International Journal of Business and Management Sciences **E ISSN**: 2708 – 4337 **P ISSN:** 2708 – 4329
Available online at http://www.ijbms.org
International Journal of Business and Management Sciences
Volume 04 (04), 2023
Received, 01 December, 2023, Accepted, 30 December, 2023, Published, 31 December, 2023.

Assessment of Integration of Sustainable Development Principles in University Curricula, A Systematic Literature Review

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Keywords:
Sustainable Development, Education for Sustainable Development, Higher Education, Curricula Assessment.

ABSTRACT

Sustainable development (SD) concerns are important and recurring in higher education (HE), industries, businesses, and other sectors globally. They are crucial considering environmental issues and the need to balance economic, environmental, and social factors. Over the past two years, HE has become more interested in sustainability, and SD features should be included in curricula to raise understanding of SD challenges. Thus, individuals and organizations can seek solutions for a more sustainable and resilient future. The first step in promoting sustainability in HE is to evaluate how well SD principles are incorporated into existing curricula. The rationale behind undertaking the Systematic Literature Review (SLR) was to ascertain the underlying cause. The SLR comprised 27 articles published in renowned journals categorized into five primary themes offering an extensive overview of research conducted over sixteen years, encompassing the years 2006 to 2022, and complied with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Those five themes focus on "The tools for assessment of integration SD principles in curricula", "Integration of SD principles in Higher Education", "Integration of SD principles in Specific Disciplines", "Barriers and Challenges in Integration", and "Case Studies and Implementation Strategies". The SLR's findings highlight a notable surge in interest regarding the integration of SD principles into university curricula, recognized as crucial in addressing global challenges like climate change, resource depletion, and societal disparities. It explored assessment techniques, obstacles in the integration of SD principles into curricula, and strategies to overcome them.

INTRODUCTION

The sustainability concept was developed by Brundtland (WCED, 1987), based on the intersections of the economic, social, and environmental aspects of corporate actions.

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Likewise, these three aspects are captured in the UI Green Metric criteria; as shown in figure: 1 the instrument Illustrates the environmental aspect including the use of natural resources, environmental management, and pollution prevention, the economic aspect includes profit and cost saving, whereas the social aspect comprises of education, community, and social involvement.

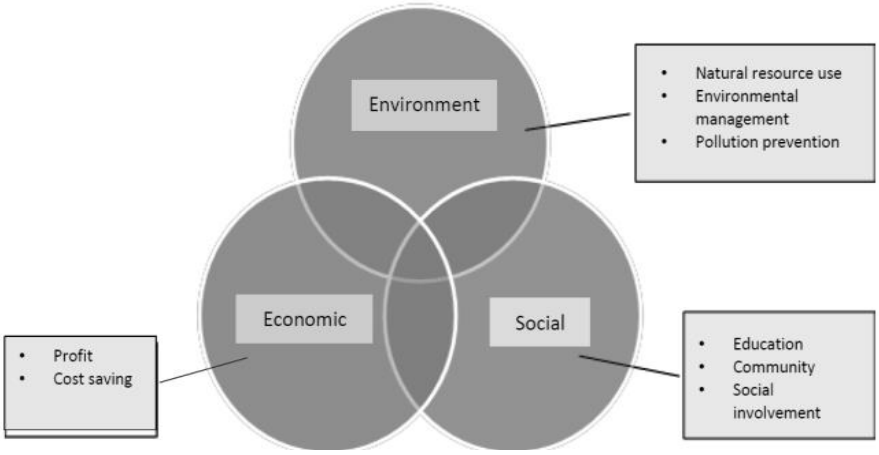

Figure 1: UI Green Metric criteria.
Source: UI Green Metric World University Rankings model (2018)

The United Nations defined 17 goals for sustainable development when it chose the 2030 plan. As of January 2016, these goals had been adopted, and they will drive international development efforts for the next 15 years (Nazar, et al., 2018). The United Nation's sustainability development goals position education at 4th place right after the most basic needs i.e. poverty reduction, hunger and health and the 17 SDGs are interconnected, in the sense that they acknowledge that actions performed in one area have ramifications in other areas and that development must achieve a balance between social, economic, and environmental sustainability. So, HEIs throughout the world are becoming very active in the promotion of sustainable development with an increasing quantity of participating stakeholders. Therefore, education is merely one of the solutions for achieving sustainable development goals, though some reasons that create hurdle in the integration of sustainable development principles are (1) Ignorance or a lack of understanding of the significance of Sustainable development (Velazquez et al., 2005). (2) a lack of appropriate settings and support for change (Velazquez et al., 2005). (3) Teachers and academics who teach in interdisciplinary courses that are required for ESD face uneasiness and the threat of losing their academic credibility (Peet et al., 2004).(4) Courses that are overburdened (Abdul-Wahab et al., 2003, Chau, 2007).(5) Teachers who might prevent or promote the integration (Barab & Luehmann, 2003). Despite these challenges, integrating sustainability into diverse

academic curricula has been recognized to be essential for providing students with the skills and insights to help societies become more sustainable (Lozano, 2010) some engineering schools have been pioneers in incorporating sustainable development and sustainability science into their curricula ((Lozano & Lozano, 2014), This is evidenced by the efforts of faculty at Chalmers University of Technology (Sweden), Tecnológico de Monterrey (Mexico), Technical University of Catalonia (Spain), TU Delft (the Netherlands), and ETH Zurich (Switzerland) (Lozano, et al., 2013).

The systematic literature review emphasizes the importance of assessing curricula in higher education. It answers the question of why curricula assessment is needed to integrate sustainable development principles into university curricula.

The need to spread sustainable development has never been greater than today, which is struggling to cope with worsening environmental problems and complex social dynamics. The concept of SD which integrates environmental protection, social justice, and economic viability has evolved from a niche theory to a widely shared aspiration in the face of many obstacles, higher education institutions, particularly universities, have the chance to shape future leaders who can make substantial and transformative changes. (WCED, 1987). The Stockholm Conference (UNEP, 1972) highlights the importance of education in promoting environmental protection and conservation. Since then, a notable array of declarations, charters, and collaborations among HEIs have emerged intending to advance environmental education (EE), sustainable development (SD), and education for sustainable development (ESD) (Lozano et al., 2013; Lozano et al., 2015; Ramísio et al., 2019).

According to Grindsted & Holm (2012) study, most universities worldwide have signed a few sustainability declarations, like the Talloires declarations (1990), the Halifax Declaration (1991), Kyoto declarations (1993), the World Declaration on Higher Education (1998), the Global Higher Education for Sustainability Partnership in 2000, the Barcelona declarations (2004), the Graz declarations (2005), the Sapporo declarations (2008), Lubeck declarations (2009). Similarly, many corporations have been encouraging universities to better prepare graduates for sustainable development. This trend has emerged as a significant motivator for educators to take a more proactive role in creating and delivering courses and curricula focused on these interdisciplinary aspects of knowledge (WBCSD, 2010). For instance, some engineering schools have been pioneers in incorporating sustainable development and sustainability science into their curricula (Glavic et al., 2009), this is evidenced by the efforts of faculty at Chalmers University of Technology (Sweden), Tecnológico de Monterrey

(Mexico), Technical University of Catalonia (Spain), TU Delft (the Netherlands), and ETH Zurich (Switzerland) (Lozano, et al., 2013), and there has been a noticeable rise in the integration and institutionalizing of sustainable development (SD) principles within the activities of higher education institutions, this includes the infusion of SD into their curricula, research endeavors, operational procedures, outreach initiatives, as well as assessment and reporting processes (Lozano., 2010). In addition to that, Lozano et al. (2014) proposed two further aspects of "Institutional Framework" and "On-campus experiences", totaling seven dimensions to be considered when analyzing the sustainability performance of universities. According to Barth and Michelsen, (2013), it is important to note that from the seven elements of HEI, 'Education' plays a central role in the promotion of sustainable development, and due to the increasing interest and involvement of universities in sustainability, there is a rising requirement to evaluate how their educational programs (curricula) cover the subject of SD along with its various aspects (Lozano & Watson, 2013). According to Boca and Saraçlı (2019), it was explained that the potential capabilities of students can be affected if sustainability principles are not adequately included in the offered curriculum, this can lead to the waste of energy resources, environmental heat emissions, carbon emissions, and over-budgeted technology development. Holdsworth et al. (2019) provided a further explanation on the matter of sustainability education in higher education prepares students to become informed citizens and future professionals who can actively contribute to a more sustainable future, and this can be achieved through awareness. To improve students' sustainability understanding, educational institutions must alter their vision, policies, instructional techniques, and curriculum. Several universities around the world have initiated efforts to incorporate sustainability knowledge into their curricula. Nevertheless, there is a gap in existing approaches for assessing how graduates apply this acquired knowledge in their respective workplaces after completing their degrees. Furthermore, a study conducted by Mukhtar et al. in 2019 presents an illustration that...The current challenges faced in sustainability encompassing issues such as ecosystem degradation, biodiversity loss, natural resource depletion, pollution, and widespread poverty are deeply intertwined with fundamental aspects of human thought. Acknowledging the urgency for transformative change, the United Nations designated the period from 2005 to 2014 as the Decade of Education for Sustainable Development (DESD), urging the thorough integration of sustainability principles at all educational levels. However, a critical research problem arises, specifically focusing on the imperative need to reassess curricula within Higher

Education Institutions (HEIs) for the incorporation of sustainable development principles. As the traditional goals of HEI curricula encompass knowledge-based, skill-based, and affective objectives, addressing all points, along with the literature research question at hand is: How can curricula be effectively evaluated and realigned to prioritize and assess the integration of sustainable development principles? The study has divided the research question into three sub-questions, which are as follows:

1. What existing literature is available on the assessment and integration of sustainable development into higher education curricula, and where can these published materials be found?
2. What themes are explored in the literature concerning assessment and incorporation/integration of sustainable development into curricula within the context of higher education?
3. What research gaps were identified in the literature concerning the assessment and integration of sustainable development into higher education?

METHODOLOGY

Systematic Literature Review is closely tied to scientific methods that aim to minimize systematic errors and biases by identifying, evaluating, and synthesizing relevant studies to address specific questions (Petticrew & Roberts, 2008). In a comprehensive SLR, the focus was on assessing and integrating sustainability in curricula. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which ensure consistency and accountability in SLR coverage (Moher et al., 2015; Shamseer et al., 2015). The stages of the review included planning, identifying relevant studies, establishing review criteria, and developing a review protocol. Subsequently, the review involved conducting a thorough search for primary studies, assessing their quality, and extracting and synthesizing data. In the final stage, the data were analyzed and discussed. The conclusion was drawn based on the findings.

Strategy of search:

The systematic literature review was conducted in two steps, each step is explained in more detail below (As shown in the figure: 2):

(1) identifying keywords and conducting searches, and,

(2) analyzing the content of the selected articles.

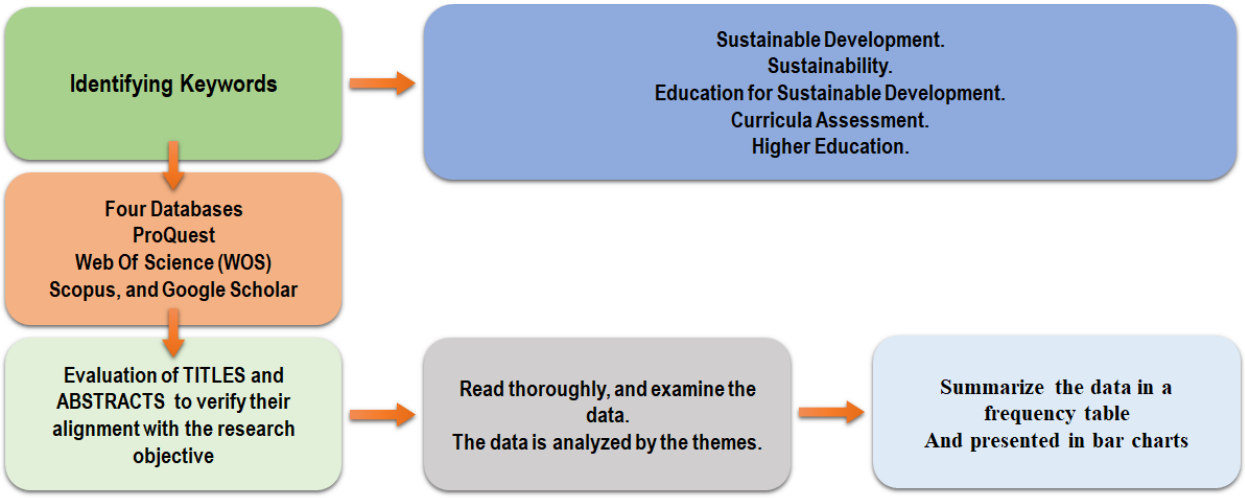

Figure:2 process of Systematic literature review

The literature search was conducted in a systematic manner utilizing the following keyword: “Sustainable development", “Sustainability", “Education for sustainable development", “Curricula assessment", and “Higher education”. The systematic literature review’s search process encompassed four databases: ProQuest, Web of Science (WOS), Scopus, and Google Scholar. Alongside the database searches, a manual search was executed, entailing the reviewing of relevant articles. This manual search encompassed both backward and forward citation searches through Google Scholar. The ultimate phase encompassed the evaluation of titles, abstracts, and keywords to verify their alignment with the research's objectives and assess the quality of the article. Following this initial screening, the articles underwent assessment through Field-Weighted Citation Impact (FWCI), the FWCI quantifies the frequency of citation of an article in comparison to a similar publication. An FWCI value surpassing 1.00 denotes that an article garners more citations than the global average for comparable works. Consequently, solely articles boasting an FWCI exceeding 1.00 were selected, resulting in a total compilation of 27 articles within the final dataset.

Inclusion and exclusion criteria

The criteria for inclusion and exclusion based on the PRISMA guidelines (2020) as detailed below facilitated the identification of relevant studies pertaining to the research questions. The research papers that meet at all inclusion criteria were selected as primary studies, while those aligning with any exclusion criteria were omitted from consideration.[i]

Inclusion criteria

- Published papers that were written in the English language.
- Papers that discussed the assessment/integration of sustainable development

- The research did not impose any geographical boundaries on the selection of papers.
- Articles that were written on the principles of sustainable development in the context of higher education.
- Papers published in the period 2006–2023.

Exclusion criteria

- Non-English language papers.
- Papers that did not use "Integration of sustainability, Assessment of sustainability, Higher education" either in the title, keyword list, abstract, or in the article itself without limitation of year of publication.
- Research papers that did not meet inclusion criteria were rejected, e.g., information that was beyond the scope of the study.
- Duplicate papers with the same contents, but published in different places.
- Papers published before the year 2006.

The research commenced with an initial dataset of 207 research papers, which then underwent a rigorous procedure of identification and filtration, based on the scrutiny of their abstracts. Compliance with the guidelines of PRISMA (Moher et al., 2015; Shamseer et al., 2015). The process followed predetermined inclusion and exclusion criteria to minimize potential biases. As a result of these systematic efforts irrelevant and duplicated papers were eliminated leading to the identification of 35 studies that were relevant to the research. Subsequently, from the pool of selected studies a subset of 27 papers emerged as directly applicable to addressing the research question under consideration as shown in Figure: 3. These studies played a vital role in providing essential evidence to support the research objectives. The findings were exclusively reported from well-conducted studies that exhibit no evidence of publication bias. The process involved the authors' interpretation of selected articles, with each article being meticulously reviewed and assessed by two authors independently. Once a consensus was reached on each article's interpretation, the data was consistently entered in a standardized format. To minimize inherent bias, the authors made a conscious effort to avoid cross-referencing the papers independently. Nevertheless, this research can be considered robust, as exhaustive measures were taken to minimize potential errors. Furthermore, the SLR process prioritizes the quality of assessment as a fundamental aspect, typically employed to ensure validity and reliability standards. The majority of the studies scrutinized in this review maintained a consistent focus on sustainable development

(SD) and its various dimensions across the world. Three researchers collaborated on this literature review, and they engaged in comprehensive discussions and comparisons of all steps both before and after the review, with the aim of enhancing inter-rater reliability in the process of literature analysis (Drost, 2011).

The search and selection process is presented in the following flow diagram, providing a comprehensive breakdown of each step. This flow diagram outlines the databases that were accessed, the documents acquired and discarded during each phase, and the rationale for their exclusion at different phases of the systematic review.

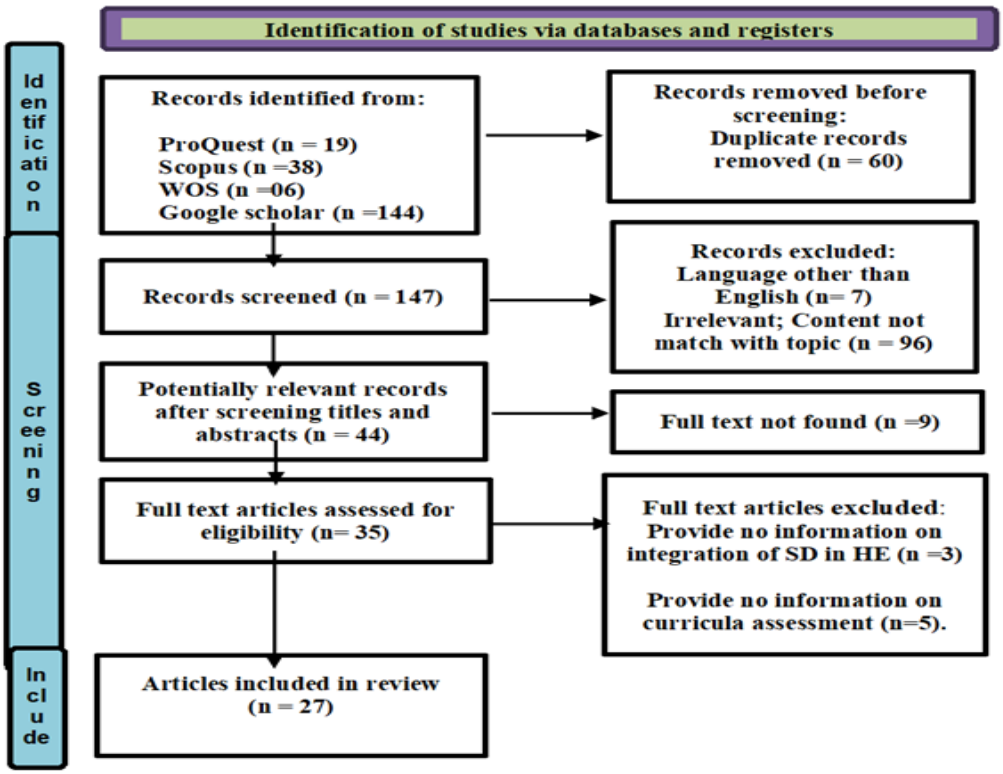

Figure: 3. Diagram for Inclusion and Exclusion Criteria

ANALYSIS

The initial phase is exploring the literature concerning assessment and the integration of sustainable development can be bifurcated into two distinct sub-questions: "What relevant literature is available/accessible on the topic “assessment and integration of SD in HEIs?" and “In which publications can this relevant literature be found/published"? Figure 4. illustrates the comprehensive results obtained from the analysis of these articles which will be detailed in the forthcoming results section.

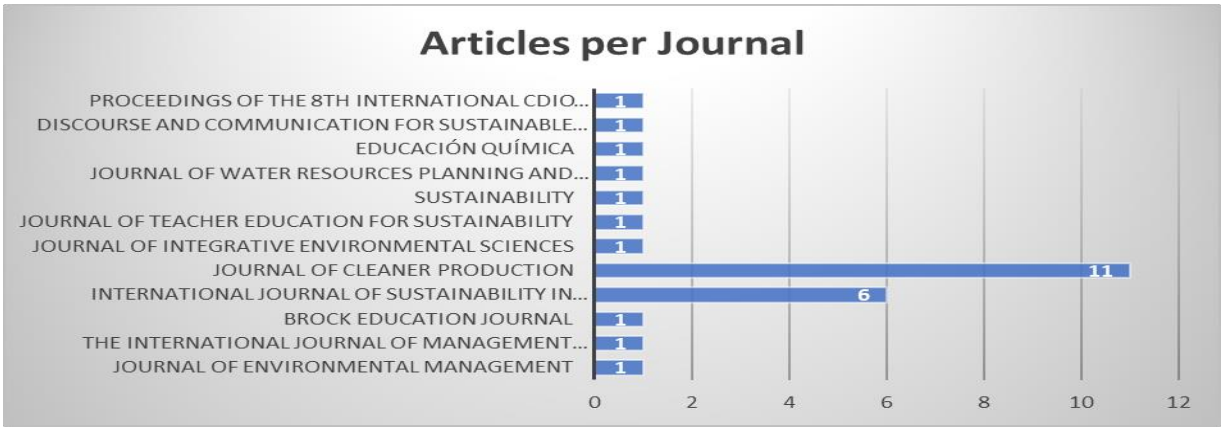

Figure :4 No of Articles per Journals

No of Articles per Journal:

The relevant literature search yielded 27 articles all of which published in reputable journals and covered the central themes of sustainability, education of sustainable development, and curricula assessment, integration, higher education. The majority of these articles published in a reputable journal such as the "Journal of Cleaner Production' (11) and the 'International Journal of Sustainability in Higher Education' (06). Additional contributions were made by articles in publications like 'Sustainability', 'Journal of Environmental Management', 'Brock Education Journal', 'Journal of Water Resources Planning and Management', 'Educación Química', 'Journal of Teacher Education for Sustainability', 'Discourse and Communication for Sustainable Education', 'Innovative Higher Education', 'Journal of Integrative Environmental Sciences', 'Socio-Economic Planning Sciences', 'The International Journal of Management Education' were included in the collection.

Interdisciplinary Coverage:

The research papers encompass a range of diverse disciplines, spanning education, management, engineering, environmental sciences, and social sciences. This diverse range underscores the interdisciplinary essence of integrating sustainable development into curricula, as illustrated in Figure 5.

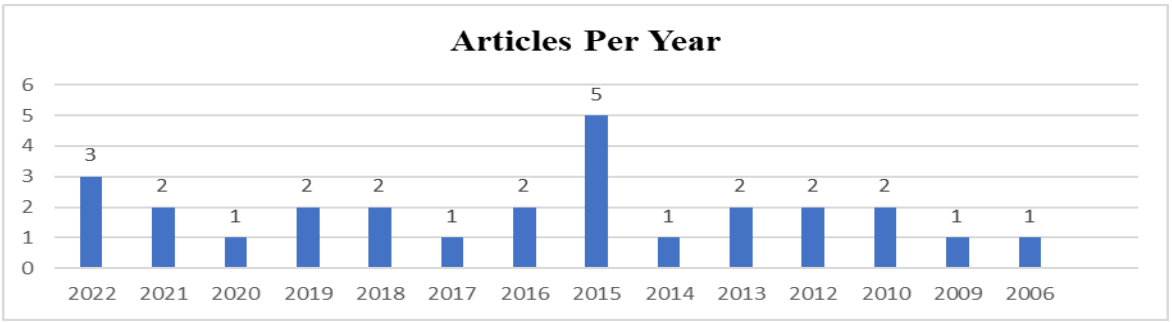

Figure:5 No of Articles Per Year

No of Articles Per Year:

The review focused on papers published from 2006 to 2022, A substantial portion of the research papers stem from recent years with a pronounced rise in publications around 2015. This heightened attention during that timeframe indicates a growing scholarly interest in the subject over the past decade. Figure: 3 visually depicts the chronological dispersion of these pivotal articles, clearly indicating a rising trend in research activity within this domain over time.

Global Perspective:

The literature comprises contributions from diverse countries and regions. Specifically, the majority of the articles focused on HEIs located in North America, including the United States, Mexico, and Canada. In South America, Brazil emerged as a focal point of investigation. Similarly, in Europe, the United Kingdom and several countries within the European continent such as Germany, Spain, Portugal, Sweden, and Belgium made significant contributions to the literature. Moving to the Asia-Pacific region, Australia and China played substantial roles in the discourse. Additionally, attention was directed towards other parts of the world HEIs in Asia, specifically Pakistan and India, were featured in the literature. South Africa, Colombia, and Slovenia were also areas of interest as well as Belgium, Malaysia, Romania, Poland, the Netherlands, Jordan, Lebanon, Russia, and Nigeria, embedding a wide international reach of research efforts.

This comprehensive dispersion of contributions highlights the global awareness and emphasis on embedding sustainability within higher education systems. It demonstrates a concerted effort by scholars and institutions across different corners of the world to address sustainability challenges through education.

No of Themes:

The analysis of the systematic overview of the literature concerning research articles has been categorized into five themes: "Assessment Tools for Integrating SD Principles in Curricula," "Integration of SD Principles in Higher Education," "Integration of SD Principles in Specific Disciplines," "Barriers and Challenges in Integration," and "Case Studies and Implementation Strategies." Collectively, the research papers encompass a wide range of themes, reflecting the dedicated efforts of higher education institutions to infuse sustainability across diverse academic disciplines. Figure 6 visually represents the dissemination of articles across five categories, providing a clear visual representation of the research field.

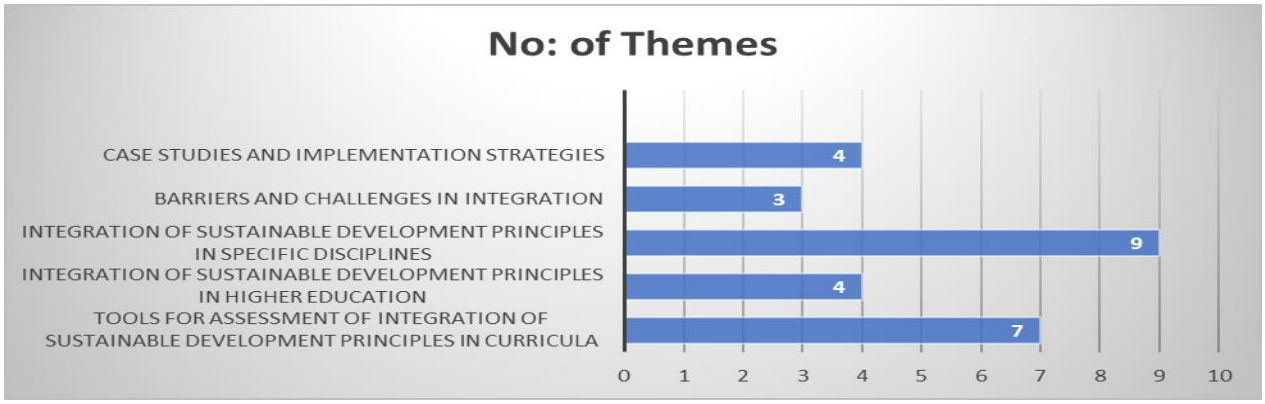

Figure: 6. No of Themes

Through an analysis of various research articles, it was observed that a total of seven (07) from 27 articles could be categorized under the overarching theme of "Tools for Assessment and Integration of Sustainable Development Principles in Curricula." The significance of these particular articles lies in their focus on providing insights, tools and methods related to effectively assessing and integrating sustainability principles into educational curricula. In the following sub-sections, each of these articles will be comprehensively elaborated upon.

Theme: 1: Tools for Assessment and Integration of Sustainability in Curricula

The analysis of Theme 1, "Tools for Assessment of Integration of Sustainable Development Principles in Curricula", revealed that Watson et al. (2013) conducted a comprehensive assessment of curriculum integration and content utilizing the STAUNCH® tool, their findings emphasized the predominant influence of environmental parameters compared to other parameters. These results were further supported by student surveys corroborating the assessment and providing a comprehensive perspective on sustainability's role in engineering education. This assessment aligns with further studies conducted by Lozano et al. (2013) and Khayat and Ahmed (2017), both employed the STAUNCH® tool to analyze curriculum integration. Notably, these studies highlighted a significant focus on the environmental aspect of sustainable development. However, the literature suggests a deficiency/lack of substantial sustainability content within engineering curricula, with environmental aspects overshadowing economic and social dimensions (Akeel et al., 2019). The versatility of the STAUNCH® tool is evident across various educational institutions, including Cardiff University, Tecnológico de Monterrey, Worcester University, the Georgia Institute of Technology, and the University of Leeds. Furthermore, the tool's application extended to all 11 Welsh universities (Lozano and Lozano., 2014). On the other hand, Biasutti et al (2016) focused on the peer review process used to revise the curricula by employing quantitative methods for curricula assessment at Jordanian universities, utilizing the Assessment Template

(AT) as their main tool to assess the revised courses revealing key themes related to Education for Sustainable Development (ESD), the strategies adopted by professors in revising curricula and discusses implications for syllabus development and teaching methods. The peer assessment process conducted through meetings and discussions showcases the commitment to integrating sustainability into higher education reflecting both metacognitive strategies and goal-oriented curriculum planning. Likewise, Alshuwaikhat., et al (2016) evaluated sustainability integration within Saudi Arabian public sector universities across teaching, research, campus operations, management, and finances by utilizing a sustainability assessment questionnaire (SAQ). The findings revealed limited progress in sustainability efforts including a lack of relevant academic courses, insufficient research focus, inadequate campus operations, and weak financial management commitment aligning with Saudi Vision 2030, policy recommendations are proposed to enhance sustainability practices in universities and position them as global benchmarks for sustainable development.

Stough et al. (2018) conducted a validation study of assessment tools for use in evaluating educational programs and courses. Two different approaches were investigated in their study: (1) The analysis of European Credit Transfer and Accumulation System (ECTS) files. (2) An instructor self-assessment supplemented by an additional course file. Their findings underscore the widespread practice within Higher Education Institutions (HEIs) of relying heavily on course overview documents such as ECTS files to assess curricular sustainability. However, the limitations of this approach became evident. The incorporation of a supplementary course file offers evaluators invaluable insights facilitating a comprehensive comprehension of how individual courses contribute to sustainable development education. This encompasses factors like sustainability concept integration, skills development, and sustainable teaching methodologies.

Obrecht et al. (2022) presented a systematic conceptual framework for integrating environmental sustainability into education to establish foundational concepts in environmental protection, social responsibility, circular economy, ecology, and eco-friendly practices to improve environmental management in industries and services. Most of the literature has described tools for assessing sustainably integration into curricula, and the list of these tools is shown in Table: 1.

Table: 1: "Tools for Assessment of Integration of Sustainable Development Principles in curricula"

S#	Tool Name	Purpose	Tool Applied in	Assessment Result	Developed by
1	STAUNCH® Tool.	Curricula assessment has been done for 19 curricula in 28 schools for 5,400 course descriptions	In the UK, Cardiff University (Lozano and Peattie, 2011).	The tool highlighted that certain areas might be modified for better sustainability integration	(Lozano, 2010)
		Curricula assessment has been done	In the USA, Technologic de Monterrey (Mexico), (Lozano.et al, 2013).	The results reveal that the curriculum is well balanced in terms of SD dimensions, with a little preference for the environment dimension	
		Curricula assessment has been done, from business faculty 698 course descriptions and 2, 063 from faculty of environment were analyzed.	In the UK, the University of Leeds, (Lozano and Young, 2013).	The tool revealed that the faculty of environment has a better contribution than the business faculty	
		The architecture curriculum of SU-E assessed.	In Iraq, Salahaddin University, (Khayat and Ahmed, 2017).	The curriculum has a very low effect of SD, which accounts for only 10% of the curriculum and includes (16%) economic, (18%) social, (40%) environmental, and (26%) cross-cutting issues	
2	STAUNCH® Tool. And students' perceptions surveys.	Curricula assessment (44-course descriptions) And student perceptions were performed.	In the USA, the Institute of Technology (Georgia), (Watson, et al., 2013).	The environmental dimension of sustainability (62%), with lower contributions to the cross-cutting (24%), economic (12%) and social (3%) ones.	(Lozano, 2010)
3	STAUNCH® Tool	Assessment of Chemistry Curricula	In the UK, Cardiff University (Lozano and Watson, 2013).	Coverage of environmental and/or social issues in some courses.	(Lozano, 2010)
4	Quantitative method: Questionnaire	Content analysis using the 37 themes of STAUNCH® Tool, and analyzed by NVivo software	Nigerian engineering curriculum	Environmental concepts are the most cited themes and social topics as the least stated issues	(Akeel, 2019)

S#	Tool Name	Purpose	Tool Applied in	Assessment Result	Developed by
5	A scan of a European Credit Transfer & Accumulation System (ECTS) file and an instructor Self-assessment via a supplementary course file.	Assessing sustainability in higher education curricula by using two approaches	A KU Leuven, Faculty of Economics and Business, Warmoesberg, Belgium	ECTS files, along with Complementary course files, provide a holistic view of curriculum sustainability, though ECTS file is a common method with limitations.	
6	Sustainability Assessment Questionnaire (SAQ) tool	Sustainability assessment of higher education institutions	public sector universities of Saudi Arabia	Results revealed that sustainability-related projects are not prioritized within universities and sustainable financial management practices are not significant.	SAQ tool developed by University Leaders for a Sustainable Future (ULSF) between 1999 and 2001
7	Quantitative methods (AT; Assessment Template)	The AT was developed to assess the revised courses as a tool for self-peer-external assessment.	Jordanian universities	Results showed that environmental concepts are the most cited themes	AT (Assessment Template) Developed by the research team directed by Prof. Makrakis within the framework of the RUCAS project.

This overarching theme reflects the collective focus of the research papers on assessing, evaluating, and integrating sustainability principles within higher education curricula. For instance, in the qualitative method, Content analysis (by using the STAUNCH® tool) serves as a valuable tool enabling researchers to systematically examine the extent to which sustainable development principles are incorporated across different courses. In the quantitative method, the questionnaire (Sustainability Assessment Questionnaire (SAQ), Assessment Template (AT)) facilitates the collection of quantifiable data from stakeholders, shedding light on perceptions and areas for improvement. By encompassing a variety of assessment tools educators and policymakers gain a holistic understanding of the progress and challenges in integrating sustainable development into curricula. This detailed examination aids in refining strategies and improving the efficacy of integration efforts ultimately contributing to the overarching goal of fostering a more sustainable and resilient educational landscape.

Theme 2: Integration of Sustainable Development Principles in Higher Education

Within the scope of the literature review sample, a total of four (04) articles out of 27 were classified under the category "Integration of Sustainability in Higher Education." The subsequent description provides a concise overview of these articles offering a glimpse into their collective insights and contributions to the realm of embedding sustainability within higher education.

Throughout the past twenty years, a noticeable trend has arisen within higher education institutions as they proactively integrate principles of sustainable development into their academic frameworks. The extent to which this integration proves effective is a core concern in the study conducted by Lozano et al. (2015) their study adopts a survey-based approach, scrutinizing 84 participants from 70 international institutions, and the findings revealed that though implementation exists, it often remains fragmented. Notably, successful integration correlates with strong commitments such as signing sustainability declarations, the role of committed leadership emerges as pivotal within this progression. Similarly, Holm et al. (2015) focused on promoting sustainability in higher education through tangible actions. They highlighted the global adoption of quality assurance and management systems to enhance teaching and learning. However, integrating education for sustainable development (ESD) within this context was relatively unexplored. Their proposed solution involved voluntarily integrating ESD into university management systems developed collaboratively with 11 Nordic universities, this approach offers a comprehensive framework guiding stages from planning to practical ESD implementation. The framework's utility was demonstrated by applying it to identify sustainability aspects across disciplines, showcasing its practicality for assimilating ESD into university practices. Additionally, Anand et al. (2015) proposed a unique approach to integrate sustainable development into higher education. Through collaboration among two universities and five colleges in Quebec, Canada, this strategy encompasses diverse elements like faculty support, program alignment, policy changes, and inter-institutional collaboration. This collaborative regional approach fosters a community of practitioners, enhancing educators' skills in sustainable development pedagogy. Early assessments show increased student understanding of sustainability concepts and a positive attitude toward sustainability. The initiative emphasizes that integration goes beyond academics, enriching the overall campus experience. Similarly, Ferguson et al. (2022) contribute by focusing on the integration of ESD through teacher training within a Jamaican institution. Their research unfolds the benefits of deliberate ESD integration, evidenced by

expanded student comprehension of sustainable development. This approach involving teacher educators collaborating on an action research project effectively broadened students' perspectives on SD, particularly regarding its social, economic, and environmental dimensions. The study underscores the significant impact of integrating ESD intentionally enabling students to better understand SD and appreciate its interdisciplinary nature, equitable education implications, and potential for driving behavioral change.

In synthesis, these studies collectively underscore the paramount importance of strategic integration efforts within higher education, whether through systematic institutional changes, regional collaborations, or teacher training, these initiatives serve as potent catalysts for fostering enhanced awareness and practical implementation of SD principles.

Theme 3: Integration of sustainable development principles in specific disciplines:

The theme “integration of sustainable development principles into specific disciplines” is explored through a collection of studies, each offering unique insights into the challenges and strategies associated with this endeavor Banga Chhokar (2010) rigorously assessed sustainable development progress in Indian higher education, comparing diverse approaches and analyzing environmental education initiatives. It covers philosophy, policy, and practice aspects, highlighting challenges like limited interdisciplinary expertise and traditional assessment methods. It also underscores the emergence of student-driven sustainability initiatives and successful community efforts offering insights into India's distinct sustainable development landscape. Continuing this exploration, Lozano & Lozano (2014) outlined a 4-year curriculum approach to embed sustainable design principles in undergraduate education, progressing from freshman-year awareness to senior capstone project application. Student assessment demonstrated enhanced comprehension and abilities with the future for a detailed evaluation of practical application and evaluation of sustainability principles. Similarly, Price & Robinson (2015) developed a strategic four-year plan to integrate sustainable design principles in the undergraduate specifically in the civil engineering curriculum, enhancing students' readiness for real-world challenges. The approach progresses from creating awareness in a freshman course, describing sustainability science in a sophomore course considering sustainability in third-year technical design courses, and culminating in senior capstone design where students apply sustainability principles. Student assessment indicated improved comprehension and ability in sustainable design over the first two years. Further evaluation of senior design submissions is planned for Year 4 to measure students' application and evaluation of sustainability principles in the design process. Furthermore,

Von Blottnitz et al (2015) presented a case study on integrating SD into chemical engineering education and discussed a successful initiative at the University of Cape Town to reform the chemical engineering curriculum by integrating SD principles. The entire curriculum was revamped, starting with a foundational first-year course that introduces nature as a guide. The approach resulted in notable improvements in students' environmental and sustainability knowledge, affirming the effectiveness of early integration of these concepts in engineering education. Conversely, the Malaysian study reveals a shared interest among stakeholders to embed SD in education, yet the challenge lies in overcoming barriers. Through a case study conducted in Selangor, the study formulates a framework for incorporating SD concepts into the chemistry curriculum, identifying essential aspects such as policy, awareness, resources, curriculum, pedagogy, and stakeholder engagement (Kanapathy et al., 2021). Together, these works emphasize the importance of early integration, pedagogical innovation, and strategic frameworks in fostering sustainable education practices across diverse contexts. Furthermore, Bradley (2019) specifically assessed sustainable development integration within an economics curriculum through a department-wide intervention, employing surveys and interviews, findings reveal partial integration with resistance and barriers, including the hindrance posed by the Research Excellence Framework in recruiting interdisciplinary economists. The study emphasizes the pivotal role of economics in sustainability and underscores the need for comprehensive changes in curriculum to address challenges and promote sustainable development goals. Similarly, Arefin et al. (2021) address sustainability integration in Australian engineering curricula, addressing challenges like resistance to change and proposing solutions centered on interdisciplinary collaboration, real-world case studies, and faculty development with institutional support. Both studies underscore the importance of transformative strategies to equip future engineers with crucial sustainability skills. According to Yadav and Prakash (2022), the focus shifts to the fast-paced business environment, stressing the imperative for management education to update curricula to incorporate sustainability. This study identifies five key factors shaping the integration of sustainable development into Indian management education: awareness, institutional frameworks, external context, readiness, and educator resourcefulness, addressing these factors enhances implementation and empowers institutions to cultivate sustainable-minded future managers. In a comprehensive overview, Qu et al. (2020) emphasize the integration of sustainability into engineering education through "new engineering education" principles, including student-centered learning and interdisciplinary problem-solving. Their strategies

involve multidisciplinary courses and project-based learning, with a focus on faculty development and institutional support.

Conclusively, this theme revolves around the integration of sustainable development principles into specific disciplines within education. These works collectively highlight diverse strategies, challenges, and outcomes related to embedding sustainability in various academic contexts. The studies emphasize the significance of early integration, structured approaches, transformative strategies, and institutional support in fostering sustainable education practices and equipping future professionals with essential sustainability skills.

Theme 4: Barriers and Challenges in Integration:

This theme focuses on the challenges faced by higher education institutions in incorporating SD principles into their curricula, particularly in fields like management and engineering. The research papers collectively tackle the difficulties and challenges associated with the integration of SD, identify obstacles within higher education systems, and emphasize the significance of overcoming these barriers to implement sustainability measures effectively.

The theme “Barriers and challenges in the integration of sustainable development” within higher education institutions is evident in the works of Lozano (2006), Leal Filho et al. (2017), and Rampasso et al. (2018). It is explained by Lozano (2006) that the integration of SD in universities faces barriers tied to basic human needs, evident through Maslow's hierarchy. Resistance emerges in three stages: unfamiliarity, deeper issues, and ingrained beliefs. These barriers link with Spence's ideas of status protection and job security fears. Universities face unique obstacles like unwillingness to change and lack of SD information. To overcome, strategies like new information, peer influence, and participation are vital for successful SD incorporation.

Additionally, Leal Filho et al. (2017) underscored persisting obstacles in holistic sustainability integration, promoting the perspective of viewing barriers as entrepreneurial opportunities. furthermore, Rampasso et al. (2018) contributed with a focus on engineering education, identifying difficulties categorized into "structure and planning" and "didactic practice." Their study validated the causal link between planning challenges and teaching difficulties. These studies confirm that barriers exist when integrating SD. This highlights the need for strategic planning and transdisciplinary collaboration to achieve effective sustainability education. By summing up the discussion, this theme addressed the struggle of integrating SD, suggesting strategies to overcome resistance, and highlighting the importance of aligning teaching methods with the comprehensive SD concept.

Theme 5: Case Studies and Implementation Strategies:

The theme focused on “Case studies and implementation strategies” related to the integration of sustainable development in higher education. These studies explore various aspects of incorporating sustainable development into different educational programs, including mechanical engineering, curricula integration, green chemistry experiments, and assessment at an engineering faculty. The collective goal is to empower future professionals with the knowledge, skills, and perspectives needed to contribute to a more sustainable world

Karpudewan et al (2009) introduced green chemistry experiments as a pedagogical strategy to teach sustainable development concepts (SDCs) and traditional environmental concepts (TECs). Repeated measures and structured interviews demonstrate that green chemistry enhances students' understanding of both SDCs and TECs, with a stronger comprehension of SDCs. The course content is regarded as engaging and timely, fostering value and behavior changes. Students consider green chemistry a valuable pedagogy for their future teaching careers, improving communication and problem-solving skills. Furthermore, to shed light on the importance of educating educators Ceulemans & De Prins (2010) discussed teaching sustainability issues and the central role of teachers in curriculum renewal for sustainability. It introduces a teacher's manual and method for integrating sustainable development (SD) into higher education curricula. The manual combines teacher capacity-building and student-engaging teaching methods, remaining valuable even with limited management support. Unique features include its adaptability, self-instructional nature, and suitability for various teacher backgrounds and training stages. The method's applicability extends beyond the authors' institution, offering the potential for adaptation in other academic programs. The article notes financial constraints for wider manual development but expresses interest in sharing experiences with similar initiatives. Furthermore, in this context, a case study explained by Salem & Harb (2012) highlights the imperative of integrating Educational Sustainable Development (ESD) principles into engineering education, specifically within Notre Dame University - Louaize's Faculty of Engineering. The analysis employs ESD tools while considering ABET accreditation requirements. A comprehensive survey across key areas like curriculum, research, operations, and more revealed areas for improvement in sustainable practices. ESD has been introduced into select engineering courses, revealing students' awareness but gaps in knowledge. The proposal includes new sustainability-focused courses, aligning with ABET guidelines. The ongoing RUCAS project aims to enhance sustainable development principles infusion, adapting to local contexts. NDU's efforts hold

the potential to set a benchmark for sustainability education among Lebanese universities, within a continuous process of promoting ESD. Moreover, Enelund et al. (2012) discussed the successful integration of sustainable development education in Chalmers University's Mechanical Engineering MSc Eng program. The approach combines top-down and bottom-up methods to align course outcomes with program objectives. Sustainability topics are included in relevant courses and a dedicated module. Incorporating sustainability into design-build-test projects enhances immersive learning. Students' surveys show increased awareness of sustainability's practical value in engineering, especially in design decisions. Challenges include adapting to varying student knowledge and aligning with engineering demands. Addressing these challenges is crucial for refining this sustainability education framework. This marks an initial step towards tailored sustainability education in mechanical engineering at Chalmers University.

This theme discussed some studies and initiatives related to incorporating SD principles into university education. These efforts involve using green chemistry experiments to enhance students' understanding of SD concepts introducing teacher manuals for incorporating sustainability into higher education curricula, and analyzing the integration of educational SD principles in engineering education with successfully integrating sustainability education into a Mechanical Engineering program. These initiatives aim to promote sustainability awareness and practices within higher education institutions offering valuable insights and methodologies for educators and institutions to follow.

Discussion

The findings derived from this categorization discussed a significant research focus on multiple fronts: These include the assessment and integration of sustainable development principles, the promotion of education for sustainable development, the evaluation of curricula to ensure sustainability integration, and the identification of barriers and challenges in the implementation of sustainable development within higher education institutions (Lozano, 2006). This multifaceted approach underscores the holistic endeavor to foster a sustainable ethos within educational frameworks. Moreover, the themes encompass aspects such as evaluating the incorporation of sustainability into various academic disciplines, assessing the effectiveness of pedagogical methods, exploring challenges and validity issues in sustainability assessment, and understanding the role of higher education institutions in preparing future leaders and experts for sustainability. While each article may possess its unique context, research questions, and findings, they all contribute to the broader discourse

on assessment and sustainability integration in curricula, collectively enriching our understanding of how universities are addressing sustainability in their curricula and gauging the effectiveness of these efforts in preparing students for a more sustainable future.

While the assessment of curricula for the integration of sustainable development principles in university education is a step in the right direction, the results revealed that numerous universities worldwide have initiated the integration of sustainability principles into their curricula across a spectrum of disciplines, encompassing fields from business and engineering to the social sciences (Lozano & Waltson, 2013). This endeavor involves not only integrating sustainable content into existing courses but also designing new courses and programs with a specific sustainability focus. The ultimate goal is to equip students to become active and engaged citizens capable of tackling the intricate sustainability challenges confronting society today (Prabawani et al., 2020). Nevertheless, the academic realm has experienced a significant increase in research focusing on assessing and integrating SD principles into university curricula. Numerous articles have illuminated the extensive literature in this domain, highlighting the significant progress made in this context. However, amidst this scholarly exploration, a discernible gap becomes evident when it comes to understanding the industry's requisites. A dearth of research exists regarding the competencies that industries expect from graduates emerging from these SD-focused programs. Additionally, there is scant insight into the precise nature of SD knowledge that these graduates have acquired and how effectively they translate it into practical application within their workplaces (Hanning et al., 2012). This gap extends further to uncovering the specific sustainable practices they integrate into their professional roles, practices that not only benefit society but also tread lightly on the environment. Thus, while the academic realm has devoted substantial attention to SD integration in higher education, the need for a more comprehensive examination of industry needs and graduate outcomes, particularly in terms of practical sustainability practices, remains a notable area awaiting in-depth exploration.

Conclusion

A systematic literature review was undertaken to assess the integration of sustainable development (SD) within HEIs and identify crucial concepts and primary research themes that underscore the significance of evaluating the incorporation of sustainable development principles in higher education. The review yielded five themes that revolve around the purposeful evaluation of merging sustainability principles and ESD into higher education

curricula spanning diverse disciplines. These themes collectively explore methodologies for assessment curricula, challenges, and outcomes linked to infusing sustainability concepts into varying subject areas. The objective is to enhance students' comprehension of sustainable development, foster a comprehensive perspective on environmental, social, and economic considerations, and equip them with the aptitude and expertise to contribute to a more sustainable future. Moreover, these themes underscore the dedication of educators, institutions, and diverse stakeholders to prepare students as catalysts for addressing global sustainability dilemmas. Curricula assessments create accountability for universities to continuously review, update, and improve their sustainability efforts. This leads to a more dynamic and responsive approach to integrating sustainable development principles. The results give a diagnostic of SD integration as well as the factors that influence it. This can help educators/teachers to figure out what criteria they're teaching and how they can enhance their courses by sharing experiences from people of diverse, educational levels, and countries, giving students more SD skills and knowledge.

The study emphasizes the importance of recognizing the interconnected nature of higher education systems. It advocates for strategies like integrating sustainability into policies and strategies, affirming commitment through declarations, and formulating comprehensive implementation plans. The ultimate goal is to ensure the comprehensive and wide-reaching integration of sustainable development principles across the entire educational landscape.

Recomendations

Several recommendations can be made based on the identified research problem and gap in assessing the application of sustainability knowledge by graduates in the workplace. It is essential for educational institutions to collacorate with industries to create standardized assessment tools that can effectively evaluate the practical application of sustainability competencies learned during higher education. These tools should provide a comprehensive evaluation, taking into account not only the technical aspects but also the graduates' capacity to integrate sustainability principles into their decision-making processes. It is important for academic institutions and industries to maintain ongoing communication to stay informed about the changing demands and challenges related to sustainability. This communication can help to update the curriculum and ensure that graduates are equipped with relevant and applicable skills. Additionally, promoting interdisciplinary collaboration within educational institutions can enhance the integration of sustainability principles across diverse disciplines. Finally, it is necessary to establish a global framework for assessing sustainability

competencies, which will enable a standardized approach that transcends regional and institutional boundaries. By implementing these recommendations, educational institutions can better prepare graduates to contribute meaningfully to sustainable practices in their respective workplaces. This will help mitigate potential negative impacts on the environment, economy, and society caused by unsustainable practices.

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