RESEARCH TRENDS ON GREEN CAMPUS IN SOUTHEAST ASIA: A BIBLIOMETRIC REVIEW

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Abstract

This study aims to uncover previous research flows and predict future research directions related to research trends on green campuses in Southeast Asia. This review uses a bibliometric approach using 1,761 journals from WoS. Two science mapping approaches (i.e., co-citation analysis and co-word analysis) are conducted to investigate past research trends and future research directions on green campuses. The trend of articles in the past has focused on sustainability in higher education environments by considering behavioral factors that influence technology adoption. In the future, articles on green campuses in Southeast Asia will emphasize management frameworks and student engagement, as well as managing renewable energy systems in sustainable practices. This study will benefit researchers, practitioners, and the public by enhancing understanding and implementing sustainability on green campuses in Southeast Asia. In the future, this article will emphasize a sustainable framework through renewable energy, sustainable behavior, collaboration, and operational management. This study provides valuable insights into green campuses, particularly in Southeast Asia, with guidance for policies and interventions that encourage behaviors to reduce environmental impacts. The article promotes sustainable practices and emphasizes the role of green campuses in shaping an environmentally conscious generation.

Keywords: Green Campus, Southeast Asia, Bibliometrics, Sustainability, Co-Citation Analysis, and Co-Word Analysis

INTRODUCTION

The implementation of a sustainable campus is the responsibility of higher education institutions; by doing so, it can improve the quality of higher education. In implementing a sustainable campus can be implemented with the concept of green campus principles (Ayu Alifia & Fakhriah, 2024). A green campus is a concept that emphasizes steps in protecting, managing, and preserving the environment on campus (Merciano et al., 2024). The implementation of sustainability on green campuses in Southeast Asia is very important in creating a healthy environment and supporting the achievement of sustainable development goals or Sustainable Development Goals (SDGs) (Kurniawati, 2024). Green campuses integrate sustainability in various operational aspects, including energy management, water management, carbon emission reduction, waste management, and environmentally friendly building design. In addition, articles that support sustainability are also an important part of the green campus concept to create a generation that is environmentally conscious and ready to face global challenges such as climate change.

Environmentally friendly operational management on campus is essential to creating a healthy environment (Tan et al., 2014). Without any improvements to the green campus program, the environmental quality around the campus will be poor and could potentially decline. Sustainability on this green campus is measured through various indicators, one of which is the UI Green Metric ranking, which includes the categories of layout and infrastructure, energy and climate change, waste, water, transportation, and education and research (Bakaruddin et al., 2023). Green campuses not only prioritize energy efficiency and natural resource management but also focus on developing environmental awareness among students and staff that can then be applied in everyday life. Although sustainability on green campuses has a positive impact on campus operations and environmental quality, its implementation often faces various obstacles, such as limited resources and budgets, and changing behavior and habits (Sugiarto et al., 2022; Tan et al., 2014).

This article focuses on past research trends and potential future directions related to sustainability on green campuses, although there have been many articles on green campus sustainability, previous research results have not comprehensively discussed the trend of green campuses from the past to the future in Southeast Asia. Green campuses offer

opportunities to integrate sustainability aspects in higher education that can support sustainable development goals (SDGs) (Bakaruddin et al., 2023). In addition, sustainability in the campus environment can also reduce environmental impacts through efficient energy management, reduced carbon emissions, and better waste management (Sugiarto et al., 2022). This research investigation focuses on mapping the knowledge structure, identifying gaps in articles, and providing valuable insights for researchers, practitioners, and communities in Southeast Asia, especially in the campus environment. This review can also provide opportunities and recommendations for academics, and help in policy making and practices on green campuses in Southeast Asia by highlighting previous research and future research trends.

The main objective of this article is to provide a comprehensive understanding of the existing literature on green campus sustainability in Southeast Asia. To achieve this objective, this article uses a bibliometric approach that systematically analyzes the relevant literature. This involves two separate bibliometric analyses, each addressing a different aspect of the literature gap and describing past and future articles related to green campus sustainability in Southeast Asia. Thus, this study seeks to achieve the following objectives:

1. To investigate the research trends of previous studies related to green campuses in Southeast Asia using co-citation analysis.
2. To investigate future research trends related to green campuses in Southeast Asia using co-word analysis.

This article follows a well-structured format, including a brief introduction, a comprehensive section explaining the bibliometric methodology used, and a third section outlining the findings of the article. The results of this article focus on past and future trends related to green campuses in Southeast Asia. The next section explains the implications and limitations of this article and provides recommendations for future research.

RESEARCH METHOD

Bibliometric Approach

This article uses a bibliometric approach to analyze literature and trends in a field. The bibliometric approach is used to uncover publication trends, and key topics, and identify

future article directions. This approach is able to form a deep and comprehensive knowledge framework on the topic being studied (Ge et al., 2024). The main advantage of the bibliometric approach is its ability to handle large amounts of data and provide objective evaluations, thereby reducing judgments influenced by personal opinions and increasing the accuracy of literature analysis results. This approach also helps researchers in strategic decision-making by mapping knowledge structures, identifying research trends, finding gaps, and future exploration opportunities (Donthu et al., 2021; Ninkov et al., 2022; Župič and Cater, 2015).

The software used in this article is VOSviewer. This software is very effective for analyzing large-scale data and presenting easy-to-understand visual maps, which is very important for mapping the article network comprehensively (Donthu et al., 2021; van Eck and Waltman, 2010). This article uses two science maps that are in line with the two objectives outlined:

1. Co-citation analysis is used to identify relationships between frequently cited documents, authors, or journals, aiming to uncover the theoretical underpinnings and intellectual history of an article's field.(Lung Shiau et al., 2023).
2. Co-word analysis identifies relationships between article topics by analyzing keywords that frequently appear in articles, which is useful for understanding conceptual structures and trending topics (Scharp, 2021).

Search Strategy and Data Collection Procedures

Article data was retrieved from the WoS database on November 3, 2024. The database is the most extensive and reliable source of scientific data collection, containing more than 74.8 million records in 254 disciplines (Singh et al., 2021)and is widely recognized in the scientific community for providing valid bibliometric indicators for in-depth comparative analysis, as well as being fair among different fields of articles (Birkle et al., 2020). Currently, as of June 20, 2024, this database indexes more than 21,800 journals (Clarivate, 2024) and has been widely used in bibliometric studies to ensure publication quality.(Fauzi, 2024). The main keywords used in this article are “green” and “campus”, which are then diversified using synonyms, related terms, and variations. Based on the diversified keywords, the following search string is used to retrieve metadata from the database: TS = (("green" OR

"eco-friendly" OR "sustain*" OR "carbon footprint*" OR "environmental* friendly" OR "greenmetric*" OR "low carbon" OR "smart" OR "eco-campus" OR "environmental conscious*") AND ("campus*" OR "universit*" OR "college*" OR "higher education" OR "HEI*" OR "higher learning" OR "IHL*")). This search extracts publications based on title, abstract, and keywords.

RESULTS AND DISCUSSION

Descriptive Analysis

The WoS database search was conducted on November 3, 2024. The initial search yielded 1,761 articles, 18,674 citations, and 18,319 no self-citations. The average citation per article was 7.68 with an H-index of 55. Figure 1 shows the number of publications and citations related to the research trend on green campuses in Southeast Asia. This shows significant interest from academics towards green campuses as the number of publications and citations continues to increase every year. The number of publications and citations is expected to continue to increase in the coming years, which contributes to the high interest, and most of the articles have not been done on the research trend of green campuses in Southeast Asia.

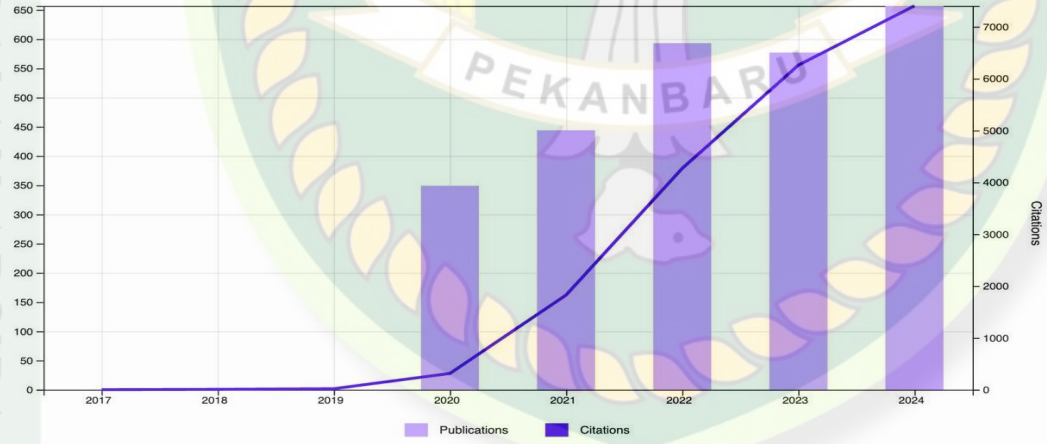

Figure 1.
Number of Publications and Citations on Research Trends on Green Campuses in Southeast Asia in WoS database retrieved on November 3rd, 2024

Co-Citation Analysis

Co-citation analysis was performed with a citation threshold of 57, resulting in 11 cited references. This analysis was performed using the cited sources, as illustrated in Figure

2. The total link strength parameter measures the overall strength of the relationship between an article and other articles in the sample. Ajzen (1991) received 67 quotes, Davis (1989) received 39 citations, and Venkatesh et al. (2003) received 32 citations. Co-citation analysis revealed three distinct clusters, each with a unique thematic focus (Table 1). These clusters consist of publications related to the same theme, identified by nodes of the same color. These themes, detailed in the following section, are the result of an inductive analysis by the authors that involved a thorough examination of each publication, including the abstract, findings, and methodology.

Table 1
Top 10 Documents with The Highest Co-Citations and Total Link Strength

Ranking	Publication	Number of Citation Documents	Total Link Strength
1	Ajzen (1991): The theory of planned behavior	67	277
2	Davis (1989): Perceived usefulness, perceived ease of use, and user acceptance of information technology	39	185
3	Venkatesh dkk. (2003): User acceptance of information technology: Toward a unified view	32	164
4	Ketchen (2013): A primer on partial least squares structural equation modeling	22	118
5	Venkatesh dkk. (2012): Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology	19	97
6	Byrne (2010): International handbook of psychology in education	23	83
7	Stern (2000): Toward a coherent theory of environmentally significant behavior	20	79
8	Venkatesh dan Bala (2008): Technology acceptance model 3 and a research agenda on interventions	12	72
9	Almaiah dkk. (2020): Exploring the critical challenges and factors influencing the E-learning system usage during the COVID-19 pandemic	12	64
10		11	63

Ranking	Publication	Number of Citation Documents	Total Link Strength
	Blok et al. (2015): Encouraging sustainability in the workplace: A survey on the pro-environmental behaviour of university employees		

Source: Created by the Author Using VOSviewer and Bibliometric Metadata

Figure 2 presents a network visualization of the co-citation analysis, with three different clusters representing different themes. The authors have labeled each cluster based on inductive interpretation. A summary of the co-citation analysis is presented in Table 2, which consists of cluster numbers and colors, cluster labels, number of publications, and representative publications.

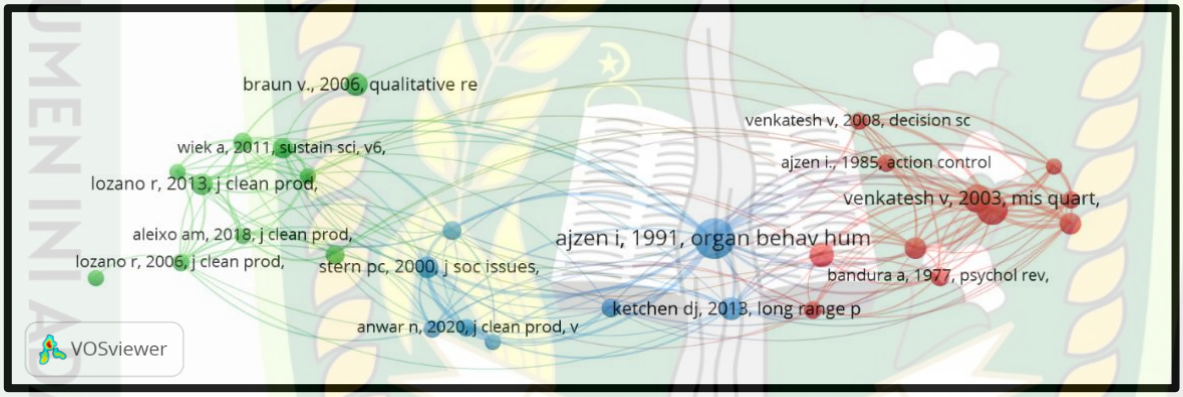

Figure 2.
Co-citation Analysis on Research Trends on Green Campuses in Southeast Asia
Source: Created by the author using VOSviewer and bibliometric metadata

Table 2
Co-Citation Analysis on Research Trends on Green Campuses in Southeast Asia

Cluster No. and Color	Representative Publication	Number of Publications	Cluster Labels
1 (red)	Venkatesh et al. (2003), Almaiah et al. (2020), Bandura (1977), Davis et al. (1989), Ajzen (1985)	11	Behavioral Factors Influencing the Adoption of Sustainability Technologies and Practices
2 (green)	Lozano et al. (2013), Wiek et al. (2011), Cortese (2003),	10	Sustainability in Higher Education: Integrating

Cluster No. and Color	Representative Publication	Number of Publications	Cluster Labels
	Aleixo et al. (2018), Braun and Clarke (2006)		Education, Research, and Campus Practice
3 (blue)	Stern (2000), Block et al. (2015), Anwar et al. (2020), Tangwanichagapong et al. (2017), Kollmuss and Agyeman (2002)	8	Sustainability and Behavior Change in Higher Education

Source: Created by the Author Using VOSviewer and Bibliometric Metadata

Cluster 1 (red): Behavioral factors influencing the adoption of sustainability technologies and practices. Cluster 1 consists of 11 publications that focus on behavioral factors that influence the adoption of sustainability technologies and practices. This cluster explores how technology is used to support sustainable practices. Key studies in this cluster include articles from Venkatesh et al. (2003) and Almaiah et al. (2020), which explore factors that influence technology in organizations and the implementation of technology in education, such as technology readiness, user capabilities, and institutional support are key success factors. This cluster also includes articles from Bandura (1977)about social learning and how observation influences individuals in technology adoption, Davis et al. (1989)about how perceived usefulness and ease of use influence technology use, and Ajzen (1985)about how individual behavior can be predicted through attitudes toward the behavior, personal opinions, and perceived behavioral control.

Cluster 2 (green): Sustainability in higher education: Integrating education, research, and campus practice. Cluster 2 consists of 10 publications that focus on campus practices in achieving sustainability goals. This cluster explores the role of articles in supporting the implementation of sustainability in the campus environment. Key studies in this cluster include articles from Lozano et al. (2013) on the importance of integrating sustainability into higher education curricula, Wiek et al. (2011)which explores the sustainability skills needed by higher education graduates to solve global challenges, as seen in an article by Cortese (2003) which emphasizes the importance of higher education in leading change towards global sustainability. This cluster also includes articles from Aleixo et al. (2018), which discuss the obstacles and drivers of implementing sustainability in the campus environment,

as well as articles from Braun and Clarke (2006), who developed a thematic analysis method frequently used in sustainability-related articles to identify key themes.

Cluster 3 (blue): Sustainability and behavioral change in higher education. Cluster 3 consists of 8 publications that focus on sustainability and behavioral change in higher education, especially on the behavior of campus communities (students, faculty, and staff) toward environmental sustainability. This cluster explores how strategies, impacts, and practical approaches to motivate campus communities to be more environmentally friendly. Key studies in this cluster include articles from Stern (2000) about the theory of environmental behavior that maps the factors that influence environmentally friendly behavior, Block et al. (2015) which evaluates the impact of sustainability programs on student behavior in higher education, and Anwar et al. (2020) which reviews sustainable education approaches to increasing environmental awareness and behavior. This cluster also includes articles from Tangwanichagapong et al. (2017) related to changes in student behavior after being exposed to sustainability programs in the campus environment and Kollmuss and Agyeman (2002), which explores the gap between environmental knowledge and behavior and identifies barriers and drivers of behavior in sustainability.

Co-Word Analysis

Co-word analysis was performed using the same database to identify the most frequently used keywords in the literature. Out of 10,715 keywords, 54 keywords met the 22 thresholds and were grouped into three clusters. The top 15 most frequently used keywords are listed in Table 3, including “sustainability” (124 occurrences), “performance” (121 occurrences), and “impact” (97 occurrences).

Table 3
Top 15 Keywords in Co-Word Analysis

Ranking	Keywords	Emergence	Total Link Strength
1	Sustainability	124	240
2	Performance	121	192
3	Impact	97	162
4	Education	92	194
5	Model	83	161
6	Management	81	141
7	Higher Education	70	140

8	Behavior	66	99
9	Higher Education	58	118
10	Sustainable Development	58	111
11	Design	57	76
12	Growth	56	53
13	Attitudes	52	126
14	Quality	50	76
15	Students	49	122

Source: Created by the author using VOSviewer and bibliometric metadata

Figure 3 presents a network visualization of the co-word analysis, with three different clusters representing different themes. The author has labeled each cluster based on inductive interpretation. A summary of the co-word analysis is presented in Table 4, which consists of cluster numbers and colors, cluster labels, number of keywords, and representative keywords.

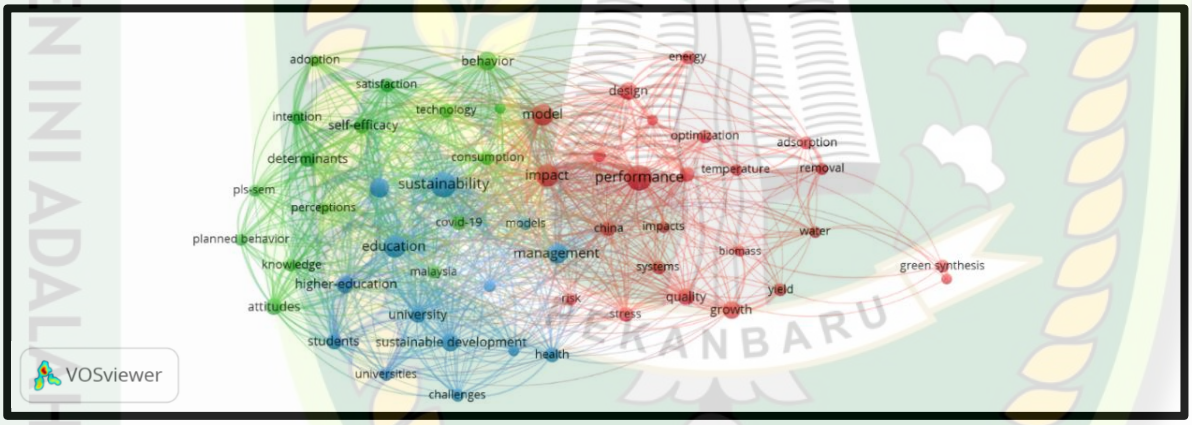

Figure 3.
Co-word Analysis on Research Trends on Green Campuses in Southeast Asia
Source: Created by the author using VOSviewer and bibliometric metadata

Table 4
Summary of Co-Word Analysis on Research Trends on Green Campuses in Southeast Asia

Cluster No. and Color	Representing Keywords	Amount Keywords	Cluster Labels
1 (red)	Impact, quality, China, system, renewable energy, energy,	24	Renewable Energy Systems and Environmental Impacts

Cluster No. and Color	Representing Keywords	Amount Keywords	Cluster Labels
	systems, optimization, impacts, water		
2 (green)	Determinants, attitudes, self-efficacy, intention, satisfaction, behavior, consumption, perceptions, adoption, knowledge	16	Determinants of Sustainable Behavior and Practice Implementation
3 (blue)	Sustainability, education, management, higher education, university, students, higher education, sustainable development, universities, framework	14	Sustainability in Higher Education: Framework, Management, and Student Engagement

Source: Created by the Author Using VOSviewer and Bibliometric Metadata

Cluster 1 (red): Renewable energy systems and environmental impacts. This cluster focuses on renewable energy utilization, system optimization, and its impact on environmental quality, including water and other systems. This is closely related to green campus sustainability in energy management as a strategy to reduce the impact of climate change and an important part of green campus environmental policy. This theme highlights green technology and infrastructure. The importance of using renewable energy systems in green campus management in Southeast Asia has huge potential to reduce carbon emissions and meet sustainability targets in the campus environment. The application of various renewable energy technologies such as solar panels, biomass, and wind turbines can reduce dependence on fossil fuels and increase energy efficiency on campus, as well as support sustainability in educational institutions (Munaro and John, 2024). An article from Leal Filho et al. (2019)also shows that almost 90% of campuses are taking energy efficiency measures, especially in buildings and equipment. This is one of the practices in implementing green campus sustainability. In addition, green campus sustainability is also implemented by practicing using renewable energy instead of fossil fuels, using more energy sources that do

not depend on carbon, using more energy-efficient technology, recycling waste to reduce waste, and adding more green plants to the campus environment (Pandya et al., 2022).

Cluster 2 (green): Determinants of behavior and implementation of sustainability practices. This cluster focuses on individual attitudes, perceptions, self-confidence, and intentions in implementing sustainability. The behavior of stakeholders, including students, lecturers, and staff is something that needs to be considered to achieve the implementation of a green campus. This theme highlights that individual behavior is the key to success in implementing a green campus and building environmental awareness, one of which is through education. Behavior that supports the environment has a very important role in reducing overall emissions and helping to address climate change (Alalawi and Omar, 2024). An article from Hansmann et al. (2020) also shows that stakeholders in a technology-focused campus environment tend to have more pro-environmental attitudes. By paying attention to the behavior of these stakeholders, the sustainability of a green campus will be achieved because this behavior is one of the most important factors in implementing sustainable practices. Self-awareness is about behaving pro-environmentally, which involves implementing a lifestyle that supports sustainability, such as using environmentally friendly transportation and saving water. In addition, student initiatives with projects and activities on campus can realize sustainability in the higher education environment.(Pramono Sari et al., 2023). The more students understand the goals of sustainable development, the greater the opportunity to implement the sustainability of the green campus. The use of project-based learning, simulations, and gamification is considered effective in building competencies. Education and pro-environmental attitudes are the main keys to forming sustainable behavior (Leal et al., 2024).

Cluster 3 (blue): Sustainability in higher education: Framework, management and student engagement. This cluster focuses on the framework of higher education management and student involvement in the implementation of green campus sustainability programs. This theme highlights campus management that supports sustainability, including policy making, and student involvement in decision-making. With the existence of policies related to green campus environmental sustainability that have been made, it will form the next generation that cares about the environment. Universities in Southeast Asia are starting to

implement sustainability in strategic policies and programs, and students are actively contributing to initiatives to help universities achieve their targets (Mansor et al., 2023). An article from Katiliute and Staniskis (2017) mentioned that students are involved in various sustainability activities, from waste sorting to environmental awareness campaigns. When students already have the habit of implementing pro-environmental behavior, such as recycling or saving energy at home, then this behavior can become a habit that can be done in the campus environment. Implementing green campus sustainability is not only related to infrastructure but also needs to pay attention to the energy used because energy savings can reduce campus operational costs and the campus can earn higher income. In addition, management and steps need to be carried out to realize green campus sustainability, for example through education and publication of articles.

Theoretical Implications

This bibliometric approach provides important insights that can help develop the literature on research trends on green campuses in Southeast Asia. This article reveals how campuses can be more environmentally friendly, especially in the Southeast Asian region, through an analysis of research trends. It shows that sustainability should not only follow international standards but also be adapted to local conditions. For example, cultural aspects, community habits, and local environmental characteristics need to be considered. This article also emphasizes the importance of understanding how environmentally friendly technologies and human behavior can support more efficient resource management on campus. Another opinion from Leal Filho et al. (2019)also supports this, emphasizing that sustainability on campus must take into account differences in climate, available resources, and the habits of the surrounding community. In addition, Probst (2022) highlights the importance of combining social, economic, and environmental aspects to achieve long-term sustainability in campus environments, especially in the Southeast Asian region. Therefore, this article suggests the development of a more flexible theory that can be relevant in various places and regions.

Practical Implications

For campus operational managers, this article provides practical guidance that can be applied immediately. One of them is to involve all parties on campus, from students and

lecturers to staff. Environmental conservation efforts include waste recycling programs, the use of renewable energy, and the creation of green spaces that can be enjoyed together. In addition, this article suggests that green campus policies should be based on local data. For example, if the campus is located in a tropical area, then the efficiency of the cooling system is a top priority. Other literature also supports this approach; the success of sustainability programs is highly dependent on the active participation of the campus community (Irungu & Liu, 2024). Meanwhile, Alalawi and Omar (2024) show that a local data-driven approach can help campus managers create relevant policies that will have a significant impact on the surrounding community. By implementing these steps, campus managers not only create a greener environment but also improve the welfare of the surrounding community.

CONCLUSION

Through co-citation analysis and co-word analysis, this study provides an overview of the past and future trends of articles on green campus sustainability in Southeast Asia. A total of 1,761 articles on green campuses were retrieved from the WoS database. The number of studies has increased consistently since 2017 and is expected to continue to increase in the coming years, indicating the importance of sustainability in the campus environment. This can ultimately improve organizational awareness and performance in the campus environment, including in carrying out its operations. In addition, co-citation analysis produced three article themes that represent past research trends, while co-word analysis produced three themes that provide research directions for future green campus researchers, especially in Southeast Asia.

This review has several limitations. First, the researcher only analyzed publications of articles published in journals indexed in WoS, excluding other documents (such as books), so it may not cover publications from other relevant sources. Combining various types of publications and other sources, such as the Scopus database, can provide a more comprehensive analysis. Second, the subjectivity in classifying the themes of the articles is based only on the author's inductive interpretation. This interpretation can lead to differences in themes depending on the context of the study. However, variations in this interpretation are very common because each researcher's approach to the data can be different. This is

considered normal as long as the variation is still within the limits of relevance to the context of the article. For further research, it is recommended to expand the database used, combine qualitative methods to increase findings, and review other aspects of green campuses, such as the influence of local culture or campus policies in supporting sustainability. With this step, future research can be broader in answering the challenges of sustainability in higher education environments, especially in the Southeast Asian region.

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