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Review

Fostering a Whole-Institution Approach to Sustainability through Systems Thinking: An Analysis of the State-of-the-Art in Sustainability Integration in Higher Education Institutions

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Abstract: Policy initiatives from the United Nations and EU institutions have emphasized the need for higher education institutions (HEIs) to fulfil a significant role in green transitioning. However, they tend to fall short of the achievement of this objective. Multiple studies indicate that HEIs assign high importance to the integration of environmental sustainability on a strategic level but generally lack dedicated policies of integration in operational aspects. This paper's research aim is to provide a meta-study that reviews, analyzes, and assesses the state of the art on research on HEI sustainability. The paper also contributes to the state-of-the-art by mapping institutional sustainability self-assessment models, tools, and guidelines in four prominent research areas: (1) sustainability integration in educational activities, pedagogical perspectives, and systemic transformations; (2) benchmarking sustainability of organizational transformation and operational optimization, and links between developmental priorities and educational settings; (3) whole-system approaches focusing on the design and implementation of whole-institution sustainability plans; and (4) HEI sustainability culture and operations. The paper's final contribution is the presentation of best practices and emerging trends in the literature. These practices were selected on the following qualitative methodological criteria based on the systems-thinking approach to whole-institution assessment: (1) the effectiveness of self-assessment models, tools, and guidelines in each respective research area; (2) the degree of integration of systems thinking and/or modeling; and (3) the incorporation of qualitative indicators for stakeholder engagement.

Keywords: systems thinking; whole-institution approach; education for sustainable development (ESD); education for sustainability (EfS); higher education; sustainable development; sustainability

Citation: Christou, O.; Manou, D.B.; Armenia, S.; Franco, E.; Blouchoutzi, A.; Papathanasiou, J. Fostering a Whole-Institution Approach to Sustainability through Systems Thinking: An Analysis of the State-of-the-Art in Sustainability Integration in Higher Education Institutions. *Sustainability* **2024**, *16*, 2508. https://doi.org/10.3390/su16062508

Academic Editor: Fermin Sanchez-Carracedo

Received: 9 January 2024
Revised: 5 March 2024
Accepted: 15 March 2024
Published: 18 March 2024

1. Introduction

Benchmarking has been a staple of business optimization strategies for decades. Broadly defined, benchmarking as a concept refers to the adoption of best practices in any industry to improve performance [1]. More recent definitions adopt a more detailed approach to optimization, including strategies, functions, processes, products, services, and other metrics of operational performance [2]. Likewise, sustainability benchmarking finds its inception in business practices through the implementation of the benchmarking concept and associated methodologies of identifying and measuring the impact of the adoption of best practices on the sustainability performance of business organizations [3]. The process

has been adopted in a variety of contexts in evaluating institutional performance; this study reviews the utility of the concept and its methodologies of evaluation in the higher education sector.

Sustainability benchmarking is a crucial practice within higher education institutions, enabling the systematic assessment and comparison of their environmental, social, and economic performance. This study explores the significance of sustainability benchmarking, methodologies specific to academic institutions, and the impact on promoting sustainable practices within the higher education sector. Sustainability benchmarking in higher education involves evaluating and comparing institutions' sustainability performance against established standards, peers, or best practices. This process is integral to identifying areas for improvement, measuring progress, and enhancing the overall sustainability efforts of universities and colleges.

Sustainability is the reflection of an organization's performance in economic, social, and environmental terms [4]. Sustainability benchmarking can elevate the performance of the organization, providing necessary feedback related to the effectiveness of the operations. Higher education institutes are indicative organizations with multiple complex operations that could rely on sustainability benchmarking to assess their efficiency and the transformation of their operations, adapting optimal solutions to sustainability standards. In particular, higher education institutes face the challenging process of combining their developmental priorities and universal policy objectives with the educational settings.

Higher education institutions (HEIs) can function as experimental spaces of learning for sustainability and should adopt sustainability principles in all their processes. HEIs must consider sustainability in all aspects of the institution (Leicht, Heiss, and Byun, 2018). In practice, a whole-institution approach suggests incorporating sustainable development through integrated management and institutional governance (including campus operations, organizational culture, student participation, application of a sustainability ethos, engagement of community and stakeholders, long-term planning, and sustainability monitoring and evaluation), as well as curricular development, making them microcosms of sustainability [5].

It is becoming increasingly vital that HEIs adopt a more holistic perspective to strengthen their contribution to sustainable development. HEIs behave as complex systems, and sustainability should be seen as a growing value that arises from interactions within and between those institutions and the environmental and social contexts in which they operate. HEIs frequently devise programmatic responses to tackle sustainability challenges, yet these efforts often fall short of effectively addressing the underlying issues. However, by implementing coordinated programs grounded in a systems framework, it becomes possible to target strategic leverage points for driving organizational change.

A systems understanding can elevate the efficacy of campus sustainability programs by facilitating the identification of crucial leverage points for enhancing action. Considering an HEI as a holistic system enables the evolution of institutional elements and interactions towards more sustainable trajectories while also revealing opportunities to promote sustainability through focused campaigns aimed at pivotal leverage points [6].

The whole-system approach should be used for knowledge elicitation among several stakeholders to create a shared understanding related to the complexity of the desired transition, and it should be used as a facilitation tool for assessing, evaluating, and planning strategies toward desired goals. It is a comprehensive and holistic framework considering all interconnected elements and relationships within a system. It involves analyzing and addressing complex problems or challenges by understanding the interdependencies and interactions among various system components. This approach emphasizes viewing the system rather than focusing on isolated parts or individual components. The system, such as an HEI, is seen as a dynamic and adaptive entity, where changes in one part can have cascading effects on other factors. It recognizes that systems are often nonlinear, meaning small changes can lead to significant and unexpected outcomes.

This review identifies best practices of institutional sustainability self-assessment models and tools, presenting at least five of those practices covering methods and approaches from systems thinking and the whole system. It covers the most prominent and recent research on whole-system approaches. The mapping and review will focus on designing and implementing whole-institution sustainability plans, including models that prioritize using self-assessment tools. The study will emphasize systemic thinking and institutional dynamics, especially from the perspectives of educational leadership and governance structures that embed sustainable principles in organizational transformations at all operational levels and in all institutional practices. It also presents indicative examples of effective self-assessment models for sustainability benchmarking applied by higher education institutes (HEIs), which are reported in the literature as effective ones. The goal of the review is to provide sustainability benchmarking tools that have already been implemented with positive outcomes and can be transferred to different university settings to facilitate the adoption and implementation of sustainable everyday practices.

As a result, the study answers the following questions:

- Which self-assessment models and tools can enhance the implementation of whole-institution sustainability policy in higher education?
- What is their level and/or potential of integration into whole-systems thinking approaches?

2. Materials and Methods

The methodological approach of the research followed a structured process of establishing a common framework to ensure that the research outputs would exhibit a satisfactory level of methodological rigor through a comprehensive and systematic approach. We first established fundamental research principles and concepts for the broader conceptualization of the framework. The conceptualization placed sustainability at the core of research design and its evolution from the 1972 Stockholm Declaration as the cornerstone of sustainable development to its formalization as the first principle of the 1992 Rio Declaration up to the current formulation of the Sustainable Development Goals. Beyond the conceptual dimension, the dimensions encompassed by the evolution of sustainability as an international principle were instrumental in identifying the thematic areas prioritized by the research as described below. We also included policies and frameworks of the European Union, such as the European Strategy for Universities, the European Sustainability Competence Framework, the Digital Competence Framework for Citizens, and the Council Recommendation on Learning for Environmental Sustainability.

A review of international and EU-level principles, frameworks, and guiding documents outlined above yielded the following research areas for further examination. The subdivision into these distinct areas allowed for a systematic literature review in each area to draw meaningful conclusions on best practices and emerging trends in each. Additionally, we conducted a general bibliometric study on sustainability benchmarking, the methodology of which is described further below.

2.1. Research Areas

The research was divided into the following four areas:

1. Fundamental principles, concepts, and policy framework parameters. We also mapped and reviewed the state-of-the-art on incorporating green skills and competencies in educational activities, both from the perspective of educators and learners. The research encompassed pedagogical perspectives such as curricular development and assessment methodologies, professional development, and interdisciplinarity in the implementation of systemic transformations in terms of the embeddedness of sustainable principles.
2. General approaches to benchmarking sustainability with an emphasis on organization transformation and operational optimization. The mapping and review also explored the link between developmental priorities and educational settings, espe-

cially with respect to universal policy objectives such as implementing the Sustainable Development Goals at a global level and the European Green Deal at an EU level.

3. The most prominent and recent research on whole-system approaches. The mapping and review focused on the design implementation of whole-institution sustainability plans, including models that prioritize the use of self-assessment tools. The research emphasized systemic thinking and institutional dynamics, especially from the perspectives of educational leadership and governance structures that embed sustainable principles in organizational transformations at all operational levels and institutional practices.
4. Benchmarking institutional performance with specific application to HEIs. The mapping and review focused on institutional operations that embed sustainability with particular emphasis on the implementation and monitoring of sustainable practices in campus site operation, as well as the promotion and development of sustainability culture in an educational setting.

2.2. Methodology

The carried-out literature map does not seek to be exhaustive. On the contrary, it is an exploratory study to depict a general outlook of the literature aligned with the stated goals. The initial search strings were used to retrieve the articles related to the objective of the present review in each research area. Further variations of search strings were used based on the results obtained and the analysis of the selected articles.

Given the anticipated transcendence and significance of the term "sustainability" in the forthcoming decades, it becomes imperative to monitor its evolution within the scientific community. To this end, a concise bibliometric analysis has been conducted. One of the key advantages of bibliometrics lies in its impartiality; it does not adhere to a unilateral imposition of criteria or conclusions by any single entity. Instead, it relies on the collective body of work within the scientific community, culminating in quantitative results. Moreover, the publication of a document represents more than just dissemination; it signifies the culmination of a creative process that is shared, evaluated, and assimilated into existing knowledge. Thus, the knowledge cycle attains its full purpose when a new discovery is published and embraced by the scientific community within the same field [7,8].

Web of Science stands out as the preeminent database, offering invaluable insights for researchers assessing scientific output. Its multidisciplinary nature proves to be a favored choice due to its capacity for filtering searches using diverse bibliographic parameters and facilitating easy access to the full texts of queried papers. The initial search string employed to gather articles pertinent to the objectives outlined in this report is provided in the text box below. Subsequent variations of this search string were crafted based on the findings and analysis of selected articles. These variations were meticulously tailored to align with the overarching goal of evaluating the application of whole-systems and/or systems-thinking approaches in sustainability studies.

("system dynamics" OR "systems thinking" OR "whole system" OR "whole institution") AND
("sustainable transition" OR "green transition" OR "sustainability")

The results from the Web of Science for this search, without applying any filters, included 2614 documents. The initial search and its distribution of publications over time is shown in Figure 1. Figure 1 shows the number of publications and the number of citations they received over time, and it is possible to note that the scientific community's interest in these topics is steadily increasing, apparently following an exponential growth trend.

These results were adjusted and refined according to the search criteria defined for this research. The Science Citation Index Expanded and Social Sciences Citation Index were selected, obtaining 1767 documents. This core collection was subsequently filtered and redefined, including articles published in scientific journals. This facilitated the research since, in addition to guaranteeing the quality of the publications, the journals included multidimensional elements, such as citation, time, language, etc. After debugging the

database, the initial query on these terms in the titles, abstracts, and keywords resulted in 1623 documents.

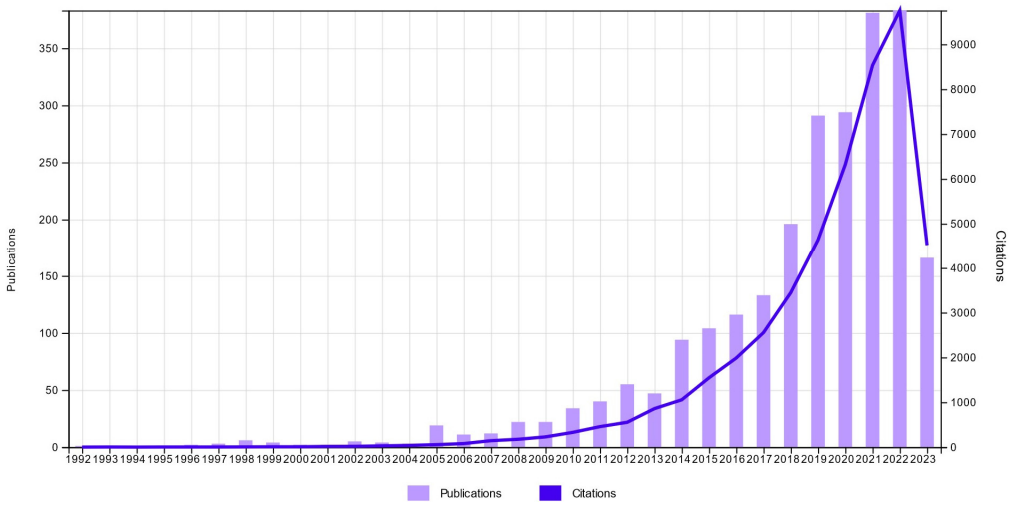

Figure 1. Number of publications and citations over the years.

The TreeMap in Figure 2 shows the leading venues where articles from the retrieved dataset were published. Most of the articles, almost one-quarter, were published in *Sustainability* (MDPI, IF—3.889), *Journal of Cleaner Production* (Elsevier, IF—11.072), and *System Research and Behavioral Science* (Wiley, IF—3.64).

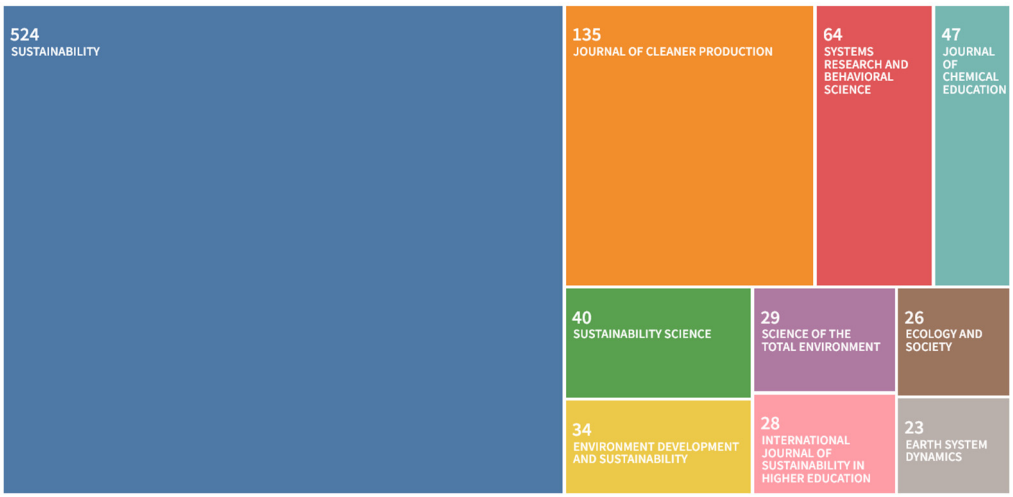

Figure 2. TreeMap identifying the journals in which the retrieved articles were published.

3. Results

3.1. Whole-Systems Approaches

Organizations are systems, and they are nested within larger systems. In order to survive, their investments must secure both short- and long-term goals. Bansal and DesJardine [9] argued that sustainability goals should analyze the balance or consistency between organizational and macro-systems over time. Besides, organizations must consider atemporal trade-offs and not omit the time concern from strategic management, which can contribute to short-termism focus and systems' failure. The authors then concluded that a dynamic systems perspective that shifts the lens to a bigger picture could make temporal effects more salient as the feedback mechanisms between levels of analysis come into view.

Hjorth and Bagheri [10] described sustainable development as an unending process defined neither by fixed goals nor by specific means of achieving them. Thus, system

dynamics operate in a whole-system fashion, and it is seen as a robust methodology for dealing with sustainability issues. They defined sustainability as "... neither a state of the system to be increased or decreased, nor is it a static goal or target to be achieved. But sustainable development is a process in which, in terms of system dynamics, the destroying reinforcing loops are controlled by means of some balancing mechanisms and where these balancing loops are allowed to act normally, as they must do in order to guarantee the system to work everlastingly." [10] (p. 86)

In addition, they presented a set of examples of successful applications of such an approach in this context. Then, they demonstrated how causal loop diagrams can be used to find the leverage points of a system. The authors also argued that there are key loops in the real world responsible for the viability of all ecosystems, including human-based ecosystems that they called "viability loops." Thus, sustainable development is a process in which those loops remain intact, and planning for sustainability is to identify the viability loops and to keep them properly operating.

The role HEIs play in increasing our society's capabilities for continuous self-renewing and dealing with the complexities of current and future challenges is not new. Jantsch [11] discussed how universities should develop interdisciplinary links between the pragmatic and normative systems levels. Then, he presented a transdisciplinary structure for the university centered on three organizational units: systems design laboratories, function-oriented and discipline-oriented departments. Jantsch identified policy sciences as a crucial linkage between those three system levels.

Pittman [12] discussed the use of whole-systems design in higher education. The author then proposed a sustainable development framework based on systemic design principles, which he considered a systemic design as a holistic approach that considers the interconnectedness of all the parts of a system. This approach is essential for addressing complex problems like climate change and sustainability.

Sterling [13] argued that for an HEI to appropriately respond to the sustainability challenge, it needs to have a deep appreciation of three fundamental areas of concern, which he metaphorically summarized as the nature of the territory now occupied, the nature of territory that sustainability implies, and the journey that is required to shift from one grounding to another. He used ideas and tools from systems thinking to map those grounds and compared the staged social and educational responses to sustainability. Those learning responses vary from "very weak" to "very strong," and changes in environmental and economic policies, degrees, and types of public awareness characterize them.

Faghihimani [14] proposed a systemic approach based on systems thinking, cybernetics theory, and the viable system model for measuring environmental sustainability at HEIs. The proposed method contains fifty indicators for measuring and comparing several international universities' environmental sustainability performance. Those indicators are organized into five categories: (1) governance and administration, (2) curriculum and study opportunities, (3) research and innovation, (4) operation, and (5) other related activities.

Stephens and Graham [15] offer a systems approach to promoting sustainability in higher education through their Transition Management Framework (TMF). This framework provides a structured way to guide research and implement sustainable change within HE. The authors highlighted the importance of reflective activities and strategic dynamics at a critical level to facilitate and accelerate the transition.

Based on a systematic literature review, Blizzard and Klotz [16] presented a framework for sustainable whole-systems design that included methods such as systems thinking, participative design, and ecosystem services. The framework is organized into the following processes:

- Problem framing: Understanding the problem as a whole, including its root causes and the different stakeholders involved.
- Visioning: Creating a shared vision for the future based on understanding the problem.
- Designing: Developing solutions that address problems at the system level.
- Implementing: This is the process of putting the solutions into practice.

- Evaluating: This is the process of measuring the effectiveness of the solutions and adjusting as needed.

Several other authors proposed similar processes-oriented frameworks for a systems approach for dealing with sociotechnical complex systems, which include a phase of problem definition, elaboration of plausible hypotheses, creating a model-based representation of the system under investigation, building confidence on the designed formulation, and finally, addressing the initial problem by developing intervention policies and uncovering new knowledge [17–23].

Those approaches were developed based on well-established literature on methods for planned organizational change and group interventions [24–26], which seek to guide multiple stakeholders through the learning process of their challenges. Argyris [26] labeled this learning process as the "double-learning loop," where information from the real world not only changes decisions but feeds back to alter mental models, and by changing mental models, it could be possible to intervene and change the system's structure.

For this learning process and the initial phases of problem framing, elaboration of hypotheses, and design of model-based representation of the context, the literature on group model building (GMB) can be of great value. This field of study is vast, and several authors contributed [20,27,28]. GMB aims to elicit stakeholders' knowledge on various aspects and register them on a formal representation while also seeking to build understanding, support, and test assertions. This approach usually consists of presenting the problem, the divergence of interpretations, the convergence of understanding, and the evaluation of alternatives [29].

Schalok, Verdugo, and Lee [30] proposed a systematic approach to organization sustainability incorporating key aspects of multiple methods. The proposed approach adapted the quality improvement PDCA cycle and identified three critical characteristics of organizational sustainability: accountability (effectiveness and efficiency), leadership (transformational and strategic execution), and organization process (high-performance teams and quality improvement). The authors emphasized the crucial role of the evaluation process in closing the quality improvement loop, incorporating multiple performance-based perspectives, best practice indicators, collaborative assessment, and a standardized self-assessment instrument. Then, the authors proposed the following set of guidelines for evaluation, aiming to:

- Make evaluation understandable and a collaborative process;
- Distinguish between micro and macro-level evaluation;
- Clarify the intended uses of the information;
- Use a logic model to frame customer-referenced evaluation questions (i.e., input = customer-referenced factors; throughput = support strategies; output = personal outcomes).

Schalok, Verdugo, and van Loon [31] proposed a transformation model to support organizations in rapidly adapting to changing challenges and opportunities and increasing their effectiveness, efficiency, and sustainability. The model is centered on three pillars (values, critical thinking skills, and innovation) and is organized around four components: transformation strategies, organization capacity, and organization outputs and outcomes. The four components integrate current literature and reflect a systems approach aligning transformation pillars and strategies. For evaluation purposes, a set of indicators with multiple perspectives on performance management was defined, including perspectives such as customer, growth, financial, and internal processes.

Besides discussing the principles and practices of the whole-system design (WSD), Stansinoupolos et al. [32] presented several case studies demonstrating how WSD has been used to improve the sustainability of engineered systems. These case studies showed how WSD can help reduce energy consumption, water consumption, and waste production while improving engineered systems' performance and reliability.

Williams et al. [33] identified that the interest in the intersection between systems thinking and sustainability management topics is increasing. They found eight research themes applying the systems thinking lens to understand sustainability management:

behavioral change, leadership, innovation, industrial ecology, social-ecological systems, transition management, paradigm shifts, and education.

3.2. Sustainability Benchmarking

The importance of sustainability as reflecting the economic, social, and environmental performance of an organization for its viability was highlighted by Yakovleva et al. [4], who suggested a multi-stage procedure to evaluate supply chain sustainability performance. They argue that the combination of quantitative data with the opinions of specialists in the field can provide stakeholders with an index appropriate for sustainability benchmarking of supply chains. The sustainable supply chain management after the COVID-19 pandemic has also caught the attention of Cherrafi et al. [34], who implemented a qualitative research approach revealing the challenges facing supply chains, such as the uncertainty in demand and supply, the regional concentration of suppliers, the globalized supply chains, the limited supplier capacity, and the reduced visibility in the supply network. For the purpose of developing sustainability, the authors suggested the promotion of the health and well-being of employees and the stabilization of the supply chain. The case of logistics service providers was examined by Gupta and Singh [35], who concluded that they utilize green practices to achieve long-term sustainability. Dupada et al. [36] highlight the knowledge-based value chains as a key factor in organizational sustainability and suggest the utilization of the Generic Benchmarking Integrated Innovation Framework for transforming knowledge into results following the organizational objectives. The transformative potential of benchmarking as a mode of governance has also been illuminated by Lecavalier et al. [37], arguing that benchmarking should be combined with various performance indicators and reflective practices to support urban transformation.

Dzoro and Telukdarie pointed out the systems perspective of sustainability [38]. The authors draw upon a banking sector South African company case study measured against global green information and communication technology benchmarks and best practices to propose the most cost-effective data center. A cross-country comparison of socioeconomic sustainability based on the intensity of information and communication technologies between advanced, emerging, and developing countries using Data Envelopment Analysis was made by Apaydin et al. [39]. The authors confirmed the strong and significant relationship between ICT and macroeconomic development. However, they found that the socio-economic impact of technologies in emerging markets is relatively lower than in developing countries.

Al Shaiba et al. [40] focused on the sustainability benchmarking of Qatari organizations. They used sustainability as a point of reference and compared the efficiency of local organizations based on international good practices to identify the reasons for inefficiency and facilitate the improvement of organizational efficiency. Overall, organizational culture and behavior, human resources, and leadership and governance are the three top areas for improving local organizations.

Benchmarking as a necessary tool for healthcare sustainability was illuminated by Huf et al. [41], who concluded that the integration of laboratories in the clinical care process could improve laboratory management. The barriers and facilitators for the creation of School Health Research Networks in England to address the need for prevention and early intervention of adolescent health and well-being were determined by Widnall et al. [42].

Florez et al. [43] suggested the use of an optimization model in the case of project management so that the sustainability performance of a construction program can be maximized. Brady and Hanmer-Dwight [44] examined the application of energy benchmarking for sustainable buildings. Brondi et al. [45] used sustainability-based optimization criteria to foster industrial symbiosis within industrial clusters, concluding that industrial symbiosis is complementary to industrial sustainability.

Van Staden et al. [46] applied optimization strategies in the case of a South African gold mine and examined the performance of mobile cooling units. The findings show a decrease in pumped water volumes and operating costs. Gordon and McCann [47] de-

scribed a stakeholder-based sustainable optimization indicator system for activated sludge wastewater treatment plants in the Republic of Ireland that facilitates optimized operation. The low-carbon sustainable operation of wastewater treatment plants was the subject of a literature review by Lu et al. [48], who suggested an innovative design framework for this purpose. Flores-Alsina et al. [49,50] noted the importance of multiple evaluation criteria for operational strategies of wastewater treatment plants. Niayifar and Perona [51] found that dynamic water allocation policies improve the global efficiency of storage systems relative to constant minimal flows. Sharifi et al. [52] evaluated 20 algorithms for multi-reservoir dams to determine the optimal operating policy. Souza et al. [53] worked on reducing physical water losses and rationalizing the use of energy in water supply systems in a case study of Brazil.

Siirola and Edgar [54] noted how operational changes could improve energy efficiency in power steam plant systems and how process control affects them. Damgacioglou and Tselik [55] developed a two-stage decomposition algorithm in an optimization model to solve a multi-period AC grid operation scheduling problem and network reconfiguration, outperforming other IEEE testbeds previously used in the literature. Masoudi et al. [56] applied a novel hybrid workflow to improve the economic recovery factor of oilfields in Malaysia. The increase in the operational capacity of harvesting planning techniques through a linear programming model was the aim of the paper by Banhara et al. [57].

3.3. Sustainability Benchmarking in Higher Education

The sustainable development performance of OECD countries was evaluated by Lamichhane et al. [58], finding that Quality Education (SDG 4) is worsening. A methodology to measure research for sustainable development was proposed by Hands and Anderson [59]. The authors tried to map the contributions to sustainable development research and its effects on university research excellence with a replicable content and thematic analysis in a large university. Nobre et al. [60], based on a literature review, suggested new learning processes for sustainability education aligned with the UN education goals and tested in undergraduate business students. Their findings support that students prefer a holistic sustainability learning approach and that changes in curricula and learning processes depend mostly on the support of the professor and dean. To avoid the drawbacks of subject-matter context about sustainability, Lemarchand et al. [61] used natural language processing to identify sustainability root keywords in module descriptions. The methodology proposed requires minimum analytical skills and effectively benchmarks university curricula to SDGs.

The innovative management strategy of the University of Johannesburg after its merger is illuminated by Barnard and Van der Merwe [62]. Their findings suggest that institutional innovation is the outcome of planning, brainstorming, benchmarking, reviewing, processing, analyzing, and managing and sustainable development can be achieved through strategic leadership, inclusive planning, and constant monitoring. Cardozo et al. [63] identified the benchmarks of four best-ranked higher education institutions and four Brazilian HEIs following the UI GreenMetric World University Ranking. The HEIs with the best ranking make structural changes and capital investments in actions with long-term returns, alternative technologies, and student participation. Regional sustainability in higher education assessment performance was made by Beringer et al. [64], who found that most higher education institutes in Atlantic Canada have integrated sustainable development in their curricula, but steps remain to be taken as regards staff development, physical operations, and student opportunities.

Abdul Razak et al. [65] highlighted the benefits of the Alternative University Appraisal for the sustainability ratings of higher education institutions, which offer benchmarking tools to support diversity. Shriberg [66] reviewed 11 cross-institutional sustainability assessment tools, concluding that decreasing throughput, simultaneous systematic changes, and cross-institutional efforts are critical parameters to enhance sustainability in higher education.

The integration of principles of responsible management education (PRME) in business schools was examined by Peschl et al. [67]. The authors combined a standard benchmarking process and an analytical framework of PRME best practices to set a benchmark for PRME signatories to improve their sustainability performance. The awareness of sustainability by faculty members of a private university in Riyadh was the purpose of the study of Alkhayyal et al. [68], which served to embed sustainability in the benchmark university. The integration of sustainability courses in Lebanese universities was the focus of the paper of El Hajj et al. [69], whose multimodal qualitative study showed that reforms in both the products and the processes of universities, as well as government support, are necessary to help sustainability. A bibliometric analysis was used by Deda et al. [70] to benchmark the sustainability of higher education institutes and the integration of life cycle assessments on their sustainability impact. Their results indicate that the main barriers to the limited adoption of LCA are the lack of internal information and managing commitment. Cappelletti et al. [71] followed the life cycle assessment approach to estimate the environmental performance of the members of the University of Foggia. The sustainable mobility indicator provided by the authors can be used to identify the benchmark, which is the best mobility scenario. Kartikowati et al. [72] conducted a map analysis of benchmarking in higher education and found that there is a lack of sustainability benchmarking studies. The nexus between GRI sustainability guidelines, key performance indicators and strategic goals was the focus of the paper by Yeung [73]. The benchmarks for the case of tertiary education institutions were self-financed institutions with impacts developed through media reporting. The development of machine learning models for sustainability assessment of high education institutes was presented by Yang and Guo [74], including key performance indicators, factor analysis, and DEA as necessary steps for the high efficiency of the model. Findler et al. [75] examined whether sustainable assessment tools can measure the impact of higher education institutes on sustainable development and found that they usually neglect it.

A survey of sustainable education on students was carried out by Watson et al. [76] to benchmark the quality of civil and environmental engineering curricula and plan their reformation. The findings showed that the integration of sustainability in the design courses would be helpful for the students. The benchmarking of criteria to validate the content of a rubric that educators can use to assess student sustainable design work in engineering was the goal of the paper of Cowan et al. [77], confirming the importance of some criteria and proposing the removal of others. The case of engineering capstone projects was presented by Brunell et al. [78]. The authors proposed a Sustainability Implications Scorecard rubric, which evaluated the effectiveness of addressing sustainability in engineering design and projects. An industry-developed design method named Planet Centric Design combined with systems thinking was introduced to master's-level students by Väätäjä and Tihinen [79], promoting the concept of sustainability, which was perceived by them as applicable to working and personal life.

Alfayozan and Almasri [80] studied the benchmarking of energy consumption in a University in Saudi Arabia to promote sustainable solutions. Hanieh and Hasan [81] developed a Go-Green integrated model for sustainability benchmarking of higher education institutions, drawing upon an opinion survey of academic experts in Palestinian universities. The carbon footprints of Spanish Universities were analyzed by Guerrero-Lucendo et al. [82]; they concluded this could serve as a valid indicator for benchmarking only if including standardized greenhouse gas and electricity consumption sources, using the same emission factors and the activity ratios were calculated from standardized functional units. Alghamdi et al. [83] applied a probabilistic fuzzy synthetic evaluation framework to operational, academic, and residential buildings at the British University of Colombia to assess the spatiotemporal variability of water, energy, and carbon flows so that the higher education institutes can follow more sustainable patterns. Good practices in sustainability were revealed by Benevides et al. [84] by comparing Brazilian universities with European and American ones and applying benchmarking on the implementation of

policies in relation to Green Campuses, Living Labs, and socioeconomic sustainability initiatives. Mendoza et al. [85] suggested a methodological framework for the resource efficiency and environmental sustainability of campuses so that the universities integrate a circular economy. The framework was applied in the case of the University of Manchester and illuminated the way circular economy principles can benchmark sustainability practices, and key stakeholders could contribute to this purpose. Benchmarking the sustainability of food environments in tertiary education was the target of Mann et al. [86]. The proposed University Food Environment Assessment tool was assessed as reliable, and a pilot test identified moderate diversity in food environments in Australia. Melles et al. [87] aimed to provide a country-specific but sector-wide study of campus sustainability in the case of Australia as portrayed in reports, plans and targets and found that higher education institutes present weak institutionalization of sustainability and sector benchmarking could be beneficial.

Cronemberger de Araújo Góes et al. [88] provided a base upon which the Brazilian HEIs could develop their sustainability assessment tools by comparing eight international SATs. Kamal and Asmuss [89] analyzed the effectiveness of benchmarking tools for assessing the University of Saskatchewan's sustainability performance and found that the Sustainability Tracking Assessment and Rating System respond effectively in all areas of campus life. Madeira et al. [90] developed a methodological framework in the case study of the Faculty of Engineering of the University of Porto, which can be used by other higher education institutes to enable sustainability reporting and benchmarking. Comm and Mathaisel [91] used Wal-Mart's best supply chain management practices to benchmark the sustainability of higher education. Caeiro et al. [92] critically analyzed the assessment and benchmarking tools for the holistic approach of integrating Education for Sustainable Development in the case of a Portuguese and a Spanish university. The study revealed the need to identify common objectives with the tools.

The case of the success of women in STEM faculty careers in a large private university was the focus of an institutional transformation project named NSF ADVANCE [93]. A study conducted within the framework of the project confirmed obstacles in career navigation, climate, and flexibility in the management of work/life balance and evaluated the university methods to address them. Following these steps, an institutional transformation strategy plan was drafted based on the organizational analysis of Bolman and Deal. Hitch et al. [94] reviewed the professional development of sessional staff in higher education institutes using the sustainability principle as a point of reference, among others, which refers to quality teaching and good staff, identifying good practices and challenges to be addressed.

Govindarahu et al. [95] identified factors that enhance sustainability in private universities in Malaysia. Fonseca et al. [96] mapped the curricula of B.Sc. and M.Sc. courses in Portuguese HEIs that addressed sustainability issues, finding that Social Sciences, Engineering and Management courses are the ones that covered this subject the most. Viegas et al. [97] provided a benchmark of sustainability practices in higher education institutes by identifying and classifying its critical attributes. Benchmarking Spanish and European universities in terms of sustainability approaches was the focus of the paper of Bernaldo et al. [98], arguing that student engagement in the action plan is necessary. The gender differences of university students about cooperative learning as a sustainable benchmark were presented by Baena-Morales et al. [99]. Females relate cooperative learning to future teaching roles and prefer groups divided following academic criteria.

Pati and Lee [100] analyzed the presidents' compensation in US higher education institutions to benchmark it so that it produces sustainability initiatives. The authors found a significant and positive relationship between the compensation and independent variables, such as environmental sustainability, but the proliferation of sustainability is not among the key criteria for salary.

3.4. Sustainability Research in Higher Education

The preceding section on sustainability benchmarking in higher education focused mainly on the thematic areas of general assessment and campus operations. Nevertheless, there is additionally a growing body of literature on substantive sustainability research in higher education. This is further subdivided into several interrelated but sufficiently distinct areas, which are outlined below.

Much of the focus on the integration of sustainability concepts in education has been devoted to various methodologies, pedagogies, and analytical tools that aim to capture the level of integration of sustainable development as a concept. While there is substantial variation in approaches, two key themes characterize the state of the art in the relevant academic literature: (1) various methods of assessing adherence to the SDGs, and (2) various attempts to evaluate the conceptualization, operationalization, and outcomes borne out of the implementation of the United Nations Decade of Education for Sustainable Development (2005–2014). Both are clearly based on fundamental principles of the growing international consensus on defining and applying concepts and methodologies in pursuit of sustainable development.

Further to this thematic breakdown, the development and evolution of the state of the art in the academic literature exhibits distinct periodicity. Early contributions followed the establishment of the Millennium Development Goals. In this period, the integration of sustainable development in education emphasized the environmental dimension. Wright's [101] meta-analysis concluded there was no consistent approach to the definition or the method of integration of sustainable development. While many institutions adhered to the conceptualizations promoted by international agreements, others prioritized a national-level approach, while others synthesized elements from a variety of sources to produce a distinct institutional implementation that did not necessarily adhere to any one established standard. The study also highlighted the complexity—and inherent lack of consensus at the time—of what the integration of sustainable development elements meant in practice; implementations ranged from sustainable campuses to academic research to the environmental literacy of faculty, staff and/or students, to the incorporation of responsibility principles as ethical pronouncements, to intra-institutional cooperation, to the development of interdisciplinary pedagogies, and to outwards relations with state and non-state entities, including liaising with industry in appropriate sectors.

The next major milestone in the literature was the end of the UN Decade of Education for Sustainable Development (ESD), which was launched in 2005 and ran until 2014, leading to a sharp increase in research output evaluating the impact of the international initiative. The main purpose of the UN Decade was to promote and integrate sustainable development principles into educational systems worldwide. The objectives included raising awareness about sustainable development issues, enhancing the quality of education by incorporating sustainable development concepts, and fostering a sense of responsibility and commitment among learners to create a more sustainable future. The official appraisal of the UN Decade came in the form of a final report compiled for UNESCO by Buckler and Creech [102], who concluded positively that ESD was increasingly effective as an enabler for sustainable development, that stakeholder engagement proved vital to its success and would be even more instrumental in the future, that ESD is increasingly galvanizing pedagogical innovation, and that ESD has spread across all levels and areas of education. The report specifically highlighted the importance of whole-institution approaches to help practice ESD. The report also concluded with several themes, trends, and recommendations for the future of ESD integration in higher education institutions:

1. Effectively driving change toward sustainability within higher education poses a considerable hurdle. To propel comprehensive institutional strategies for ESD, it is imperative to broaden and advocate for leadership development initiatives targeting senior university executives and governors. This expansion should encompass various forms of support, such as coaching, peer learning, action learning, and mentoring.
2. The demand among students for sustainability-focused education is increasing.

3. Ensuring that every student, irrespective of their discipline or career aspirations, acquires the skills to contribute to a more sustainable world is paramount. To achieve this, novel approaches to curriculum reform are imperative, including the enhancement of capacity among academic staff. The objective is to transition sustainable development from being solely a specialist 'career' focus to a fundamental learning outcome with a lifelong orientation across all fields of study. The growing demand from students for a sustainability-centric education could serve as a pivotal catalyst for curriculum and teaching practice reforms and warrants closer monitoring.
4. Further exploration of online learning is essential for advancing ESD in higher education.
5. Facilitating the development of academic staff and fostering organizational learning are crucial components in the establishment of sustainable universities,
6. Collaborative networks among higher education institutions play a vital role in enhancing capacity and extending influence on ESD.
7. There is a growing interest in sustainability-related research. It is imperative to systematically track such research, assessing its impact on policy and practice beyond individual institutions. Moreover, research on ESD should be acknowledged and encouraged as a significant academic pursuit. It should be firmly rooted in national ESD research agendas and plans.
8. Research on ESD has experienced a notable increase during the UN Decade.
9. Significant strides have been made in sustainability within campus operations. Enhancing the greening of campus operations can be further strengthened by implementing mechanisms for sharing tools and approaches, particularly those aimed at reducing carbon footprints.
10. HEIs are expanding the value and influence of their teaching and research within local communities, thereby catalyzing change. Scaling up collaboration and partnerships between university researchers and community stakeholders is essential to further enrich learning experiences, bolster the understanding of local social, environmental, and economic concerns, and actively contribute to solutions for achieving sustainability at the local level.

The report was followed by seminal contributions to the literature assessing the effects of the UN Decade and establishing approaches for future implementation. Wals' [103] meta-study of the literature led to numerous conclusions, primary among which was the recognition of an emerging trend, while the use of ESD prior to the UN Decade referred primarily to operational optimization (environmental management, university greening and reducing a university's ecological footprint), the use since shifted towards pedagogy, learning, instruction, community outreach, and partnerships. Leal Filho et al. [104] described the achievements of the UN Decade but also highlighted the gaps in terms of moving from rhetoric to action, implementing more pillars towards a widened conception of sustainable development, and targeting and engaging policymakers. Most importantly, the paper presents a list of measures aimed at realizing the principles of sustainable development:

1. To strengthen sustainable development-related competencies.
2. To foster multi-stakeholder dialogue among individuals and organizations representing various dimensions of sustainable development, including economic, social, cultural, environmental, and other relevant aspects.
3. To prioritize the methodological justification of research rather than focusing extensively on the intricacies of methods and outcomes.
4. To consider the ultimate objectives or goals of the research.
5. Apart from utilizing benchmarking tools to assess and monitor sustainability in higher education institutions, establishing user-friendly ESD knowledge-sharing platforms using information and communication technologies can significantly enhance accessibility to ESD resources.
6. Securing funding for ESD activities and projects is paramount for realizing the objectives of the UN Decade.
7. Facilitating the exchange of experiences at an international level.

8. Implementing a systems approach to education for sustainability in higher education.
9. To further understand and promote campus sustainability, a systems framework must be used.

Lastly, Beynaghi et al. [105] studied the effects of the UN Decade in the context of the recently adopted SDGs and presented a set of policy measures for a "second decade" to coincide with their pursuit. They framed future scenarios in three distinct areas of sustainable development in HEIs: a social, an environmental, and an economic orientation. Respectively, their suggested policy measures were as follows:

1. Social Orientation
    a. Universities and faculty need to receive clear signals indicating that societal engagement is both valued and encouraged [106].
    b. University performance appraisal systems possess significant potential to steer university behavior toward desired outcomes [107,108].
    c. Government funding programs can specify socially oriented themes for research and collaboration with external stakeholders, neighboring communities, and regions [109].
    d. When evaluating faculty performance for tenure, universities and departments should consider societal engagements and impacts alongside traditional outputs.
    e. It is essential to align education, research, and outreach efforts with local needs to foster genuine social engagement.
2. Environmental Orientation
    a. National governments can allocate research funds based on performance, considering contributions to environmental sustainability.
    b. The campus serves as an excellent opportunity for universities to showcase environmental sustainability and foster innovation [110,111].
    c. Universities can increasingly leverage their campuses, buildings, and real estate assets as "living laboratories" [112].
    d. Initiatives led by universities for urban reform can serve as catalysts for innovation in green building practices and environmental enhancements [113].
    e. Universities can provide diverse opportunities for students and faculty to engage with urban environmental transformation processes, using them as platforms for experiential and project-based sustainability education [114,115].
3. Economic Orientation
    a. Governments have the capacity to implement measures that encourage universities to establish closer ties with industry and utilize their resources to foster economic growth.
    b. Governments can revise their expectations concerning university-industry collaborations, moving beyond traditional "hard" outcomes like patents and licenses [116] to include "softer" forms of engagement and economic activity that align with the Education for Sustainable Development (ESD) goals, such as internships [117], student consulting for industry [118], and collaborative teaching.
    c. Universities can provide incentives to faculty members to promote the commercialization of research outcomes [119].

Following the adoption of the SDGs in the post-2015 international developmental agenda, research on the integration and attainment of the goals has attracted the most scholarly attention in the relevant academic literature. Given the expansive scope of the SDGs that adopt a holistic approach that aims to enhance the interrelated aspects of developmental attributes, a comprehensive review of the state of the art is beyond the scope—and size limitations—of this study. As a result, we devote our attention to the causal linkages between the attainment of the SDGs and the degree to which higher education institutions can both benefit from and contribute towards these causal pathways.

Albareda-Tiana et al. [120] produced the first seminal case study on the implementation of the SDGs at the University level through a case study of the International University of Catalonia. The study concluded that the consistent incorporation of ESD, as well as specific references to the SDGs into university curricula, is essential for HEIs to make a robust commitment to the promotion of a culture of sustainability. This will require a fundamental reconceptualization of the principles that guide a university's mission, in addition to the adoption of practices to put these principles into effect. Reworked curricula must exemplify the interconnections between different dimensions of sustainability to properly train individuals for constantly evolving job markets. Lastly, implementing ESD and the SDGs in higher education can lead to synergies within HEIs in addition to linkages outside the institutions to society at large. Leal Filho et al. [121] further emphasized this transformative aspect in all institutional characteristics of HEIs but especially highlighted the need to prioritize the transformation of curricula. They place particular focus on the role of faculty to accommodate and expedite this transformative process through the development of collaborative processes, as well as the necessity for a whole-institution approach towards the embeddedness of a culture and a set of practices for sustainability. Kioupi and Voulvoulis [122] placed a singular emphasis on education through an examination of SDG4. While they do not focus exclusively on HEIs, they conclude that a systems perspective is essential for the transformative potential to be realized at all levels of education.

Subsequent contributions to the state of the art in the literature have emphasized the importance of curricular development even further. Leal Filho et al. [123] asserted that HEIs must align both their curricula and their research to SDGs. In so doing, HEIs may develop, test, and use new content, learning methods, and transformative approaches. Furthermore, they must develop more applied research around the SDGs and suggest that doctoral programs are best suited for this purpose. Lastly, they highlight the role of active student engagement. Similarly, Purcell et al. [124] conceptualize universities as "living labs" for sustainability where the experimental aspects of this transformation can serve as a guide towards recognizing and adopting good practices.

Lozano et al. [125] assessed the connections between different competence areas in sustainable development education and pedagogical approaches used and found that while economic, environmental, and cross-cutting dimensions tend to be addressed almost equally, the social dimension remains the most underdeveloped and the least addressed by university curricula. More specifically, they identified gaps in developing competencies in justice, responsibility, and ethics; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; tolerance for ambiguity and uncertainty; and critical thinking and analysis. They also identified that the pedagogical approaches least likely to develop ESD competencies are case studies, supply chain/life cycle, and lecturing. Instead, they suggested prioritizing pedagogies such as eco-justice and community; project- and/or problem-based learning; community service learning; mind and concept maps; jigsaw/interlinked teams; and place-based environmental education. Similarly, Tejedor et al. [126] suggested five active learning strategies as good didactic strategies to promote competencies in sustainability: service learning, problem-based learning, project-oriented learning, simulation games, and case studies.

As the literature matures, more recent contributions have focused more thoroughly on individual issues and challenges to be met along the transformative path toward the integration of ESD. For example, Okanovic et al. [127] provided a framework whereby universities can assess green content and eco-labeling in their curricula as the means to increase their competitiveness by meeting the increasing requirements of green jobs. Lastly, Kioupi and Voulvoulis [128] presented a framework encompassing six steps that offer tools to assess the alignment of university programs' Learning Outcomes (LOs) to sustainability and how to translate them into competencies for sustainability. They suggest that teaching staff and program coordinators should:

1. Evaluate the congruence of their program's Learning Outcomes (LOs) with their sustainability vision.

2. Transform the aligned LOs into competencies.
3. Define sustainability competencies through explicit statements outlining what students must master, encompassing cognitive, affective, behavioral, and metacognitive dimensions.
4. Assess the assessment methods used in a course to determine their effectiveness in evaluating students' competency development, and if necessary, adopt alternative methods.
5. Assess student performance or progress and furnish evidence regarding the effectiveness of the learning and teaching process.
6. Determine the program's contribution to fostering sustainability competencies in its learners.

4. Conclusions and Future Directions

The presented map study identified several approaches related to a systems approach to sustainability. These approaches rely on the whole-system, whole-institution, transformation management, and assessment methods. By merging and adopting these tools, HEIs can embrace a sustainable mindset, implement environmentally responsible practices, and foster a culture of sustainability within their campus, contributing significantly to a more sustainable future for the institution and the broader community.

Whole-system approaches to sustainability in higher education focus on the interconnectedness of all institution aspects, from teaching and research to campus operations and community engagement. This approach recognizes that sustainability is not just about changing one or two areas of the institution but transforming the entire institution to be more sustainable. Whole-institution approaches to sustainability go a step further than whole-system approaches by requiring the active participation of all stakeholders, from students and faculty to staff and administrators, ensuring that sustainability is not just a few people's responsibilities but something everyone in the institution is committed to.

Self-assessment tools can help higher education institutions assess their sustainability performance and identify areas for improvement. These tools can also help institutions to track their progress over time. When used together, whole-system, whole-institution, and self-assessment tools can provide HEIs with the framework and support necessary to plan and design strategies for transitioning to more sustainable operation, development, and education.

In addition, the research produces the following recommendations for higher educational leaders:

1. Recognize that the Higher Education Institution (HEI) system comprises numerous interconnected elements, encompassing the institutional framework, education, research, campus operations, community outreach, collaboration with other higher education institutions, on-campus life experiences, assessment and reporting practices, integration of Sustainable Development into the institutional framework, on-campus life experiences, and 'Educate-the-Educators' programs.
2. Commit to Sustainable Development by integrating it into the HEI's policies and strategies.
3. Show the HEI's commitment by signing an array of declarations, charters, and initiatives.
4. Establish short-, medium-, and long-term plans for institutionalizing sustainable development; and ensure that sustainable development is implemented throughout the system.

In further research, the approaches described in this review shall be tailored to design a framework that will support incorporating sustainability principles and strategies within HEIs. One example of such a transformation is the incorporation of the whole-institution sustainability approach in HEI through systems thinking (e.g., by changing/adapting existing curricula), promoting green and sustainable transitions (e.g., developing short/medium/long-term plans), and supporting education and training on the systems approach to addressing cross-cutting policies (e.g., European Commission's Green Deal). The framework resulting from the combination of such approaches can help to achieve systemic integration of sustainability and promote an institutional model to support strategic planning that effectively

responds to evolving needs and conditions to attain systemic integration of sustainability at the institutional level.

Lastly, it should be emphasized that technological integration already plays a crucial role in advancing sustainability initiatives within higher education institutions, and this trend will only accelerate in the future. Leveraging technology can enhance data collection, analysis, communication, and overall efficiency in various aspects of sustainability. As a result, sustainability benchmarking will increasingly integrate and prioritize more technological dimensions and innovative good practices. Future studies should follow suit in highlighting these trends while remaining cognizant of the fact that the fast pace of innovation can also represent a limitation. It is likely that technological innovation can outpace integration in higher education institution sustainability strategies, thereby making it difficult to adopt good practices before they become obsolete by further technological advancement. This phenomenon may be exacerbated by institutional inertia. Scholarship on sustainability benchmarking in higher education institutions can serve an additional purpose by providing up-to-date solutions and good practices that can be adopted in the short term.

Author Contributions: Conceptualization, O.C., S.A. and J.P.; methodology, O.C., D.B.M., S.A., E.F., A.B. and J.P.; writing—original draft preparation, O.C., D.B.M., S.A., E.F., A.B. and J.P.; writing—review and editing, O.C., D.B.M. and J.P.; visualization, S.A. and E.F.; supervision, O.C. and J.P.; project administration, J.P.; funding acquisition, S.A. and J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was co-funded by the European Commission's Erasmus+ program, grant number 101086809.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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