC). One prior research article was referenced to support this study, with the complete screening process illustrated in Figure 1.

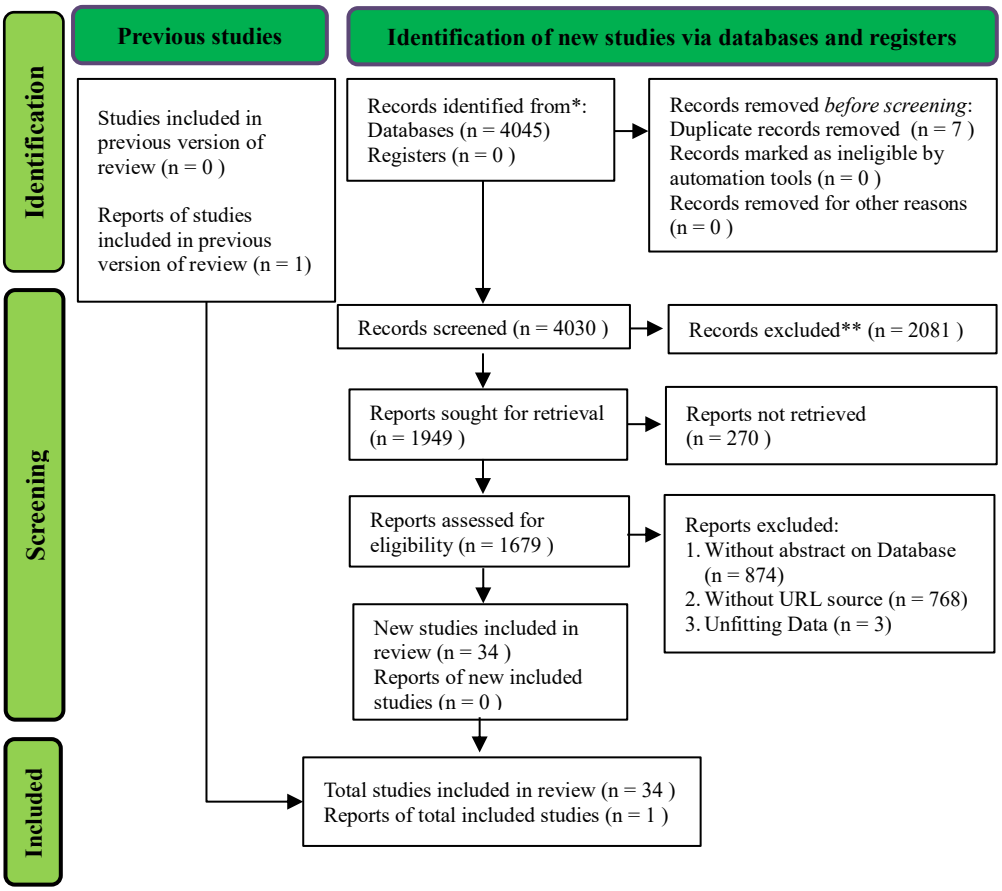

Fig. 1. Selected and filtering articles using PRISMA method

Table 1 below shows the selected articles, the selected literature comprises 34 articles published from 2019 to 2024 across 28 different sources (journals and books), with an

average citation rate of 19.77 per year. The collection includes 26 peer-reviewed journal articles and 8 conference proceedings, involving 91 authors in collaborative research efforts.

Table 1. Information from Selected Articles

Description	Results	Description	Results
Publications Year	2019-2024	Authors and co-author	91
Source (journals, books, etc.)	28	Articles	26
Citations Per Year	19.77	Proceedings/Conferences	8

Figure 2 shows the The publication trend of green building and assessment tools research in Indonesia shows an upward pattern from 2019 to 2024, with peak publications in 2022-2023, while a notable decline occurred in 2020, potentially due to pandemic-related research limitations.

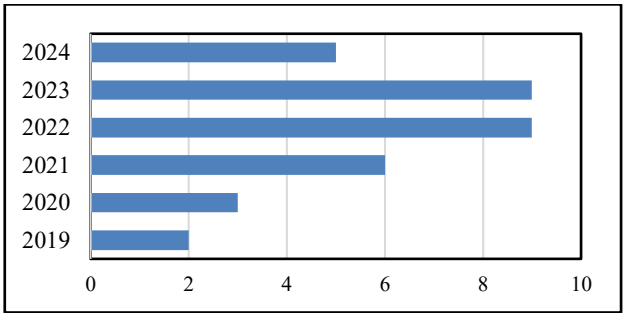

Fig. 2. Number of publications released each year

Figure 3 illustrates the distribution of citations among the most frequently referenced articles, showing how some publications stand out in making important contributions to the field of green building-related research or the topics covered in this study. Articles with the highest citations are most likely to be important cornerstones or references in this study.

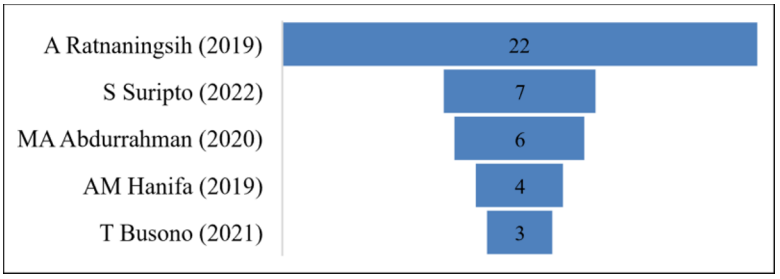

Fig. 3. Top 5 Most cited publications

Publications by A Ratnaningsih (2019) [11] were the most cited with 22 citations, followed by S Suripto (2022) [2] with 7 citations, MA Abdurrahman (2020) [12] with 6 citations, AM Hanifa (2019) [13] with 4 citations, and T Busono (2021) [14] with 3 citations.

3.2 Keywords Analysis

The selected articles were visualized using VoSViewer and the relationship between keywords is summarized in Table 2 by displaying the most frequently occurring keywords in the publications selected for this study. Overall, this table shows that the selected research consistently addresses the concept and application of green building in Indonesia, with particular attention to aspects related to energy efficiency, assessment criteria, and the role of the Green Building Council Indonesia, namely:

Table 2. Frequency of occurrence of keywords in green building research

Keywords	Occurences	Keywords	Occurences
Green building	46	Energy	17
Research	31	Implementation	16
Indonesia	19	Aspect	14
Green construction	19	Criteria	14
Green building concept	18	Green building council indonesia	12

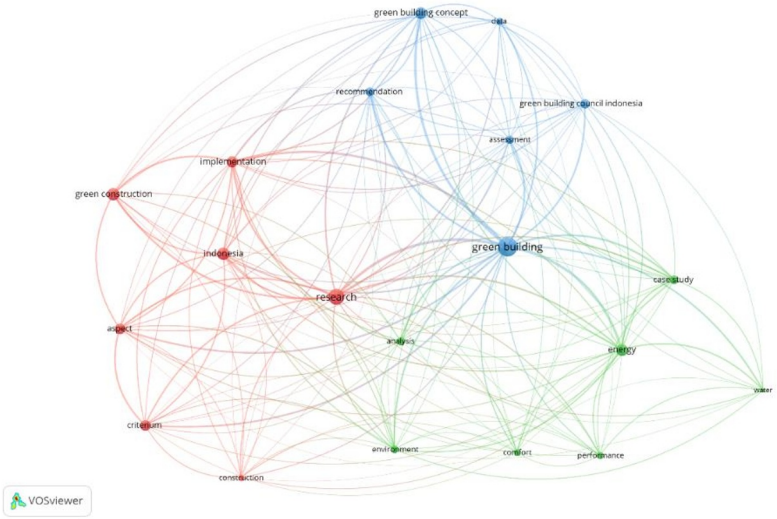

Fig. 4. Network of article keywords

The keyword analysis reveals "green building" as the most frequent term (46 occurrences), followed by "research" (31), "Indonesia" (19), "green construction" (19), and "green building concept" (18). Other significant keywords include "energy" (17), "implementation" (16), "aspect" and "criteria" (14 each), and "Green Building Council Indonesia" (12).. Figure 4 is the resulting bibliometric map showing that “green building” is a central topic in the analyzed literature, with close links to various other keywords such as green building concepts, recommendations, implementation, research, and energy efficiency. These keywords fall into three main clusters:

a. Red Cluster: Focuses on implementation and research aspects, consisting of keywords such as “green construction,” “research,” “Indonesia,” “implementation,” “aspect,” and “criteria.”

b. Blue Cluster: Deals with green building concepts and recommendations, including keywords such as “green building concept,” “recommendation,” “data,” “assessment,” and “Green Building Council Indonesia.”
c. Green Cluster: Focuses on environmental and performance aspects, with keywords such as “energy,” “environment,” “comfort,” “performance,” “water,” and “case study.”

Each cluster reflects a focus on the theoretical, practical, and technical aspects of green building in Indonesia. The lines connecting the keywords show that topics such as energy and research are often discussed together with green building, reflecting the complexity and interconnectedness between the various aspects in this research.

3.3 Green Building Rating Tools Used in Indonesian Case Study

With 34 articles selected using the PRISMA method and analyzed bibliometrically based on the frequency of keyword occurrence, the next step was to conduct an in-depth review of the content of these articles. This review covered three main aspects: (1) the type of building used as a case study, (2) the stage of the building life cycle analyzed, and (3) the Green Building assessment tool applied. A summary of the review of each of the selected articles can be seen in Table 3 below.

Table 3. Summary of green building case studies in Indonesia

No.	References	Building Type	Building Phase	Green Building Rating Tools
1	[15]	Office Building	Planning	Greenship NB v.1.2
2	[14]	Educational Building	Planning	Greenship NB v.1.2
3	[11]	Educational Building	Planning	Greenship NB v.1.2
4	[13]	Sport Facility	Planning	EDGE
5	[16]	Medical Building	Planning	EDGE
6	[17]	Civil Building	Planning and Construction	Greenship NB v.1.2
7	[18]	Public Facility	Construction	Greenship NB v.1.2
8	[2]	Office Building	Construction	Greenship NB v.1.2
9	[19]	Civil Building	Construction	Greenship NB v.1.2
10	[20]	Commercial Building	Construction	MAGC
11	[21]	Educational Building	Construction	MAGC
12	[4]	Commercial Building	Construction	MAGC
13	[22]	Educational Building	Construction	MAGC
14	[23]	Public Facility	Construction	MAGC
15	[12]	Residential Building	Construction	MAGC
16	[24]	Educational Building	Operational	Greenship EB v.1.1
17	[17]	Educational Building	Operational	Greenship EB v.1.1
18	[25]	Educational Building	Operational	Greenship EB v.1.1
19	[26]	Office Building	Operational	Greenship EB v.1.1
20	[27]	Medical Building	Operational	Greenship EB v.1.1
21	[28]	Religious Facility	Operational	Greenship EB v.1.1
22	[29]	Commercial Building	Operational	Greenship NB v.1.2
23	[30]	Office Building	Operational	Greenship NB v.1.2
24	[31]	Medical Building	Operational	Greenship NB v.1.2
25	[32]	Educational Building	Operational	EDGE
26	[33]	Educational Building	Operational	EDGE
27	[34]	Transport Building	Operational	EDGE

No.	References	Building Type	Building Phase	Green Building Rating Tools
28	[35]	Educational Building	Operational	EDGE
29	[5]	Single House	Operational	EDGE
30	[36]	Residential Building	Operational	EDGE
31	[37]	Medical Building	Operational	EDGE
32	[38]	Office Building	Operational and Maintenance	Greenship EB v.1.1
33	[39]	Public Facility	Operational and Maintenance	Greenship EB v.1.1
34	[3]	Religious Facility	Operational and Maintenance	Greenship EB v.1.1

An analysis of 34 case studies across various building types (educational, office, medical, and public facilities) shows primary focus on the operational phase, particularly in energy efficiency and resource management. Assessment tools vary by phase: Greenship New Building v.1.2 leads in planning and construction, Greenship Existing Building v.1.1 excels in operational phase, EDGE specializes in operational assessment of educational and medical buildings, while MAGC focuses on construction phase for commercial and public facilities. Each assessment tool demonstrates specific advantages for different phases and building types, emphasizing the importance of appropriate tool selection for optimal sustainability outcomes.

By building type, the education sector dominates with 29% (10 cases), followed by office buildings at 15% (5 cases), and medical facilities at 12% (4 cases). Commercial buildings and public facilities each represent 9% (3 cases), while civil, religious, and residential buildings each account for 6% (2 cases). Transportation, sports facilities, and single buildings show minimal representation at 3% each (1 case). These findings demonstrate strong green building implementation in educational and commercial sectors, while revealing significant gaps in transportation and sports facilities.

In terms of building lifecycle, the operational phase dominates with 47% (16 studies), followed by construction phase at 26% (9 studies), and planning phase at 15% (5 studies). Only 3% (1 study) addresses combined planning and construction phases, while 9% (3 studies) focus on operation and maintenance. The dominance of the operational phase reflects its longest duration and greatest sustainability impact, however, limited studies integrating multiple phases indicates the need for comprehensive research addressing continuity across building stages.

4 Discussion

The results of this study reveal significant insights into the frequency of the four green building assessment tools—EDGE, Greenship Existing Building, Greenship New Building, and MAGC—and their application across various building types in Indonesia. The analysis indicates a notable preference for certain tools within specific phases of building projects. However, to better understand these trends, it is essential to explore the contextual factors influencing their prevalence.

4.1 Contextual Factors Influencing Tool Selection

Several The selection of green building assessment tools in Indonesia is influenced by three key factors:

- The regulatory framework demonstrates government support for sustainable construction through Green Building Regulation, promoting tools like Greenship that align with national goals. However, newer tools like MAGC face integration challenges due to evolving regulations.
- Economic factors significantly impact tool adoption, with well-funded projects able to implement comprehensive assessment tools requiring substantial investment in sustainable technologies. Smaller projects often opt for simpler tools or forgo assessment due to budget constraints.
- Social awareness plays an increasingly important role as public demand for sustainable practices grows. Rising environmental concerns drive certification demands, favoring recognized tools like EDGE and Greenship that validate sustainability efforts.

4.2 Limitations of Each Tool

The green building assessment tools in Indonesia face distinct limitations: EDGE lacks adaptation to local climate and cultural factors despite its user-friendly design, Greenship's comprehensive framework is hindered by complex documentation requirements that deter smaller developers, while MAGC faces adoption challenges due to limited recognition and perceived credibility as a new tool.

4.3 Practical Implications of Research

The practical implications of this research reveal distinct preferences in green building assessment tools across development phases in Indonesia: during planning, Greenship New Building v.1.2 excels for office and educational buildings while EDGE serves sports and medical facilities; in construction, Greenship NB v.1.2 dominates civil and public facilities while MAGC specializes in commercial and educational buildings; for operations, Greenship Existing Building v.1.1 leads across various building types with EDGE focusing on educational and transportation facilities; and in operational maintenance, Greenship EB v.1.1 remains primary for office and public facilities.

4.4 Comparison with International Trends

To contextualize the findings, comparing them with international trends in green building assessment is beneficial. Globally, there is an increasing emphasis on integrated assessment tools that evaluate environmental, social, and economic impacts, often aligned with the United Nations Sustainable Development Goals (SDGs). In contrast, Indonesia's approach focuses primarily on environmental metrics, which may limit the overall impact of green building initiatives. This difference could be attributed to varying levels of development and sustainability prioritization in the construction sector. Additionally, the relative infancy of Indonesia's green building movement compared to more developed nations indicates significant potential for growth and adaptation of these assessment tools.

5 Conclusion

This research provides in-depth insights into the utilization and effectiveness of green building assessment tools in Indonesia through a bibliometric analysis and evaluation of assessment tools based on existing case studies. The analysis of 34 case studies reveals that the focus of green building concept implementation lies predominantly in the operational phase, with 47% of the research concentrated in this area. This finding underscores the

significance of energy efficiency and resource management during the operational lifespan of buildings in achieving environmental sustainability.

The most frequently employed assessment tools are Greenship New Building Version 1.2 (NB v.1.2) and Greenship Existing Building Version 1.1 (EB v.1.1), which are dominant in the planning, construction, and operational phases. EDGE (Excellence in Design for Greater Efficiencies) demonstrates prominence in the operational phase, especially for educational and medical buildings that require high energy efficiency, while MAGC (Model Assessment Green Construction) is more commonly applied in the construction phase, particularly for commercial buildings and public facilities.

The bibliometric analysis revealed that the primary keywords in the reviewed literature included "green building," "research," "Indonesia," "green construction," and "green building concept," each exhibiting significant frequency of occurrence. Cluster analysis segmented the keywords into three main groups: the Red Cluster, focusing on implementation and research aspects; the Blue Cluster, addressing green building concepts and recommendations; and the Green Cluster, concentrating on environmental aspects and building performance. This mapping indicates that topics such as energy efficiency and research are frequently discussed in conjunction with green building concepts.

Additionally, the research identified a pressing need for further exploration in underrepresented sectors, such as transportation and sports facilities, and highlighted shortcomings in studies that thoroughly integrate the various phases of a building's lifecycle. For policymakers, it is essential to encourage the development of policies that support the adoption of green building assessment tools by providing incentives and necessary resources for green projects. Developers and practitioners should enhance their training and understanding of existing assessment tools, particularly focusing on their application in underrepresented sectors. Additionally, academics are encouraged to conduct further research that includes comparative analyses of green building assessment tools in international contexts, aiming to identify best practices that can be effectively applied in Indonesia.

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