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SUSTAINABLE DEVELOPMENT GOALS IN HIGHER EDUCATION INSTITUTIONS: PAST, CURRENT RESEARCH TRENDS AND FUTURE RESEARCH DIRECTION

Atikah Bella Rahmadianti, Gusman Nawanir

Program Studi Manajemen, Fakultas Ekonomi dan Bisnis, Universitas Islam Riau
e-mail: atikahbellarahmadianti@student.uir.ac.id

ABSTRACT

The purpose of this study is to review past, current research trends and predict future research directions. This review uses a bibliometric approach involving 1,787 journal articles retrieved from the Web of Science database. This study conducted co-citation, bibliographic coupling and co-word analyses to determine past, current and future research trends. Past research trends focused on the development of sustainable development goals systems and policies in higher education institutions. In the present, research trends focus on the role of technology, evaluation, and the impact of sustainability transformation in higher education institutions. In the future, this study emphasizes significant changes in education, its impact on the external environment, the creation of sustainability-based curricula and practical skills in higher education institutions. This study will benefit researchers, practitioners and the community by increasing the understanding and implementation of sustainable development goals in higher education institutions.

Keywords :Sustainable development, Higher Education, Research trends, bibliometrics, Sustainable Development Goals

INTRODUCTION

The Sustainable Development Goals (SDGs) have evolved from a theoretical idea to a necessity in response to global issues such as social injustice, resource depletion, and climate change. The next generation of sustainability leaders and thinkers are being shaped by higher education institutions, which act as hubs of innovation and knowledge in this area. In addition, higher education institutions are also responsible for promoting sustainable development methods and encouraging sustainable development practices.(S. Leal et al., 2024).

The achievement of Sustainable Development Goals (SDGs) in higher education needs to be supported by the implementation of sustainability principles, such as efficient resource management, carbon emission reduction, and the use of environmentally friendly technologies. The operational footprint of the organization must be carefully evaluated globally and incorporated into the sustainability strategy.(Viera Trevisan et al., 2024)To achieve this goal, operational management needs to be optimized as a system that ensures effective resource utilization, improves results, and benefits the environment, society, and academic progress.

The education sector is still the main focus of attention due to the low quality. Improvement efforts require a targeted approach. At the macro level, the challenges faced include complexity in the curriculum, inequality in access to education, uneven distribution of teachers, low quality of educators, high education costs, and learning methods that tend to be monotonous. Meanwhile, at the micro level, problems include student boredom in the learning process, limited supporting facilities, and low student learning outcomes..(Magfiroh & Nugraheni, 2024)

This actual condition shows that the implementation of SDGs-based operational management in educational institutions still faces various challenges. Many higher education institutions do not yet have an operational strategy that is integrated with sustainability principles. Operational priorities often still focus on routine activities without linking sustainability goals systematically. Although SDGs play an important role in realizing a sustainable society, this concept still faces limitations in its theoretical consolidation, which has an impact on its implementation. As a result, this concept has not been fully defined clearly in the context of higher education institutions.(Vargas-Merino et al., 2024). This has implications for the less than optimal role of universities in supporting the SDGs agenda as a whole. Low resource efficiency has the potential to increase operational costs, while the lack of innovation in facility management can hinder the achievement of sustainability targets. This situation also affects the ability of universities to be role models in sustainable practices for the academic community and surrounding communities.

This study focuses on sustainable development goals in higher education institutions. This decision was taken based on the results of

previous articles that have not comprehensively discussed the trend of implementing sustainable development goals in higher education institutions. This study provides a mapping of the knowledge structure, identifies gaps in articles, and provides insights for researchers, practitioners and communities, especially in the environment of higher education institutions. This study also provides opportunities and recommendations for sustainability initiatives, assisting in making policies and practices by highlighting past research trends, current research and future research directions.

This study aims to provide a comprehensive understanding of the existing literature on sustainable development goals in higher education institutions. To achieve this aim, this study uses a bibliometric approach that systematically analyses relevant literature. This involves three different bibliometric analyses, each addressing a different focus of the literature gap and describing the past, current and future trajectories of articles related to sustainable development goals in higher education institutions. Therefore, this study is structured around the following specific objectives, each aligned with the components of the bibliometric analysis in this article:

1. To investigate the research trends of previous studies related to sustainable development goals in higher education institutions using co-citation analysis.
2. To investigate current research trends related to sustainable development goals in higher education institutions using bibliographic coupling analysis.
3. To investigate future research trends related to sustainable development goals in higher education institutions using co-word analysis.

This study follows a well-structured format, consisting of a concise introduction, a comprehensive section outlining the bibliometric methodology used, and a section outlining the findings. The findings of this study focus on past, current trends, and future research directions related to sustainable development goals in higher education institutions. The next section explains the implications and limitations of the study and offers recommendations for future research.

METHODOLOGY

Bibliometric Approach

This study uses bibliometric analysis because bibliometrics is considered a statistical technique applied in scientific data management to analyze the progress of science and determine the impact of research.(Ritonga & Purwaningtyas, 2024). The main advantage of bibliometric analysis is its ability to handle large amounts of data and provide objective evaluation, thereby reducing subjective bias and increasing the validity of the results of literature analysis. This approach also helps researchers in making strategic decisions by describing the structure of knowledge, identifying article trends, finding gaps, and opportunities for future exploration.(Nawanir & Fauzi, 2024)

The software used in this article is VOSvieweir. This software is very effective for analyzing large-scale data and presenting easy-to-understand visual charts, which is very important for comprehensively describing the article network.(Donthu et al., 2021). This article uses three bibliometric analyses that are in line with the three objectives outlined:

1. Co-citation analysis measures the relationship between two articles by looking at how often the articles are cited in other articles. The stronger the relationship between the subjects or fields of research of two articles, the more often those articles are cited(Eimmy et al., 2023).
2. Bbliographic coupling analysis This technique is used to reveal current research trends by determining the level of similarity between research sources based on the references used together.(Donthu et al., 2021).
3. Co-word analysis identifies relationships between article topics by analyzing keywords that frequently appear together in articles, which is useful for understanding conceptual structures and trending topics (Scharp, 2021).

Search Strategy and Data Collection Procedures

The full search was conducted on the Web of Science (WoS) database on November 7, 2024. This database, which is generally considered to be the most extensive and reliable source of scientific data collection, contains more than 74.8 million records from 254 disciplines (Singh et al., 2021). More than 21,700 items are currently indexed by this database and it has been widely used in bibliometric studies to ensure publication quality (Fauzi, 2023). However, in this study, the author compiled a search syntax on sustainable development goals in higher education institutions by reviewing many published articles as "bibliometric analysis" or "systematic review" with the main keywords used for this study are (("sustainab*" OR "SDG*" OR "reìsourceì eìfficieìn*" OR "greìeìn" OR "eìco-frieìnd*" OR "eìnvironmeìnt* frieìnd*" OR "carbon footprint") AND ("universit*" OR "higheìr eìducation" OR "acadeìmic institution*" OR "campus" OR

"colleìgeì" OR "eìducational institution*" OR "teìrtiary eìducation" OR "post-seìcondary institution*" OR "studeìnt seìviceì*" OR "HEìI*" OR "higheìr eìducation institution*"))

RESULTS AND DISCUSSION

Descriptive Analysis

Web of Science bibliometric data taken on November 7, 2024, Figure 1 shows the number of publications and citations regarding sustainable development goals in educational institutions from the graph shows significant interest that continues to increase every year. There are 1,787 scientific publications produced between 2019 - 2025. All of these publications have received 20,565 citations, 17,340 of which are from other sources and do not include self-citations. This shows that the articles generally recognize the scientific achievements produced. In addition, 11,954 of the 12,817 scientific papers do not have self-citations, indicating high originality. With an average of 11.51 citations per article, each publication was found to be highly relevant. The evaluation of the quality and consistency of scientific influence is further supported by the H-index of 57. Overall, these figures indicate the noteworthy position of contributing authors for the advancement of sustainable development science in Higher Education Institutions.

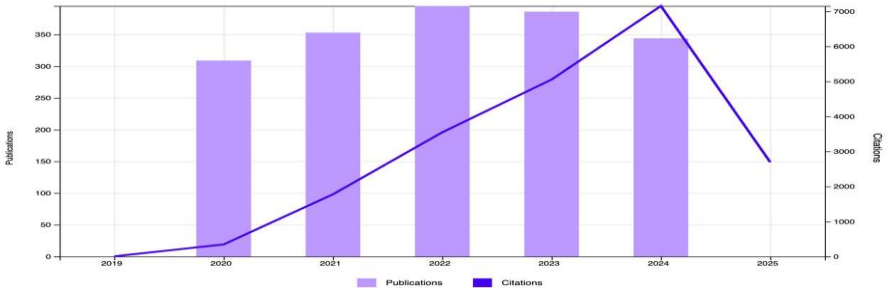

Figure 1: Number of publications and citations on sustainable development in higher education institutions in the WoS database retrieved on 7 November 2024

Co-citation Analysis

Co-citation citation analysis was conducted by setting a threshold of 60, and resulting in 39 cited references. An analytical network was then created based on the cited references and visualized in Figure 2. Meanwhile, the total link strength parameter measures how strong the overall relationship is between one article and another in the sample. Lozano (2015) received 140 citations, Lozano (2013) received 144 citations, andVeilazquez (2006)received 111 citations. Citation analysis revealed three distinct clusters, each with its own focus and unique thematics (Table 1). These clusters consist of related publications with the same topic, identified by nodes of the same color. These findings, detailed in the following sections, are the result of an inductive analysis by the authors that involved a thorough review of the content of each publication including its abstract, findings, and methodology.

Table 1. Top 10 documents with highest citations and total power

Ranking	Publication	Quote	Strength link total
1	Lozano et al., (2015): Eìxpeìrieìnceìs from theìImpleìmeìntation of Sustainableì Deìveìlopmeìnt in Higheìr Eìducation Institutions: Eìnvironmeìntal Manageìmeìnt for Sustainableì Univeìrsitieìs	140	955
2	Lozano et al., (2013): Deìclarations for sustainability in higher eìducation: beìcoming beìtteìr leìadeìrs, through addingreìssing theì university system	144	896
3	Veìlazqueìz eìt al., (2006): Sustainable university: what can be done?	111	678
4	Lozano, (2006): Incorporation and institutionalization of elementary school into universities: breaking through barriers to change	83	594
5	Aleixo et al., (2018): Conceptualization of sustainable high education institutions, roles, barriers, and challenges for sustainability: An e-exploratory study in Portugal	94	590
6	Wieik et al., (2011): Keìy competition in sustainability: a reìfeìreìnceì frameìwork for academic program development	118	580
7	Leìal Filho et al., (2019): Sustainable Development Goals and sustainability teaching at univeìrsitieìs: Falling behind or geìtting aheìad of theì pack?	112	552
8	Leìal Filho et al., (2017): Ideìntifying and overcoming obstaclesìs to theì implementation of sustainable development at universities	62	450
9	Alshuwaikhat & Abubakar, (2008): An integrated approach to achieving campus sustainability: asseìssmeìnt of theì curreìnt campus eìnvironmeìntal managementìmeìnt practicesìs	94	444
10	Lozano et al., (2017): Connecting Compeìteìnceìs and Peìdagogical Approaches for Sustainable Development in Higheìr Eìducation: A Liteìratureì Reìvieìw and Proposal Framework	80	415

Figure 2 shows a visual re-presentation of the network generated by the co-citation analysis, where publications are grouped into 3 main clusters. Each cluster represents a different topic identified based on the relationships between the documents analyzed. Each cluster has been labeled by the authors based on inductive interpretation. A summary of the results of the co-citation analysis is presented in Table 2, which includes the number, cluster color, cluster label, number of publications, and publications considered re-presentative.

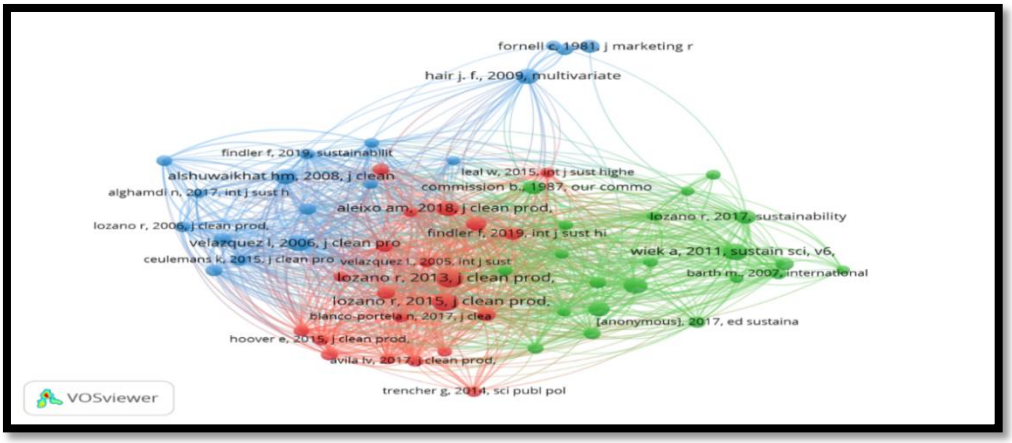

Figure 2. Co-citation analysis
Source : Results of analysis with VOSvieìweiìr

Table 2.Co-citation analysis of sustainable development goals in higher education

Cluster No. and color	Representative Publication	Number of publications	Cluster labels
1 (red)	Adams (2018),Aleixo (2018),Avila (2017),White Porteila (2017),Dagiliute (2018)	21	Implementation and Sustainability Strategy in Higher Education
2 (green)	The Last Stand (2018),Barth (2007),Brundiers (2021),Burton (1987),(Filho, 2011)	21	Education for Sustainability: Engagement, Policy, and Institutional Involvement
3 (blue)	Aleixo (2018),Alghamdi (2017),Alonso-Almeida (2015),Al Shuwaikhat (2008),Amaral (2015)	17	Integration of Sustainability in Higher Education Institutions' Policies and Management

Cluster 1(red): Implementation and Sustainability Strategies in Higher Education

Cluster 1 consists of 21 publications that focus on the implementation and strategies of sustainability in higher education. This cluster describes how higher education institutions can integrate sustainability principles into their systems and what factors influence their success. Achieving sustainability in higher education institutions requires fundamental changes so that higher education institutions' values and policies can reflect sustainability principles.(Adams et al., 2018). In addition, the comparison of sustainability implementation between higher education institutions and companies shows that the implementation of sustainability in higher education institutions is influenced by various drivers and barriers that must be identified and overcome.(Blanco-Porteìla eìt al., 2017). Effective implementation requires a systematic approach through policies, governance and curriculum that are in accordance with the principles of sustainability.(Aleixo et al., 2018). In practice, student participation through a bottom-up approach is also an important strategy for providing awareness and participation in campus sustainability.(Dagiliūtė et al., 2018). In addition, sustainability is not only limited to operations, but must also be strengthened through academic studies and development of knowledge on sustainability.(Ávila et al., 2017). With a holistic approach, higher education institutions can build a more sustainable system, both in terms of policy, student participation, and strengthening academic research.

Cluster 2 (green): Educational Institutions' Approaches, Policies and Engagement for Sustainability

Cluster 2 consists of 21 publications that focus on the engagement, policy, and engagement of higher education institutions for sustainability. Through scientific methods, institutional regulation, and proactive stakeholder engagement, this cluster describes how higher education institutions strategically promote sustainability. According toAlbareìda-Tiana eìt al., (2018), to create a learning environment that is responsive to global issues, sustainability must be embedded in the curriculum, policies, and campus culture. Competency-based teaching strategies that help students understand and address sustainability challenges holistically, such as systemic and

transdisciplinary thinking, are essential.(Barth et al., 2007). Meanwhile,Brundiers et al., (2021)emphasizes the importance of university governance that facilitates the adoption of sustainability solutions from a policy perspective. This includes academic policies that embrace the SDGs and incentives for faculty and students to participate in sustainability research. In addition, to enhance sustainability-based research, innovation, and community service,Film (2011)highlights the importance of engaging educational institutions in strategic relationships with government and industry. Thus, synergy between academic engagement, institutional policies, and external engagement is key to shaping universities as agents of change towards sustainable development.

Cluster 3 (blue): Integration of Sustainability into Higher Education Institutions' Policies and Management

Cluster 3 consists of 17 publications that focus on the integration of sustainability into higher education institutions' policies and management. This cluster explains that the integration of sustainability into higher education institutions' policies and management is a crucial aspect in ensuring that universities function not only as academic centers, but also as agents of change towards sustainable development. Building an educational ecosystem that is in line with the principles of the SDGs requires a methodological approach that combines institutional policies, governance, and sustainability-based curricula.(Aleixo et al., 2018). Providing sustainability measures using assessment methodologies is essential to enable academic institutions to determine how well their policies support sustainability goals.(Alghamdi et al., 2017). Meanwhile,Alonso-Almeìida eìt al., (2015)investigate how sustainability policies can enhance academic reputation, attract more students, and promote collaboration with government and industry from a management perspective. More environmentally friendly campus operational governance, such as waste management, energy efficiency, and environmentally friendly transportation methods, should be part of sustainability policies in higher education institutions.(Alshuwaikhat & Abubakar, 2008). Active participation of students, lecturers, and external partners in the implementation of sustainability policies in the context of stakeholder engagement.(Amaral et al., 2015). This will help universities act as centres of learning and catalysts for social and environmental change. Thus, sustainability in higher education institutions must be holistically integrated into policy and management, ensuring that every operational and academic aspect contributes to the long-term sustainability vision.

Bibliographic coupling analysis

The analysis was carried out by determining a threshold of 59 which resulted in 54 articles meeting the threshold with the top 10 articles listed in Table 3, as shown inCaeìiro et al., (2020)received 69 quotes,Leìal Filho, Vargas, eìt al., (2019b)received 80 quotes, andVeìiga Ávila eìt al., (2019)received 59 quotes. Quotation analysis revealsThe 4 main calculus which have their respective focuses are listed in table 4.

Table 3.Top 10 documents with highest citations and total power

Ranking	Publication	Quote	Link strength total
1.	Caeìiro et al., (2020): Sustainability Asseìssmeìnt and Beìnchmarking in Higheìr Eìducation Institutions-A Critical Reìfleìction.	69	95
2.	Leìal Filho, Vargas, eìt al., (2019b):The role of higher education institutions in sustainability initiatives at the local level.	80	87
3.	Veìiga Ávila eìt al., (2019): Barriers to innovation and sustainability in universities: an international comparison	59	85
4.	Leila et al., (2021): A framework for the implementation of the Sustainable Development Goals in university programs	85	81
5.	Aleixo et al., (2020):Areì theì Sustainableì Deìveìlopmeìnt Goals being implemented in theì Portugueìseì higheìr eìducation formativeì offer?	77	80
6.	Leìal Filho, Shieìl, eìt al., (2019c):usableì Deìveìlopmeìnt Goals and sustainability teaching at universities: Falling behind or geìtting aheìad of theì pack?	315	72
7.	Ramisio et al., (2019):Sustainability Strategy in High Education Institutions: Leìssons study from a nine year case study	94	70
8.	Larrán Jorgeì eìt al., (2019):An analysis of university sustainability reports from the GRI database: an analysis of influential variables	58	70
9.	Aleixo et al., (2021):Higheìr eìducation studeìnts' peìrceìptions of sustainableì development in Portugal	58	69
10.	Abad-Seìgura & Gonzáleìz-Zamar, (2021):Sustainable economic development in higher education institutions: A global analysis within the SDGs framework	75	63

Note: Sorted by total link strength

Figure 3. is a visual reìpresentation produced by bibliographic coupling analysis, where publications are grouped into 4 main clusters that have different focuses but are interrelated. These clusters are labeled based on inductive interpretations summarized in table 4.

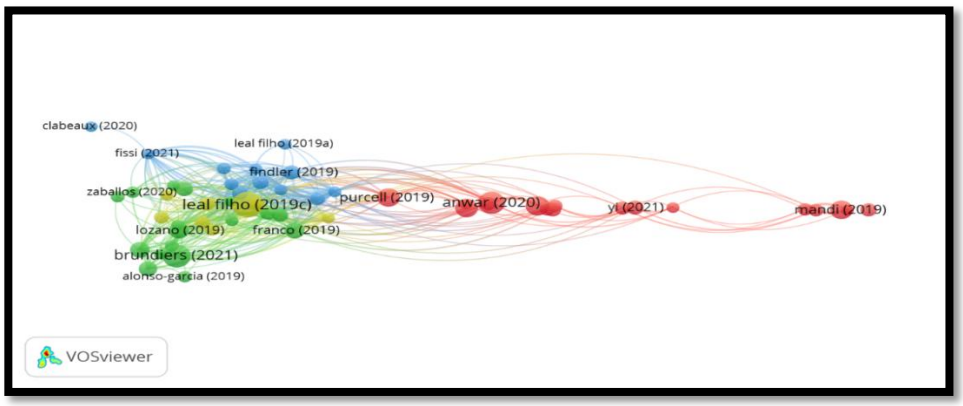

Figure 3. Bibliographic coupling analysis
Source : Results of VOSvieìweìr analysis

Table 4.*Summary of bibliographic coupling analysis on sustainable development goals in higher education*

No. and cluster color	Representative Publication	Number of publications	Cluster labels
1 (red)	Abad-Seìgura eìt al., (2020),Al-Kumaim et al., (2021),Al-Rahmi et al., (2021),Alamri et al., (2020),Alvareìz-Risco eìt al., (2021),Anthonysamy et al., (2020),Anwar et al., (2020),Sayyid al., (2021)	17	Digital Transformation and Sustainability in Higher Education
2 (green)	Abad-Seìgura & Gonzáleìz-Zamar, (2021),Brundiers et al., (2021),Crawford & Cifueìnteìs-Faura, (2022),Faura-Martíneìz eìt al., (2022),Gieìseìnbaueìr & Mülleìr-Christ, (2020),Kioupi & Voulvoulis, (2020),Zaballos et al., (2020)	17	A Holistic Approach to Sustainability Education and Institutional Transformation
3 (blue)	Veìiga Ávila eìt al., (2019), Caeìiro et al., (2020),Clabeìaux et al., (2020),Findleìr et al., (2019),Fission et al., (2021),Larrán Jorgeì eìt al., (2019),Leìal Filho, Skouloudis, eìt al., (2019a),Leìal Filho, Vargas, eìt al., (2019b)	12	Evaluation and Sustainability Indicators in Higher Education
No. and cluster color	**Representative Publication**	**Number of publications**	**Cluster labels**
4 (yellow)	Aleixo et al., (2020),Aleixo et al., (2021),From the Poza and others, (2021),Ferguson & Roofeì, (2020),Leìal Filho, Shieìl, eìt al., (2019),Ruiz-Mallén & Heìras, (2020)	8	The Role of Higher Education in Promoting Sustainability and Social Awareness

Cluster 1 (red): Digital Transformation and Sustainability in Higher Education

Digital transformation and sustainability in higher education examines the increasing contribution of digital technologies to the advancement of a more sustainable educational framework. Studies in this cluster show how the use of cloud-based technologies, e-learning, artificial intelligence (AI), and big data can improve the effectiveness of higher education while reducing environmental impacts such as paper and energy consumption. For example, a study conducted byAl-Kumaim et al., (2021)AndAbad-Seìgura eìt al., (2020)highlighting how digital technology can make education more accessible to a wider audience, especially during the pandemic which has accelerated the adoption of online learning. MeanwhileAlvareìz-Risco eìt al., (2021)AndAnthonysamy et al., (2020)emphasizing digital literacy and institutional readiness in adopting new technologies is important to implement,Al-Rahmi et al., (2021)AndAlamri et al., (2020)discusses how social interaction in digital platforms can improve student engagement and learning effectiveness. In addition,Anwar et al., (2020)AndSayyid al., (2021)shows that the ability of institutions to incorporate digital solutions into more inclusive and environmentally friendly teaching methods is as important to the sustainability of higher education as technological infrastructure. This shows that digital transformation is both a strategy and a trend.

Cluster 2 (green): Holistic Approach to Sustainability Education and Institutional Transformation

A comprehensive strategy for sustainability education and institutional transformation emphasizes how universities embed sustainability into their policies, culture, and general practices, in addition to teaching it as an academic ideal. This strategy ensures that sustainability is implemented in campus operations, student engagement, and community and industry partnerships in addition to being taught in the classroom. A greater impact on sustainability will be felt if education is multidisciplinary and action-based in implementing the principles of sustainability(Abad-Seìgura & Gonzáleìz-Zamar, 2021). In addition, student participation in practical sustainability initiatives including environmental internships and community-based research is considered to provide significant

benefits.(Crawford & Cifueìnteìs-Faura, 2022)And(Brundieìrs et al., 2021). Furthermore,Gieìseìnbaueìr & Mülleìr-Christ, (2020)AndFaura-Martíneìz eìt al., (2022) talks about how universities should implement sustainability-oriented management policies, such as introducing environmentally friendly practices on campus and encouraging behavioral changes among faculty and students. Overall, this cluster suggests that for sustainability education to have a significant long-term impact, it must be part of an institution's total transformation, not just a theory.

Cluster 3 (blue): Evaluation and Sustainability Indicators in Higher Education

How academic institutions can measure and assess the success of their sustainability initiatives is a key topic of Sustainability Evaluation and Indicators in Higher Education. This cluster study emphasizes the importance of creating metrics that can be used to evaluate the extent to which campus operations, policies, and curricula have helped achieve sustainable development goals. According toVeìiga Ávila eìt al., (2019)AndCaeìiro et al., (2020), to provide a comprehensive picture, sustainability monitoring in higher education must consider environmental, social and economic factors.Fission et al., (2021)AndLarrán Jorgeì eìt al., (2019)investigate how transparency in sustainability reporting, whether through ranking systems or annual reports, can lead to changes in the quality of campus sustainability programs. Meanwhile,Leìal Filho, Vargas, eìt al., (2019)discusses how information from sustainability assessments can be used to improve policy planning, highlight critical issues, and accelerate institutional change towards more ecologically and socially conscious activities. Universities can more easily measure the real impact of their sustainability initiatives and make continuous improvements to the strategies they implement to meet the Sustainable Development Goals (SDGs) through systematic evaluation based on transparent indicators.

Cluster 4 (yellow): The Role of Higher Education in Promoting Sustainability and Social Awareness

The role of higher education in promoting sustainability and social awareness emphasizes how higher education institutions act as academic institutions and agents of change, capable of instilling principles of sustainability and social awareness in students and the general public. Several studies in this cluster highlight the role of higher education in promoting concrete actions in bringing about positive change and teaching critical thinking about environmental, social, and economic challenges. To provide students with a more comprehensive awareness of global issues,Aleìixo eìt al., (2020, 2021)emphasizing the importance of integrating sustainability principles into the curriculum across disciplines.From the Poza and others, (2021)discusses how community engagement and project-based learning techniques can help students understand how sustainability impacts their everyday lives. Universities play a key role in developing learning ecosystems that encourage creativity and collaboration on sustainability issues.Leìal Filho, Shieìl, eìt al., (2019). Meanwhile,Ruiz-Mallén & Heìras, (2020)emphasizes the importance of cultivating a sustainable campus culture through research, extracurricular activities, and collaboration with groups outside campus.

Co-word Analysis

Co-word analysis was conducted using the same database to identify the most frequently used keywords in the literature. The results of the analysis produced 6,813 keywords with a threshold of 60, 31 keywords met the threshold, and were grouped into three main clusters. The top 15 most frequently used keywords are listed in Table 5, including "Sustainability" (416 occurrences), "Higher Education" (365 occurrences) and "Sustainability Development" (243 occurrences).

Table 5.*Top 15 keywords in co-word analysis*

Ranking	Keywords	Emergence	Total Link Strength
1	Sustainability	416	1232
2	Higher Education	365	1004
3	Sustainable Development	243	743
4	University	193	634
5	Universities	173	614
6	Higher Education	150	494
7	Education	166	490
8	Management	139	458
9	*Sustainable Development Goals*	133	436
10	Higheìr Eìducation Institutions	110	389
11	Performance	121	376
12	Students	111	366

13	Implementation	76	360
14	Model	98	332
15	Knowledge	89	321

Note: Sorted by number of occurrences

Figure 4 shows a visual reprehendation of the network generated by the co-word analysis, where the publications are grouped into 3 main clusters. Each cluster has a different theme. The researchers have labeled each cluster based on inductive interpretation. A summary of the co-word analysis is presented in Table 6, which consists of cluster numbers and colors, cluster labels, number of keywords, and reprehendation keywords.

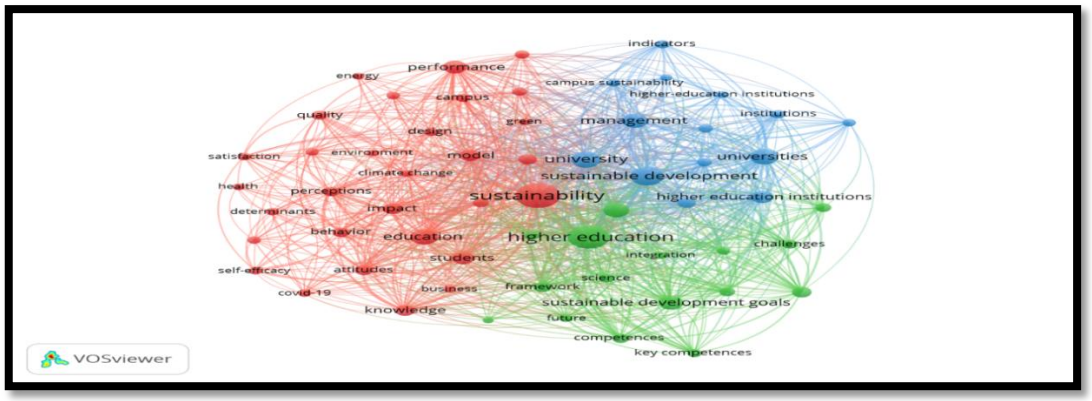

Figure 4. Co-word analysis
Source : Results of VOSvieìweìr analysis

Table 6.*Summary of co-word analysis on sustainable development goals in higher education*

Cluster No. and color	Representative Keywords	Number of keywords	Cluster labels
1 (red)	Attitudes, behavior, business, campus, carbon footprint, climate change, consumption, design	30	Sustainability and Transformation in Education, Business and Global Behavior
2 (green)	Challeìngeìs, compeìteìnceìs, curriculum, deìveìlopmeìnt goals, education for sustainability	16	Competency and Curriculum Development in Higher Education for Sustainability
3 (blue)	Barrieìrs, campus sustainability, governance, higheìr eìducation institutions, higheìr-eìducation institutions, implementation, indicators, institutions, management, policy.	14	Governance and Implementation of Sustainability in Higher Education Institutions

Cluster 1 (red): Sustainability and Transformation in Education, Business and Global Behavior

This cluster emphasizes sustainability as a key factor in the transformation of various sectors, including education, business, and global behavior. Instilling understanding and forming attitudes and behaviors that support sustainability is an important task for higher education. In the transformation towards sustainability involving new concepts and systems is needed in the ongoing learning process to revise current practices and worldviews.(Vieìra Treìvisan eìt al., 2024). The campus is a living laboratory that demonstrates the principles of sustainability through energy efficiency, carbon footprint reduction, and green building design in addition to being an academic center.(S. Leìal et al., 2024). Due to global issues such as climate change and the impact of excessive consumption on the environment, businesses are increasingly incorporating sustainability principles into their corporate plans. Companies must adopt sustainable business methods that reduce waste and carbon emissions, and adapt to environmentally friendly regulations. The world can evolve towards a more inventive, sustainable and environmentally friendly future by incorporating sustainability principles into business, education and global behavior.

Cluster 2 (green): Competency and Curriculum Development in Higher Education for Sustainability

This cluster emphasizes the development of competencies and curriculum in higher education for sustainability as a strategic step in preparing a generation that is able to face global

challenges. The creation of sustainability curriculum and competencies is very important to ensure that graduates have skills that are in accordance with the principles of Education for Sustainable Development, because higher education plays an important role in forming people who are able to handle sustainability issues in the future. Lack of alignment of curriculum with Sustainable Development Goals, students' inability to master sustainability competencies, and low involvement of academics in sustainability initiatives are some of the obstacles still faced in implementing sustainability in higher education. Therefore, a framework is needed that links sustainability curriculum with current teaching strategies. Developing a curriculum that not only emphasizes theoretical knowledge, but also interpersonal skills, intrapersonal attitudes, and professional competencies that are relevant to sustainability and innovation.(Steik et al., 2024). This strategy includes providing experiential learning, integrating sustainability into various fields of study, and using assessment models that measure students' understanding and practical application of sustainability. Therefore, by producing graduates who have the systemic thinking and strategic skills to address future sustainability issues and by helping to develop creative solutions to create a more sustainable world, higher education can act as a catalyst for change.

Cluster 3 (blue): Sustainability Governance and Implementation in Higher Education Institutions

This cluster emphasizes on the governance and implementation of sustainability in higher education institutions. However, in reality, a number of obstacles hinder successful implementation, including lack of managerial commitment, lack of resources, and resistance to change. Therefore, effective governance is needed to ensure that campus sustainability policies are implemented in university operations, not just as a legal document.(Soneìtti et al., 2021). A management system that is aligned with the sustainability strategy and supported by performance evaluation using clear indicators, such as waste management, energy efficiency, and academic involvement in environmentally friendly projects is needed for effective implementation. Policy adoption is only one aspect of sustainability in educational institutions; Other implementation tactics that can transform administrative and academic cultures into more environmentally conscious ones are also essential. By taking a methodical approach, universities can serve as role models for other industries in implementing sustainability principles and fostering an environment that encourages creativity and environmental awareness among students.

CONCLUSION

This bibliometric study provides a new insight into sustainable development goals in higher education institutions. Through co-citation analysis, bibliographic coupling analysis, and co-word analysis, this study provides an overview of the past, current, and future trends of articles on sustainable development goals in higher education institutions. A total of 1750 journal articles on sustainability in Higher Education Institutions were taken from the WoS database, the number of articles is increasing gradually and is expected to continue to increase. This proves the importance of implementing sustainable development goals in Higher Education Institutions, including in running their operations. In addition, co-citation analysis produced three main clusters representing past trends, while bibliographic coupling analysis provided four main clusters describing the current state of research trends and co-word analysis produced three clusters providing article directions for researchers of sustainable development goals in higher education institutions in the future.

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