

A Bibliometric Analysis of the Development of Research on Environmental Issues and Sustainability in Modern Society's Built Environment Studies in Indonesia

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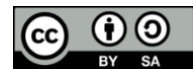
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ABSTRACT

This bibliometric analysis delves into the landscape of environmental sustainability research within Indonesia's built environment studies. As a nation undergoing rapid urbanization, understanding the trajectory of scholarly contributions addressing environmental issues becomes imperative. The study employs comprehensive data metrics, including publication trends, influential works, and potential research gaps, to offer a panoramic view of the field. Through clustering and overlay visualization, research trends are identified, and the top-cited documents shed light on influential works. The analysis also reveals less-explored areas, guiding future research directions. The comparison with previous studies enriches our understanding of the field's evolution. The implications extend beyond academia, providing practical guidance for policymakers and practitioners involved in shaping Indonesia's built environment sustainably.

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1. INTRODUCTION

In recent decades, the escalating concerns surrounding environmental degradation and sustainability have propelled the field of built environment studies to the forefront of academic research worldwide [1], [2]. The intricate relationship between modern society and its built environment in the context of Indonesia, a nation undergoing rapid urbanization and development, necessitates a comprehensive examination of the scholarly contributions addressing environmental issues and

sustainability [3], [4]. This paper endeavors to conduct a meticulous bibliometric analysis to trace the evolution, key trends, and influential contributors in the realm of environmental research within the built environment studies in Indonesia.

The built environment, encompassing urban infrastructure, architecture, and land use, plays a pivotal role in shaping the ecological footprint of a society [5]. With Indonesia being a dynamic archipelagic nation experiencing unprecedented urban growth, understanding the trajectory of research endeavors in

environmental sustainability becomes imperative for policymakers, academics, and practitioners alike [6]. This bibliometric analysis aims to uncover the chronological evolution of research themes, identify seminal works, and elucidate patterns of collaboration within the academic landscape dedicated to sustainable built environments in Indonesia.

Against the backdrop of global climate change and the urgency to adopt ecologically responsible practices, scholars in Indonesia have increasingly turned their attention towards exploring innovative solutions within the built environment. As we embark on this bibliometric journey, we seek to unveil the thematic shifts in research, the impact of international collaborations, and the emergence of interdisciplinary approaches in addressing the complex challenges posed by environmental issues and sustainability in the built environment.

By scrutinizing the scholarly output, citation patterns, and collaboration networks, this paper aims to provide a panoramic view of the current state of research on environmental sustainability within Indonesia's built environment studies [7]–[10]. As we delve into the rich tapestry of academic contributions, our objective is to inform future research directions, foster meaningful collaborations, and contribute to the formulation of informed policies that harmonize the burgeoning urban landscape with ecological imperatives in Indonesia. Through this bibliometric exploration, we endeavor to illuminate the evolving narrative of environmental consciousness within the nation's built environment studies, ultimately contributing to the global discourse on sustainable urban development.

2. LITERATURE REVIEW

2.1 *Environmental Issues in Modern Society*

Environmental issues in modern society have reached a critical juncture, posing significant challenges to the health of the planet and its inhabitants [11]. One pressing concern is climate change, driven largely by human activities such as burning fossil fuels and deforestation [12], [13]. The

rise in greenhouse gas emissions has led to a warming planet, resulting in more frequent and severe weather events, rising sea levels, and disruptions to ecosystems [14]. These changes not only threaten vulnerable species but also jeopardize the livelihoods and well-being of human communities worldwide.

Another prominent environmental issue is the alarming rate of biodiversity loss. Human expansion, habitat destruction, and pollution have contributed to the extinction of numerous plant and animal species [15]–[17]. The loss of biodiversity not only diminishes the intrinsic value of diverse ecosystems but also undermines their resilience and ability to provide crucial ecosystem services such as pollination, water purification, and disease regulation. The interconnectedness of species underscores the importance of preserving biodiversity for the overall health of the planet. In addition to climate change and biodiversity loss, pollution remains a pervasive environmental challenge [18]–[20]. Air pollution, primarily caused by industrial emissions and vehicular exhaust, poses severe health risks to human populations and contributes to respiratory diseases. Water pollution, stemming from agricultural runoff, industrial discharges, and improper waste disposal, contaminates rivers, lakes, and oceans, threatening aquatic life and jeopardizing access to clean water for human consumption. Addressing pollution requires concerted efforts to reduce emissions, regulate waste disposal, and promote sustainable practices across various sectors.

The unsustainable use of natural resources exacerbates environmental issues, leading to deforestation, soil degradation, and depletion of freshwater sources [21]. Overexploitation of forests not only diminishes vital carbon sinks but also disrupts ecosystems and accelerates the loss of biodiversity. Agricultural practices, including monoculture and excessive use of chemical inputs, contribute to soil erosion and degradation, compromising the productivity of arable land [19]. Sustainable resource management and conservation efforts are imperative to ensure the availability of

essential resources for current and future generations [20].

Lastly, the environmental challenges faced by modern society are intertwined with social and economic factors. Environmental degradation often disproportionately affects marginalized communities, exacerbating social inequalities. Addressing environmental issues requires a holistic approach that considers the interconnectedness of environmental, social, and economic systems. Efforts to promote sustainability, mitigate climate change, and protect biodiversity must be accompanied by inclusive policies that prioritize environmental justice and equitable access to resources, fostering a harmonious relationship between humanity and the planet [19], [20], [22]–[24].

2.2 Sustainability Issues in Modern Society

Sustainability issues in modern society have become increasingly prominent, with environmental concerns taking center stage [18]. One of the primary challenges is climate change, driven by the accumulation of greenhouse gases in the atmosphere from human activities such as burning fossil fuels and deforestation [25]. The resulting global warming has led to rising sea levels, extreme weather events, and disruptions to ecosystems, posing significant threats to biodiversity and human communities. As societies grapple with the consequences of climate change, there is a growing recognition of the need to transition towards sustainable energy sources, reduce carbon emissions, and adopt practices that promote resilience and adaptation [26].

In addition to climate change, the depletion of natural resources is a pressing sustainability issue [27]. The rapid growth of global populations and consumption patterns has intensified the strain on finite resources such as water, minerals, and arable land [28]. Over-exploitation and mismanagement of these resources contribute to ecosystem degradation, soil erosion, and loss of biodiversity [29]. Sustainable resource management practices, including circular economy principles and responsible consumption, are crucial for mitigating these

challenges and ensuring the long-term availability of essential resources [30].

Another significant sustainability concern is the alarming rate of biodiversity loss. Human activities, including habitat destruction, pollution, and over-exploitation of species, have pushed many ecosystems to the brink of collapse [31]. The loss of biodiversity not only diminishes the resilience of ecosystems but also affects food security, as many societies depend on diverse ecosystems for agriculture and fisheries. Conservation efforts, habitat restoration, and the implementation of policies that safeguard biodiversity are essential components of addressing this critical sustainability issue [29].

Social sustainability is an integral aspect of the broader sustainability landscape. Inequities in access to resources, education, healthcare, and economic opportunities persist globally, exacerbating social tensions and hindering the overall well-being of communities [32]. Achieving social sustainability involves fostering inclusive and equitable societies, addressing poverty and inequality, and promoting social justice. Moreover, recognizing the interconnections between environmental and social sustainability is essential for implementing holistic solutions that address the complex web of challenges facing modern society [30].

3. METHODS

The study employs a bibliometric analysis to scrutinize the evolving landscape of research on environmental issues and sustainability within the context of the built environment studies in Indonesia. To achieve this objective, a comprehensive search was conducted across prominent databases such as Scopus, Web of Science, and Google Scholar, utilizing specific search terms pertaining to environmental issues, sustainability, and the built environment in the Indonesian context. The inclusion and exclusion criteria were established to refine the dataset, considering factors such as publication date, language, and relevance to the research theme. Key bibliometric

variables, including publication year, authorship details, journal impact factor, and keywords, were extracted and subjected to thorough data-cleaning procedures. The analysis encompasses descriptive statistics to delineate publication trends and authorship patterns, as well as advanced techniques like network analysis and keyword co-occurrence analysis to unravel intricate relationships within the scholarly landscape. Quality assessment incorporates considerations of journal impact factors and citation counts. Ethical considerations, limitations, and validation steps are also addressed to ensure the robustness and reliability of the bibliometric analysis. The statistical analysis, implemented through dedicated software or programming languages, and the software validation process contribute to the comprehensive methodology employed in this study.

3.1 Data Metrics

Table 1. Data Metrics

Publication years	: 1979-2023
Citation years	: 44 (1979-2023)
Paper	: 980
Citations	: 442272
Cites/year	: 10051.64
Cites/paper	: 451.30
Cites/author	: 300469.10
Papers/author	: 640.37
Author/paper	: 2.08
h-index	: 346
g-index	: 650
hI,norm	: 293
hI,annual	: 6.66
hA-index	: 95
Papers with ACC	: 1,2,5,10,20:975,953,864,703,464

The table summarizes the scholarly output and impact of a researcher or a group of researchers over the period from 1979 to 2023. The dataset includes 980 papers published during this timeframe, accumulating an impressive total of 442,272 citations. This results in a remarkable average of 10051.64 citations per year and 451.30 citations per paper, highlighting the significant impact of the research output. On an individual level, the average author has contributed to approximately 640.37 papers, with a ratio of 2.08 authors per paper. The h-index, a widely used metric to measure both productivity and impact, is reported as 346, indicating that 346 papers have been cited at least 346 times each. The g-index, another measure of productivity and impact, stands at 650. The hI, norm and hI, annual values provide additional insights into the h-index when normalized for authorship and annual publication rates, respectively. The hA-index, a variation considering the number of authors on each paper, is reported as 95. Notably, the table also indicates the number of papers associated with specific citation thresholds, such as 1, 2, 5, 10, and 20 citations, offering a detailed breakdown of the distribution of impact across the research portfolio. The table paints a comprehensive picture of a highly productive and impactful research career or group, with a consistent and influential presence in the academic landscape over the past four decades.

4. RESULTS AND DISCUSSION

The first analysis in this bibliometric study is to identify classifications from previous research. Using the Network Visualization menu, results are obtained as in Figure 1 below.

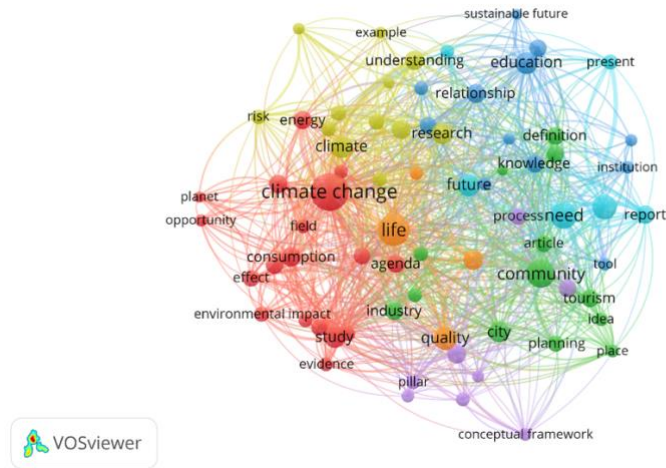


Figure 1. Network Visualization

From the image above, term mapping is represented by various and contrasting colors. Seven different colors represent the existence of seven clusters or groups. In other words, previous research related to this topic

is classified into seven groups with each group having a different theme and each item in the group having the same theme. Specifically, we show the composition of items in each cluster in Table 2 below.

Table 2. Cluster Composition

Cluster	Items
1	Climate change, consumption, economic development, economic growth, energy, environmental impact, innovation, modern society, planet, sustainable development, sustainable society, transition
2	City, Community, industry, nature, planning, sustainable environment, tourism
3	Education, environmental education, environmental issue, higher education, institution, sustainable future
4	Climate, environmental justice, environmental problem, governance, risk, sustainable education
5	Framework, principle, pillar, social sustainability, sustainability assessment
6	Future, present, world commission
7	Life, quality

After successfully identifying how research is related to environmental issues and sustainability in modern society, the next step is to look for research trends. The help of the

VOS Viewer application with an overlay visualization menu is able to present research trends on this topic.

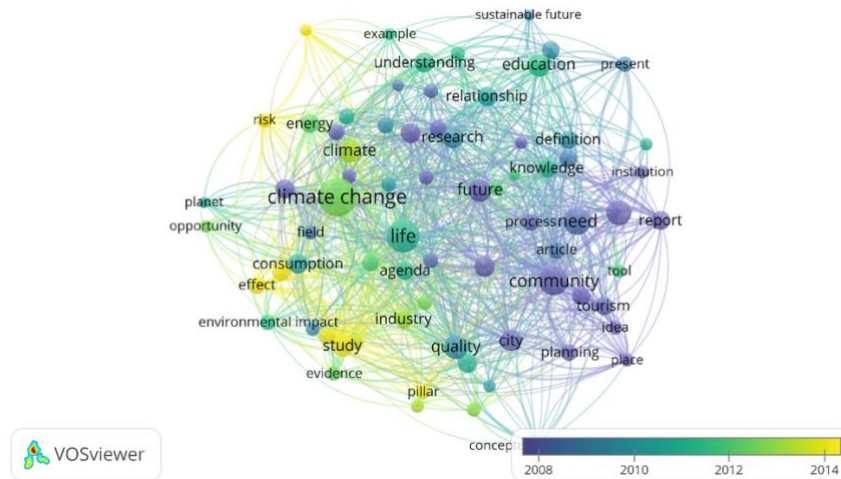


Figure 2. Overlay Visualization

There are at least three main colors, namely purple, green and yellow. Referring to the timeline bar at the bottom of Figure 2, the terms and their network which are colored purple indicate that they were present earlier, namely around 2008. This shows that in that time period, the research trend was more towards topics such as community, tourism, cities, and climate change. Meanwhile, from around 2010 to 2012, research trends tended to focus more on discussions related to

education, quality and energy. These two categories have a general nature because they have been around for a long time. One topic that is still new is the risk that began to emerge around 2014.

Researchers also identify articles that are priority and main and have great significance and role in this field. Through Table 3 below, researchers show the 10 articles with the highest number of citations from various databases.

Table 3. Top Cited Document

Citations	Authors and year	Title
8584	DW Pearce, RK Turner (1989)	Economics of natural resources and the environment
6930	JS Dryzek (2022)	The politics of the earth: Environmental discourses
5954	T Dyllick, K Hockerts (2002)	Beyond the business case of corporate sustainability
5865	D Pearce (2013)	Blueprint 2: greening the world economy
5720	P Ghisellini, C Cialani, S Ulgiati (2016)	A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems
5292	M Mowforth, I Munt (2015)	Tourism and sustainability: Development, globalization and new tourism in the third world
4502	NMP Bocken, SW Short, P Rana, S Evans (2014)	A literature and practice review to develop sustainable business model archetypes
4461	DI Stern (2004)	The rise and fall of the environmental Kuznets curve
4102	SM Lele (1991)	Sustainable development: a critical review
3983	NL Panwar, SC Kaushik, S Kothari (2011)	Role of renewable energy sources in environmental protection: A review

After identifying research trends, the next step is to dig up information regarding potential topics that are still interesting for

research in the future. These topics offer a high research gap because they are new and uncommon. The characteristic is to find terms

that rarely appear in research related to this topic.

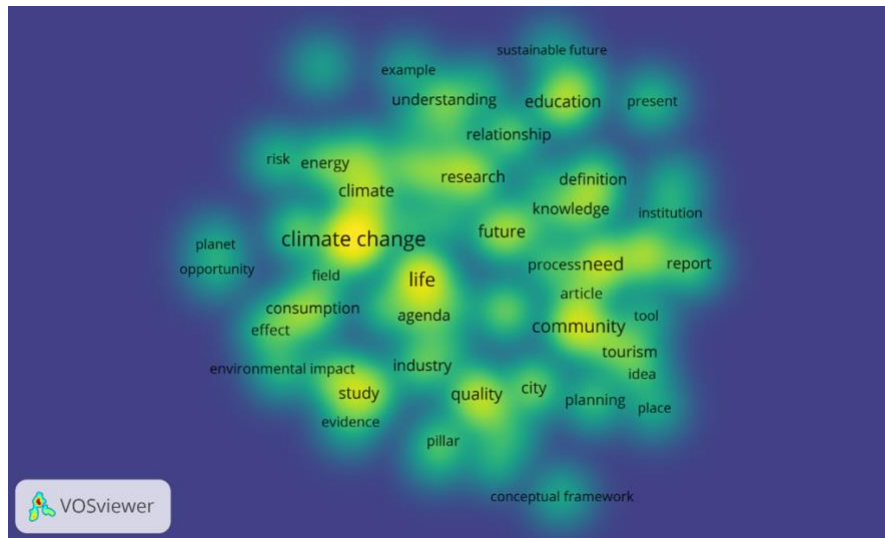


Figure 3. Density Visualization

Through a feature called density visualization, several terms are obtained that are still rarely found, such as sustainable future, risk, planet, planning, and opportunity. This can be a guide for future research to be directed towards these

discussions. As reinforcement, we provide a specific explanation through Table 4 below which identifies the terms that appear most frequently and least frequently as a basis for subsequent research.

Table 4. Most Frequented and Fewest Occurrence

Most Frequented		Fewest Occurrence	
Item	Occurrence	Item	Occurrence
Climate change	119	Sustainable environment	10
Life	82	Sustainable future	10
Community	66	planet	11
World commission	50	Environmental justice	12
quality	45	Sustainability education	12

The table offers insights into the frequency of certain terms or concepts in a given context. Among the most frequently mentioned items, "Climate change" takes the lead with 119 occurrences, signifying its prominence in the discussions. Following closely are "Life" with 82 occurrences and "Community" with 66 occurrences, indicating these concepts are also central to the discourse. On the other hand, the items with the fewest occurrences include "Sustainable environment" and "Sustainable future," each mentioned only 10 times, suggesting these terms are relatively less emphasized.

Additionally, "Planet" has 11 occurrences, "World commission" is mentioned 50 times, "Environmental justice" occurs 12 times, and "Quality" has 45 occurrences. "Sustainability education" is also mentioned 12 times. While these terms have more occurrences than the least mentioned items, they fall behind the most frequently mentioned ones. It's important to note that the interpretation is solely based on the frequency of the terms and lacks information about the context or the nature of these occurrences.

Comparison with Previous Study

Several studies have conducted bibliometric analyses of environmental issues and sustainability. These analyses use quantitative approaches to highlight trends in the literature, identify influential authors, and analyze the content of published documents. The studies employ various software programs such as VOSviewer and CiteSpace to handle large databases and perform objective data analysis. The analyses cover a wide range of topics, including sustainability, risk management, environmental, social, and governance (ESG) research, and the influence of sustainability reports on social and environmental issues. The findings of these studies provide valuable insights into the intellectual structure and research trends in the field of environmental sustainability. For example, a study titled "Bibliometric Analysis of Environmental, Social, and Governance Management Research from 2002 to 2021" conducted an in-depth analysis of ESGM to identify the main trends that still need to be strengthened in Sustainable Management Systems [33]. Another study offers an overview of the status of and emerging trends in environmental, social, and governance (ESG) research through a bibliometric approach using CiteSpace [34].

Implication

The study on environmental sustainability in Indonesia's built environment has some important takeaways. First, it helps us see the main topics researchers are looking at, so we can understand what's important. Second, it points out the most influential works, so researchers know what to focus on. Third, it shows areas that need more attention, like

"sustainable future" and "risk." Fourth, it compares with past studies, giving us a bigger picture of what's been happening. Policymakers can use all this information to make decisions that fit with what research shows. Also, it encourages teamwork between different fields for better solutions. Lastly, it reminds researchers to be ethical and do good quality work. In short, this study isn't just for academics – it's useful for anyone involved in making our buildings and cities in Indonesia more sustainable.

5. CONCLUSION

In conclusion, the bibliometric analysis of environmental sustainability in Indonesia's built environment offers valuable insights for researchers, policymakers, and practitioners alike. By highlighting current research trends, influential works, and potential areas for future exploration, the study serves as a roadmap for understanding and addressing environmental challenges. The comparison with previous studies enriches our understanding of how the field has evolved. Policymakers can use these insights to inform evidence-based decision-making, while the emphasis on interdisciplinary collaboration underscores the importance of a holistic approach to sustainable solutions. The study's practical implications extend beyond academia, providing guidance for shaping a more sustainable built environment in Indonesia. Ultimately, the findings contribute to a collective effort to harmonize urban development with ecological imperatives, fostering a balanced and resilient relationship between society and the environment.

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