Mapping Sustainability Indicators in Higher Education Institutions: A Multi-Framework Analysis Based on the UNEP Sustainable University Framework

Harpito[1,2], Insannul Kamil[1*], Dicky Fatrias[1]
[1]Department of Industrial Engineering, Andalas University, Padang 25163, Indonesia

[2]Department of Industrial Engineering
Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru 28293, Indonesia
[*]*insannulkamil@eng.unand.ac.id*

Date received: November 5, 2025
Revision accepted: November 17, 2026

Abstract

Universities play a pivotal role in advancing global sustainability agendas through education, research, and institutional governance. Yet, most existing sustainability assessment frameworks remain fragmented and overly focused on environmental performance. This study adopts a hybrid review approach combining database searches with official framework documents, followed by directed content and mapping analysis to classify 463 sustainability indicators from eight global and regional higher-education frameworks. Databases included Science Direct, MDPI, and official institutional manuals, with defined inclusion and exclusion criteria, a 2015–2024 time span, and an English-language restriction. Two researchers independently coded all indicators using a predefined codebook and aligned them with the UNEP Sustainable University Framework (UNEP-SUF), covering four dimensions—Environment & Climate (EC), Teaching & Research (TR), People & Society (PS), and Administration & Governance (AG)—with inter-coder reliability of $\kappa = 0.75$*. Results reveal a significant imbalance: EC (48.81%), AG (22.03%), PS (17.06%), and TR (12.10%), indicating that sustainability measurement remains predominantly environmental and operational. UI GreenMetric and FAS-EUC showed a higher concentration of environmental indicators, whereas STARS offered more equitable representation across dimensions. Pielou's evenness index evaluated dimensional proportionality, while frequency counts confirmed EC dominance. As a technical foundation for campus sustainability, the UNEP-SUF supports an indicator-based assessment and decision-support method for Science and Technology (S&T) applications in campus infrastructure management, enabling HEIs to address structural imbalances across all four dimensions. Future work requires weighted scoring and empirical validation to strengthen generalizability.*

Keywords*:* sustainability indicators, higher education institutions (HEIs), UNEP-SUF, hybrid review, mapping analysis

1. Introduction

Sustainability in higher education institutions (HEIs) has evolved from mere policy compliance to a core institutional value aligned with the United Nations Sustainable Development Goals (SDGs) (United Nations, 2023). As transformative agents, HEIs shape sustainable societies through education, research, and institutional governance (Purcell *et al*., 2019; Saleh & Adly, 2024). However, earlier approaches to mainstreaming sustainability awareness often struggled to translate broad global goals into actionable institutional indicators (Kioupi & Voulvoulis, 2019; Budihardjo *et al*., 2021).

To address this, various sustainability assessment frameworks such as STARS, UI GreenMetric, and FCSA have advanced institutional benchmarking (Horan & O'Regan, 2021). Yet, many of these tools lack methodological consistency and fail to capture the interlinkages between education, governance, and community engagement (Ruiz-Mallén & Heras, 2020). Existing frameworks frequently emphasize environmental and operational indicators, leading to structural imbalances that undervalue teaching, research, and social governance (Rosa *et al*., 2024). For instance, UI GreenMetric prioritizes physical infrastructure and energy metrics (Isa *et al*., 2021), constraining universities' ability to measure multidimensional sustainability progress.

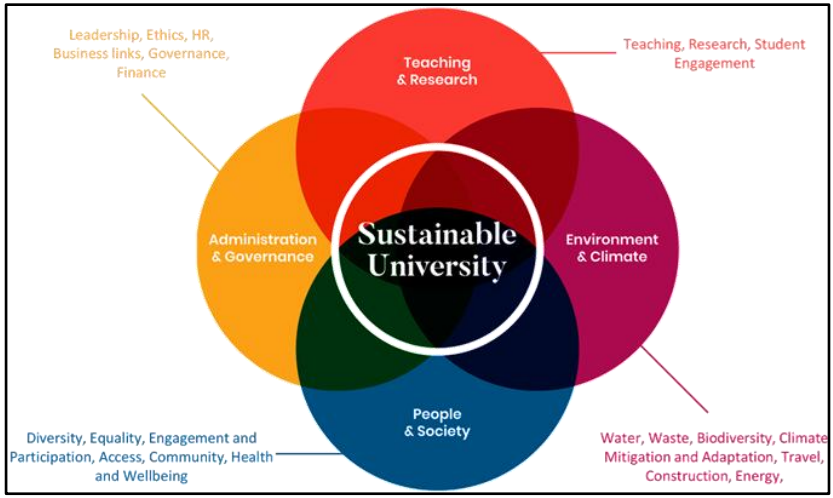

Figure 1. The UNEP Sustainable University Framework (UNEP, 2021)

Recognizing these limitations, the United Nations Environment Programme introduced the UNEP Sustainable University Framework (UNEP-SUF) in 2021 (UNEP, 2021), as shown in Figure 1. This framework articulates four core dimensions: Teaching and Research, People and Society, Environment and Climate, and Administration and Governance. It serves as a comprehensive guide for institutions aiming to synchronize their technical and academic efforts with the SDGs (UNEP, 2021). The UNEP-SUF promotes a participatory approach in co-creating context-specific metrics, providing a robust structure for multidimensional institutional evaluation (Rodríguez-García *et al*., 2019; Lattu & Cai, 2020).

While earlier comparative analyses have evaluated various higher education sustainability assessment tools (Fischer *et al*., 2015; Alghamdi *et al*., 2017; Berzosa *et al*., 2017), the empirical application of the UNEP-SUF to evaluate true multidimensional balance remains limited. Consequently, there is a pressing need for a systematic synthesis that identifies gaps and opportunities for achieving balanced assessments. Addressing this gap provides a direct technical contribution by establishing an indicator-based assessment and decision-support method. This systems-oriented approach enables HEIs to holistically integrate environmental engineering and infrastructure management with their critical academic, social, and governance dimensions.

To address these limitations, this study utilizes a hybrid review combined with directed content and mapping analysis. The primary objective of this study is to map the indicators of eight higher-education sustainability assessment frameworks onto the four UNEP-SUF dimensions (EC, TR, PS, AG) and to compare how evenly each framework covers them. Furthermore, the study applies Pielou's evenness index to measure proportionality, offering quantitative evidence of structural imbalances among the analyzed frameworks.

2. Methodology

This study employed a hybrid review method, followed by directed content analysis and a quantitative mapping analysis. This consistent design was chosen to systematically identify, classify, and quantitatively map university sustainability indicators against the UNEP-SUF dimensions. The methodology avoided a conventional database-only systematic review to

capture highly practical institutional metrics (including grey literature). The process was structured into three sequential stages.

2.1 Stage I – Indicator Collection

The initial stage centered on gathering sustainability indicators from university assessment frameworks using a hybrid retrieval strategy. The primary search was conducted on August 25, 2024, targeting peer-reviewed articles within the Title, Abstract, and Keywords fields. To address database specifications, the search string for ScienceDirect was *("higher education" OR "university") AND ("sustainability assessment" OR "indicators")* utilizing the "Research Articles" filter (yielding 540 records). For MDPI, the string was *("higher education sustainability assessment indicators") OR ("university sustainability assessment indicators") u*tilizing the "Article" document type filter (yielding 131 records).

Recognizing that relying exclusively on the selected primary databases (ScienceDirect and MDPI) may miss localized developed frameworks, a supplementary manual search was executed. This involved targeted retrieval via Google Scholar and institutional repositories, which successfully identified regionally specific tools not indexed in the primary platforms (such as FCSA from Indonesia, FAS-EUC from Egypt, and the SAFU thesis). Furthermore, official websites of global systems (UI GreenMetric and AASHE STARS) were manually searched to retrieve their latest technical manuals. To ensure data consistency, all extracted framework versions were strictly fixed to their published status as of August 2024.

All identified records were independently screened by two reviewers. Any disagreements regarding study inclusion were resolved through consensus discussion involving the third author. The inclusion criteria were: (a) frameworks published in English; (b) publication timespan between 2015 and 2024; (c) focus on HEI sustainability assessment; and (d) provision of an explicit list of indicators. The 2015 baseline aligns with the UN SDGs' adoption and captures a decade of framework evolution. Furthermore, grey literature—including a thesis, proceedings, and official manuals of global systems like AASHE STARS and UI GreenMetric—was purposefully included. This inclusion is essential to capture both localized assessment metrics and widely operationalized global standards that are inherently underrepresented in mainstream peer-reviewed databases. Conceptual articles lacking practical indicator lists were excluded. This screening process adhered

to the PRISMA 2020 flow guidelines (Page *et al*., 2021) as shown in Figure 2.

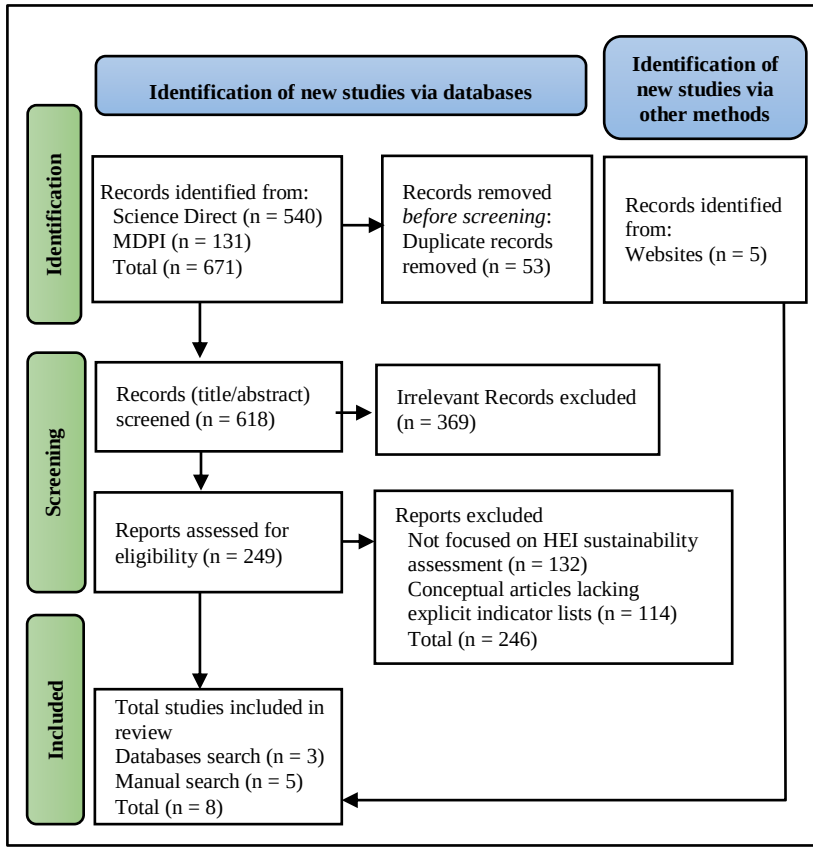

Figure 2. PRISMA 2020 flow diagram selection process

2.2 Stage II – Direct Content Analysis

Following the final selection of the eight frameworks, a total of 463 indicators were extracted. To systematically classify these metrics, a directed content analysis was applied using the UNEP-SUF as the predefined deductive framework. Each extracted indicator was rigorously evaluated based on its semantic meaning and primary operational focus, and subsequently categorized into one of the four UNEP-SUF dimensions: Environment & Climate (EC), Teaching & Research (TR), People & Society (PS), or Administration & Governance (AG). For indicators encompassing multiple

sustainability aspects, the classification was strictly determined by the indicator's dominant technical objective.

2.2.1 Phase 1: Unit of Analysis Definition

The first stage involved defining an appropriate unit of analysis to address terminological inconsistencies arising from the structural diversity of the selected frameworks. As these tools often employ varying hierarchical terminologies such as 'criteria,' 'sub-criteria,' and ‘indicators’ or 'credits'. To ensure cross-framework comparability, the unit of analysis was functionally defined as the lowest thematic scoring item—the most specific operational level within a framework that requires distinct data and carries an independent evaluation weight. To maintain functional equivalence across diverse nominal terminologies (e.g., Dimensions, categories, credits, indicators), the exact structural element counted as an 'indicator' was standardized. This prevents overrepresentation of highly fragmented frameworks, as detailed in Table 1.

Table 1. Codebook for Indicator Classification based on UNEP-SUF Dimensions

Framework	Original Structural Hierarchy	Unit Counted as "Indicator" (Lowest Scoring Item)
Framework of Campus Sustainability Assessment (FCSA)	Criterias → Sub-criterias → Indicators	Indicators
A Sustainability Assessment Framework for Universities (SAFU)	Dimensions → Category → Indicators	Indicators
A robust PICSOU framework (PICSOU)	Dimensions → Category → Indicators	Indicators
A Framework for Assessing the Sustainability of Egyptian University Campuses (FAS-EUC)	Criterias → Indicators → Sub-indicators	Sub-indicators
Sustainable Assessment Tools for Higher Education Institutions (SATHEI)	Dimensions → Aspect → Topic	Topic
Campus Sustainability Assessment Tools (CSAT)	Category → Sub-category → Indicators	Indicators
Sustainability Tracking, Assessment & Rating System (STARS)	Category → Sub-category → Credit	Credits

UI GreenMetric World University Rankings (UI-GM)	Category / Criteria → Indicator	Indicators

2.2.2 Phase 2: Codebook Development

To ensure objectivity and coding consistency, a formal codebook was developed, strictly anchored to the operational definitions of the UNEP-SUF technical manual (UNEP, 2021) (see Table 2). Recognizing that sustainability metrics frequently intersect multiple domains, this codebook extends beyond basic conceptual definitions by establishing explicit decision rules, tie-breakers, and boundary examples. For instance, indicators blending financial administration with academic output were resolved using a primary/secondary coding approach that prioritizes the metric's dominant operational intent. Furthermore, specific deviations from standard UNEP operationalizations—such as distinguishing student capacity building from institutional staff structures—were formally flagged and documented within the decision rules

Table 2. Codebook for Indicator Classification based on UNEP-SUF Dimensions

UNEP-SUF Dimension	UNEP (2021) (Primary Definition)	Decision Rule & Tie-Breaker (Operationalization)	Boundary Example & Resolution
EC	Focuses on institutional environmental footprint, resource efficiency, and climate impact mitigation.	**Rule:** Code as EC if the metric physically quantifies environmental consumption, emissions, or ecological footprint. **Tie-breaker:** If an indicator involves infrastructure investment (AG) but its scoring is strictly based on *physical ecological performance* (e.g., kWh saved, water recycled), assign to EC.	**Example:** *Green building investments*. **Resolution:** If measuring building certification level (LEED/green metric), code as EC. If measuring the exact financial budg*et al*located, code as AG.
TR	Encompasses the integration of sustainability into curricula, pedagogy, and academic	**Rule:** Code as TR if the metric evaluates academic learning outcomes, student courses, or research publication metrics.	**Example:** *Sustainability research funding*. **Resolution:** Despite involving financial

	research outputs.	**Tie-breaker:** If an indicator blends financial support with research (e.g., funding grants), the primary operational target is *academic knowledge generation*. Assign to TR.	administration (AG), the primary intent is expanding academic output. Code as TR.
PS	Addresses equity, health, well-being, community outreach, and social engagement.	**Rule:** Code as PS if the metric evaluates human well-being, diversity, community volunteering, or social equity. **Tie-breaker:** If an indicator blends environment with community (e.g., public clean-ups), assign to PS if it measures *human participation* (headcount/hours).	**Example:** *Community environmental outreach.* **Resolution:** If the metric counts student/staff volunteering hours, code as PS. If it measures tons of waste collected during the event, code as EC.
AG	Covers institutional policy, planning, human resources, finance, and structural campus management.	**Rule:** Code as AG if the metric evaluates written policies, budgetary allocations, HR frameworks, or organizational structures. **Tie-breaker:** *Deviation flag:* While UNEP loosely integrates "capacity building" in AG, operationalization here assigns student capacity building to TR, and strictly limits AG to *staff/institutional organizational structure*.	**Example:** *Sustainability committee staff wages.* **Resolution:** Although related to human well-being (PS), this is a structural institutional capacity metric. Code as AG.

2.2.3 Phase 3: Coding Process and Reliability

All 463 extracted indicators were independently mapped into the four UNEP-SUF dimensions by two raters (the first and second authors). Prior to this final coding process, a 10% pilot sample (approx. 46 indicators) was independently

evaluated to calibrate the codebook; to prevent training bias, this pilot data was strictly excluded from the final reliability calculations.

During the full classification, independently coding all 463 indicators resulted in 386 agreements and 77 inter-rater coding disagreements, primarily occurring when environmental performance metrics intersected with governance structures. To systematically address these boundary cases, a primary/secondary coding approach was implemented as a sensitivity analysis. To rigorously validate mapping consistency, inter-rater reliability was assessed. The independent evaluation yielded a raw proportional agreement of 83.4% (386 out of 463 indicators agreed upon), resulting in a Cohen's Kappa coefficient of 0.75 (95% CI [0.70, 0.80]), indicating substantial agreement (Landis & Koch, 1977). To account for potential prevalence bias caused by the high density of Environment & Climate indicators, Krippendorff's alpha was also calculated, yielding a highly consistent $\alpha = 0.75$.

The specific per-dimension agreement and the distribution of the 77 coding disagreements are detailed in the confusion matrix (Table 3). Any residual discrepancies were fully resolved through a consensus discussion moderated by the third author, anchored strictly to the primary intent defined by UNEP (2021).

Table 3. Confusion matrix of independent inter-rater classification

Rater Classification	Rater 2 (EC)	Rater 2 (TR)	Rater 2 (PS)	Rater 2 (AG)	Total (Rater 1)	Per-dimension Agreement
Rater 1 (EC)	**200**	6	12	12	230	87.0%
Rater 1 (TR)	4	**48**	2	2	56	85.7%
Rater 1 (PS)	7	1	**62**	6	76	81.6%
Rater 1 (AG)	16	3	6	**76**	101	75.2%
Total (Rater 2)	227	58	82	96	463	*Overall P_o = 83.4%*

2.3 Stage III – Mapping and Balance Analysis

The final analytical stage involved a mapping analysis to assess the degree of coverage and alignment of the identified indicators within the UNEP-SUF dimensions. This assessment focused strictly on the numerical distribution of

metrics across the four sustainability dimensions, deliberately avoiding subjective qualitative weighting regarding indicator depth or quality. To visually identify concentration areas, dimension-specific imbalances, and representational gaps, the initial results were synthesized using matrices and 100% stacked bar charts.

Building upon this foundational frequency distribution, the structural balance of each framework across the four UNEP-SUF dimensions was quantitatively evaluated using the Normalized Shannon Entropy index (H_N) (Shannon, 1948; Pielou, 1966; Ding *et al*., 2016). The balance score is calculated using Equation 1:

$$H_N = \frac{-\sum_{i=1}^{k} p_i \ln(p_i)}{\ln(k)} \quad (1)$$

where $k = 4$ represents the total number of UNEP-SUF dimensions, and p_i is explicitly defined as the proportional share of indicators classified into the i-th dimension (n_i/N). Because the natural logarithm of zero is undefined, any occurrence of zero counts within a dimension was computationally treated using the standard mathematical limit $\lim_{p_i \to 0} p_i \ln(p_i) = 0$.

Mathematically, this index yields a maximum baseline score of $H_N = 1$ only when a framework exhibits a perfectly equal distribution (an exact 25% share) across all four dimensions. It is acknowledged that the UNEP (2021) guidelines do not prescribe an equally weighted distribution as a normative requirement. However, this 25% equal-share baseline was established in this study as a theoretical comparative benchmark. It effectively operationalizes the concept of "comprehensive sustainability integration," providing a standardized metric to detect systemic structural biases—such as an over-concentration on environmental metrics at the expense of social or governance aspects—rather than serving as a prescriptive target.

To ensure analytical reliability, 95% bootstrap confidence intervals were computed for all H_N scores, as entropy metrics can be highly unstable in frameworks characterized by small sample sizes or extreme skewness (e.g., PICSOU, where $n = 22$ with only a single PS indicator). Based on 10,000 resampling iterations, this bootstrapping procedure guarantees that the reported dimensional balance metrics remain statistically robust against variations in framework indicator volume.

3. Result and Discussion

3.1 Description of Frameworks and Indicators

Based on the hybrid review, several sustainability assessment frameworks for higher education institutions were identified, developed both by individual researchers and global organizations. These frameworks vary in terms of geographical scope, structural complexity, and the number of criteria and indicators used to evaluate sustainability performance. Table 4 provides a detailed overview of the selected frameworks, including their origin, year of update, coverage, and indicator structure.

Table 4. Selected University Sustainability Indicator Frameworks

Framework	Developer (update year)	Scope	Number of Criteria	Number of Sub-Criteria	Number of Indicators
Framework of Campus Sustainability Assessment (FCSA)	(Wiganingrum *et al*., 2018)	Indonesia	5	15	35
A Sustainability Assessment Framework for Universities (SAFU)	(Sanghvi, 2020)	Netherlands	3	16	69
A robust PICSOU framework (PICSOU)	(Jiang & Kurnitski, 2023)	Estonia	3	6	22
A Framework for Assessing the Sustainability of Egyptian University Campuses (FAS-EUC)	(Konbr *et al*., 2023)	Egypt	5	12	88
Sustainable Assessment Tools for	(Du *et al*., 2023)	China	3	9	34

Higher Education Institutions (SATHEI) Campus Sustainability Assessment Tools (CSAT)	(Dawodu *et al*., 2023)	China	8	14	66
Sustainability Tracking, Assessment & Rating System (STARS)	*(Advancing Sustainability in Higher Education (AASHE), 2024)*	Global	5	13	60
UI GreenMetric World University Rankings (UI-GM)	(UI GreenMetric, 2024)	Global	6	-	89

Wiganingrum *et al*. (2018) developed a Framework of Campus Sustainability Assessment specifically tailored for Diponegoro University, Indonesia. Structured around a hierarchy of five criteria, 15 sub-criteria, and 35 indicators, the model employs a Multiple Criteria Decision-Making (MCDM) approach, specifically the Analytical Hierarchy Process (AHP). This methodological choice facilitated the prioritization of indicators and the calculation of a quantitative sustainability score. The assessment highlighted critical operational challenges, identifying high electricity consumption, suboptimal waste management, and the scarcity of green open spaces as significant determinants of the university's overall sustainability performance (Wiganingrum *et al*., 2018).

Sanghvi (2020) developed a comprehensive sustainability assessment framework for the University of Twente, structured around 3 criteria, 16 sub-criteria, and 69 indicators. This multi-dimensional model evaluates performance across diverse domains, including Volunteerism to gauge community engagement, and Academic Programs and Research to assess curriculum integration and scholarly contribution to policy. Additionally, operational aspects like Food and Dining and Managed Green Spaces are analyzed to address environmental impacts and ecosystem services. Collectively, these metrics offer a holistic guide for optimizing sustainability practices within higher education institutions (Sanghvi, 2020).

Addressing the need for streamlined assessment tools, Jiang and Kurnitski (2023) introduced a performance-based framework centered on carbon mitigation. Unlike complex predecessors, this user-friendly model utilizes 22 indicators across three criteria to evaluate critical metrics like GHG emissions, energy efficiency, and indoor environmental quality. The framework explicitly bridges technical performance with global standards, integrating the UN Sustainable Development Goals (SDGs) and Triple Bottom Line principles. This approach ensures that higher education institutions can practically assess environmental impacts while maintaining alignment with broader social and economic sustainability objectives (Jiang & Kurnitski, 2023).

To foster sustainable development within Egyptian higher education, Konbr *et al*. (2023) introduced a robust assessment framework structured around five criteria, 12 sub-criteria, and 88 indicators. This multidimensional model holistically evaluates operational efficiency—ranging from energy utilization to waste management—while strictly adhering to the UN Sustainable Development Goals (SDGs). Designed to complement international standards like STARS, the framework transcends technical metrics by emphasizing the socio-economic contributions of green campuses to human well-being. Additionally, it advocates for a participatory approach, identifying active stakeholder engagement in resource conservation as a fundamental prerequisite for realizing environmentally resilient institutions (Konbr *et al*., 2023).

Driven by the need for a suitable sustainability assessment tool for universities in China, Du *et al* (2023). developed the Sustainable Assessment Tools for Higher Education Institutions (SATHEI) in 2023, designed to provide both an overview and a targeted analysis of campus sustainability in China. Structured around three criteria, nine sub-criteria, and 34 indicators, the framework evaluates institutional performance while fostering tripartite collaboration among HEIs, industry, and government. The study introduces two complementary instruments — Quick Analysis Tool (QAT) and In-Depth Benchmarking Tool (IBT) — to assess key dimensions including operations, education, research, and community engagement. By integrating these metrics into strategic campus planning, the model aims to enhance stakeholder participation and drive universities toward superior sustainability standards through rigorous data collection (Du *et al*., 2023).

Responding to specific infrastructural challenges—such as centralized water systems, Dawodu *et al*. (2023) developed a localized sustainability assessment framework for Chinese universities. Comprising eight criteria, 14 sub-criteria, and 66 indicators, the model addresses the limitations of standardized global tools, which often lack sufficient stakeholder engagement. The study advocates for a participatory approach, prioritizing diverse stakeholder perspectives over exclusive expert input. By explicitly integrating local contextual factors, the framework mitigates the inadequacies of uniform strategies, ensuring that sustainability metrics accurately reflect regional realities rather than relying on generic international standards (Dawodu *et al*., 2023).

In addition to the indicators developed by individual researchers, several global sustainability assessment systems, such as STARS and UI GreenMetric, have also proposed widely recognized indicator sets. These global systems provide indicators that are equally significant compared to those introduced in previous research-based frameworks. Both STARS and UI GreenMetric offer comprehensive metrics that not only facilitate the evaluation of sustainability practices but also promote continuous improvement and foster collaboration among higher education institutions worldwide (Ulkhaq *et al*., 2018; Amey *et al*., 2020).

To provide a holistic sustainability assessment, The Association for the Advancement of Sustainability in Higher Education (AASHE) launches STARS version 3.0 evolved to encompass five criteria, 13 sub-criteria, and 60 indicators as detailed in the STARS 3.0 Technical Manual (AASHE, 2024). This robust structure allows institutions to evaluate diverse dimensions, from teaching to resource efficiency. More than a mere benchmarking tool, STARS is designed to foster a culture of innovation, preparing future leaders for complex challenges. Ultimately, it empowers higher education institutions to operationalize social responsibility and contribute significantly to local and global SDG achievement.

Grounded in the Triple Bottom Line principles, the UI GreenMetric framework provides a standardized global ranking system for university sustainability. While the 2024 guidelines summarize the assessment into 51 broad indicators, a granular examination of the official operational questionnaire reveals a more detailed assessment model comprising six criteria and 89 specific measurable metrics/items that universities are required to fulfill (UI GreenMetric, 2024).

Operational performance is heavily evaluated through Setting and Infrastructure, Energy and Climate Change, Waste, Water, and Transportation. Concurrently, the Education and Research criterion assesses the academic integration of sustainability knowledge. It is important to acknowledge that UI GreenMetric applies specific percentage weights to these categories for final scoring (UI GreenMetric, 2024). However, this current study's mapping analysis intentionally focuses on the unweighted numerical frequency of the 89 operational metrics. This approach was selected to assess the systemic breadth, structural complexity, and conceptual coverage of the framework across the UNEP-SUF dimensions, rather than calculating institutional performance scores. This multi-faceted structure allows for a holistic benchmarking of institutional performance across diverse operational and pedagogical dimensions.

The review revealed that some frameworks, such as UI GreenMetric (UI-GM) and STARS, have global coverage and include a large number of indicators (89 and 60 respectively), emphasizing their comprehensive approach to institutional sustainability assessment. Context-specific frameworks also demonstrate significant depth and structural complexity; for instance, FAS-EUC (88 indicators), SAFU (69 indicators), and CSAT (66 indicators) utilize extensive, multidimensional structures to address complex institutional sustainability practices. In contrast, other localized models, such as FCSA (35 indicators), SATHEI (34 indicators), and PICSOU (22 indicators), utilize more targeted assessment approaches, reflecting specific adaptations to local sustainability challenges.

These variations in scope and structure highlight the diversity of sustainability assessment practices, indicating the absence of a universally standardized framework and underscoring the need for alignment with globally recognized structures such as the UNEP-SUF.

3.2. Classification of Indicators Based on UNEP-SUF Dimensions

The classification of indicators was carried out to assess the extent to which existing university sustainability frameworks reflect the holistic approach advocated by the UNEP-SUF. This process employed a directed content analysis approach, whereby indicators collected from eight sustainability frameworks were systematically coded and aligned with UNEP-SUF dimensions, namely: Environment & Climate (EC), Teaching & Research (TR), People & Society (PS), and Administration & Governance (AG), as

illustrated in Figure 3. This classification enabled the identification of dominant areas of focus, and potential gaps in indicator coverage, providing a structured basis for evaluating the comprehensiveness and balance of sustainability frameworks in higher education

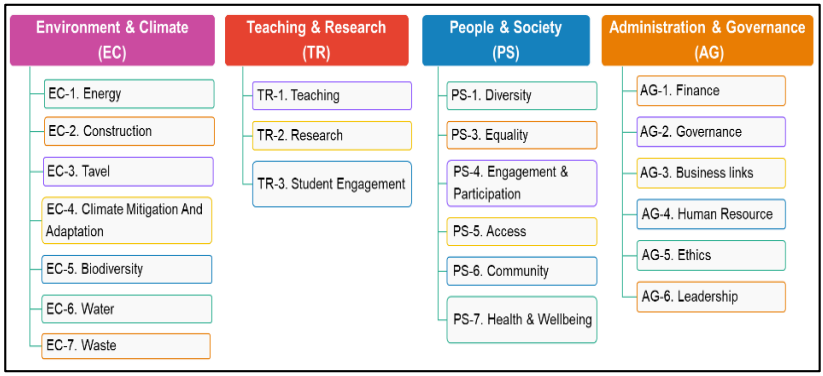

Figure 3. Classification of Indicators Based on UNEP-SUF Dimensions

Based on the classification of sustainability indicators collected from eight diverse assessment tools—stratified by geographical scope (ranging from global models to national and single-university applications) and by primary purpose (comprehensive frameworks versus specifically environment-oriented tools)—a total of 463 indicators was identified. Acknowledging this stratification is vital, as environment-oriented tools are expectedly environment-heavy. Nevertheless, these indicators were aggregated and categorized into the UNEP-SUF dimensions to evaluate the macro-level landscape. The classification process was conducted using a thematic coding technique to ensure that each indicator was accurately aligned with the conceptual structure of UNEP-SUF. The distribution of indicators across the four dimensions is presented in Table 5 and Figure 4, offering a comprehensive overview of the dominant areas of focus within the analyzed frameworks and revealing gaps that limit the achievement of a balanced and holistic approach to sustainability in higher education institutions.

The analysis revealed a significant imbalance in the distribution of sustainability indicators across the UNEP-SUF dimensions. The Environment & Climate (EC) dimension accounted for the largest share, with 226 indicators (48.81%), reflecting a strong emphasis on environmental sustainability and operational aspects such as energy use, waste management, and climate change mitigation. In contrast, the Teaching & Research (TR) dimension was

considerably underrepresented, comprising only 56 indicators (12.10%), suggesting limited integration of sustainability into academic curricula and research agendas. The Administration & Governance (AG) dimension included 102 indicators (22.03%), indicating moderate attention to institutional governance and policy frameworks for sustainability. Meanwhile, the People & Society (PS) dimension represented 79 indicators (17.06%), highlighting a relatively low focus on social aspects such as diversity, equality, and community engagement.

Table 5. Distribution of Indicators Across UNEP-SUF Dimensions

UNEP-SUF Dimensions	Number of Indicators	Percentage	Description
I. Environment & Climate (EC)	226	48.81%	The environmental impact of its operational activities and its contribution to climate change mitigation
II. Teaching & Research (TR)	56	12.10%	Transforming the curriculum and research agenda towards a direction that supports the SDGs
III. People & Society (PS)	79	17.06%	Focusing on the social aspects of sustainability in the university context
IV. Administration & Governance (AG)	102	22.03%	Reflects the extent to which sustainability is integrated into university governance.

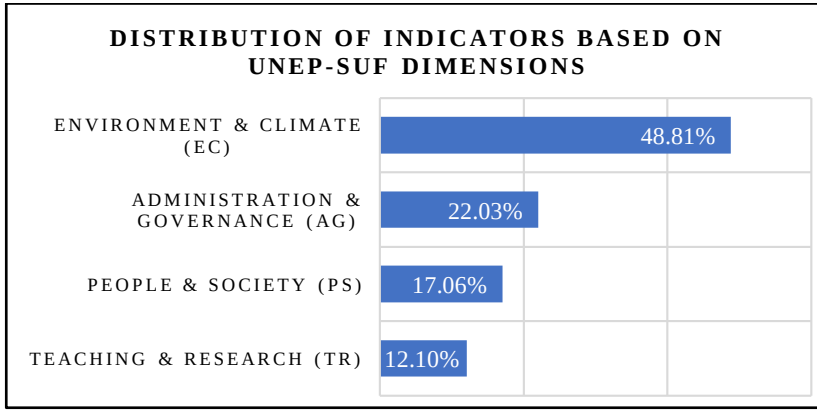

Figure 4. Distribution of Indicators Across UNEP-SUF Dimensions

Descriptively, these findings demonstrate that the prevailing landscape of university sustainability assessment remains disproportionately anchored in the operational management of physical campus facilities. Although governance structures are gaining recognition within these tools, the core academic missions specifically Teaching and Research (TR) and vital social inclusion aspects (PS) are notably underrepresented. This persistent imbalance indicates that current quantitative metrics fail to fully capture the holistic, multidimensional sustainability strategies necessary for comprehensive institutional transformation.

3.3 Indicator Mapping (Mapping Analysis)

Following the classification of indicators into the four UNEP-SUF dimensions, the next step involved conducting a systematic mapping of indicators across the analyzed frameworks. The primary objective of this mapping process was to visualize the relative coverage of each framework in relation to the sustainability dimensions defined by UNEP-SUF. This technique, commonly referred to as mapping analysis, was applied to evaluate the alignment, comprehensiveness, and representativeness of indicators within each framework.

The mapping analysis was operationalized through the construction of a comprehensive matrix, where rows represent the eight selected frameworks and columns correspond to the four UNEP-SUF dimensions. To ensure a consistent base for comparison, data in each cell is presented in the format of 'Count (Percentage)'. These percentages are calculated based on the total number of indicators per framework (row-based normalization), allowing for a direct comparison of proportional priorities across different assessment tools. This structured matrix format facilitates the immediate identification of dominant focus areas and dimension-specific disparities by comparing the proportional percentages. The resulting analysis is presented in Table 6, illustrating the extent to which each framework aligns with the multidimensional nature of sustainability in higher education.

Overall, the matrix confirmed that the imbalance in focus across dimensions remains a major challenge in the development of university sustainability indicators. The strong emphasis on environmental aspects has not been adequately complemented by equivalent attention to academic, social, and governance dimensions. Consequently, this mapping provides a solid foundation for advancing the development of sustainability frameworks that

are more balanced and aligned with the multidimensional structure outlined in the UNEP-SUF. To better understand these imbalances, the following discussion provides a detailed examination of indicator distribution across the UNEP-SUF dimensions, highlighting dominant areas and underrepresented domains.

Table 6. Structure of Indicator Mapping Matrix

Framework	UNEP-SUF Dimension				Total Indicators (n)
	EC Environment & Climate	TR Teaching & Research	PS People & Society	AG Administration & Governance	
FCSA	17 (48.57%)	5 (14.29%)	7 (20.00%)	6 (17.14%)	35
SAFU	31 (44.93%)	6 (8.70%)	14 (20.29%)	18 (26.09%)	69
PICSOU	15 (68.18%)	4 (18.18%)	1 (4.55%)	2 (9.09%)	22
FAS-EUC	50 (56.82%)	12 (13.64%)	8 (9.09%)	18 (20.45%)	88
SATHEI	16 (47.06%)	5 (14.71%)	4 (11.76%)	9 (26.47%)	34
CSAT	21 (31.82%)	4 (6.06%)	22 (33.33%)	19 (28.79%)	66
STARS	12 (20.00%)	10 (16.67%)	17 (28.33%)	21 (35.00%)	60
UI-GM	64 (71.91%)	10 (11.24%)	6 (6.74%)	9 (10.11%)	89
Total (N)	226 (48.81%)	56 (12.10%)	79 (17.06%)	102 (22.03%)	463

3.3.1 Environment & Climate (EC)

The Environment & Climate (EC) dimension emerged as the most dominant across all frameworks, accounting for 226 indicators (48.81%). This result suggests that most university sustainability frameworks remain oriented toward operational environmental issues such as energy, water, waste management, transportation, and climate change mitigation. Assessing within-framework percentages to determine structural emphasis, UI GreenMetric (UI-GM) and PICSOU allocate the vast majority of their metrics to this dimension (71.91% and 68.18%, respectively), demonstrating a strong emphasis on physical and ecological aspects of sustainability measurement.

FAS-EUC also shows a dominant environmental focus (56.82%). The predominance of indicators within this dimension reflects a prevailing perception of sustainability as primarily an environmental issue, rather than a holistic, systemic concept.

3.3.2 Teaching & Research (TR)

In sharp contrast, the Teaching & Research (TR) dimension represented the smallest proportion, comprising only 56 indicators (12.10%). This result demonstrates that most frameworks had not yet fully integrated sustainability concepts into academic teaching and research practices. The highest internal shares for the TR dimension were actually found in PICSOU (18.18%), STARS (16.67%), SATHEI (14.71%), and FCSA (14.29%). Although FAS-EUC and UI-GM contributed the highest raw numbers to this dimension (12 and 10 indicators, respectively), their actual within-framework emphasis is comparatively lower (13.64% and 11.24%) due to their larger overall sizes. These findings reinforce the observation that academic integration of sustainability remains inconsistent across existing frameworks.

3.3.3 People & Society (PS)

The People & Society (PS) dimension comprised 79 indicators (17.06%), signaling a relatively low focus on social aspects of sustainability within higher education. This dimension encompassed issues such as equity, diversity, community engagement, and the well-being of academic staff and students. Evaluating within-framework emphasis, CSAT dedicated the highest internal proportion to this dimension (33.33%), reflecting a strong orientation toward social inclusion and community development. STARS followed with 28.33%. In contrast, PICSOU allocated only 4.55% of its metrics to this category, revealing the limited representation of social sustainability within its carbon-focused structure.

3.3.4 Administration & Governance (AG)

The Administration & Governance (AG) dimension represented the second-largest category, with 102 indicators (22.03%), underscoring the growing recognition of institutional governance in advancing sustainability goals. This dimension included indicators related to organizational policies, institutional ethics, leadership, and strategic sustainability management. Based on within-framework percentages, STARS emerged as the framework with the strongest

internal emphasis on governance (35.00%), followed by CSAT (28.79%), SATHEI (26.47%), and SAFU (26.09%). These findings suggest that several frameworks have begun strengthening institutional governance structures to support sustainability, although efforts remain uneven across the global higher education landscape.

3.4 Balance and Distributional Evenness Analysis

To augment the descriptive frequency analysis and ensure a robust assessment of dimensional distribution, a Balance Index Analysis was performed. Specifically, this was calculated using the Normalized Shannon Entropy (H_N) for each framework. This metric serves as a quantitative measure of distributional evenness across the four UNEP-SUF dimensions. Interpretatively, an index value approaching 1 indicates perfect equilibrium, reflecting a high degree of evenness in indicator counts across the dimensions. Conversely, a value closer to 0 denotes significant numerical skewness or specialization, typically reflecting a heavy concentration of indicators in specific environmental operational aspects. Table 7 presents the computed Balance Index results alongside bootstrap confidence intervals and dimension-specific deficits, offering a quantitative basis for comparing structural proportionality

Table 7. Distributional Evenness and Maximum Dimension Deficit per Framework

Framework	Total Indicators (n)	Shannon Entropy (HN)	95% CI for HN*	Lowest Dimension (Max Deficit)	Log-Ratio to Parity (ln(pi/0.25))
STARS	60	0.970	[0.880, 0.994]	TR (16.67%)	-0.405
CSAT	66	0.908	[0.808, 0.957]	TR (6.06%)	-1.417
FCSA	35	0.904	[0.706, 0.975]	TR (14.29%)	-0.560
SAFU	69	0.899	[0.783, 0.957]	TR (8.70%)	-1.056
SATHEI	34	0.895	[0.698, 0.968]	PS (11.76%)	-0.754
FAS-EUC	88	0.819	[0.693, 0.901]	PS (9.09%)	-1.012
PICSOU	22	0.671	[0.342, 0.854]	PS (4.55%)	-1.705

UI-GM	89	0.647	[0.486, 0.764]	PS (6.74%)	-1.311

The entropy analysis reveals significant divergence in framework design strategies, but it also highlights a critical mathematical limitation: a high overall H_N score can mask severe single-dimension deficits (masking effect) if the remaining dimensions are adequately balanced. To address this, Table 7 introduces the Log-Ratio to Parity ($LRP = \ln(p_i/0.25)$) for the lowest-performing dimension of each framework. An LRP closer to 0 indicates parity (25% equal share), while a large negative value exposes an acute deficit.

When evaluated together, these metrics provide a more transparent assessment. Frameworks such as STARS and FCSA exhibit higher entropy values ($H_N > 0.90$) with relatively mild LRP deficits, reflecting a generally more even distribution of indicator counts. FAS-EUC ($H_N = 0.819$) aligns more closely with the moderate-evenness tier represented by SAFU and SATHEI (0.89--0.90), showing a balanced yet slightly operation-leaning structure.

Conversely, the analysis exposes the masking effect within CSAT: despite achieving a high overall entropy (0.908), its Log-Ratio to Parity reveals a severe single-dimension deficit in Teaching & Research ($LRP = -1.417$). This proves that CSAT's overall indicator spread masks a profound academic underrepresentation. Meanwhile, specialized frameworks like UI GreenMetric ($H_N = 0.647$) and PICSOU ($H_N = 0.671$) demonstrate substantially lower entropy values, accompanied by acute LRP deficits in TR and PS. Rather than independently confirming institutional functions, these quantitative structural skews closely mirror the explicit design purposes stated in their respective foundational technical documents—such as UI GreenMetric's primary emphasis on campus physical operations and PICSOU's deliberate focus on carbon accounting.

It is important to note that a lower entropy score does not inherently imply a framework is flawed; rather, it reflects a specific scope. However, when viewed through the comprehensive lens of the UNEP-SUF, frameworks with low balance indices may present a risk of strategic misalignment if used as the sole guide for institutional sustainability, potentially leading universities to overlook critical academic and social responsibilities.

3.5 Comparative Implications Visualization

The Stacked Bar Chart (Figure 5) visualizes the comparative composition of sustainability dimensions across the eight frameworks utilizing a 100% stacked bar chart format. Unlike absolute frequency plots, this visualization normalizes the variation in total indicator counts, facilitating a direct assessment of proportional priorities independent of scale bias. A distinct visual dichotomy is evident in the results: frameworks such as PICSOU and UI GreenMetric are characterized by a dominant Environment & Climate (EC) component, which occupies approximately 70% of their respective profiles. This distribution signals a prevailing orientation toward eco-efficiency and campus operations

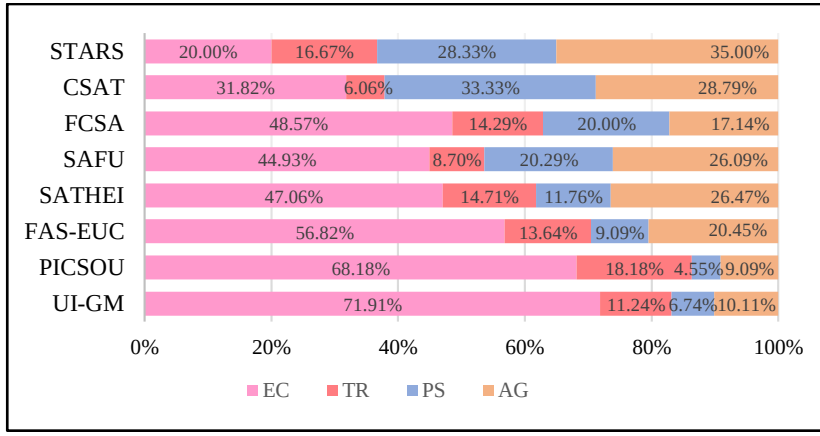

Figure 5. Proportional Distribution of Indicators on UNEP-SUF Dimensions (Stacked Bar Chart 100%)

Conversely, the chart reveals differing structural approaches among the remaining frameworks**.** STARS displays a more equitable segmentation, where both the Teaching & Research (TR) and People & Society (PS) dimensions constitute substantial portions of the assessment structure. CSAT, while allocating a substantial portion to PS (33.33%), demonstrates a distinct weakness in the TR dimension (6.06%). This graphical evidence visually illustrates the preceding entropy analysis, reflecting the structural distinction between frameworks functioning primarily as environmental management tools and those attempting to integrate the multiple dimensions of a holistic sustainable university model. Ultimately, the chart underscores a persistent imbalance among the analyzed frameworks, highlighting a recurring emphasis

on environmental metrics at the expense of the comprehensive academic, social, and governance dimensions requisite for systemic sustainability in higher education.

4. Conclusion and Recommendation

This study systematically mapped 463 sustainability indicators from eight international assessment frameworks against the UNEP-SUF, providing a granular evaluation of how higher education sustainability is currently measured. The analysis, complemented by a Normalized Shannon Entropy (H_N) measure of distributional evenness, confirms a pronounced structural asymmetry among the eight analyzed frameworks. The Environment & Climate (EC) dimension overwhelmingly dominates the assessment landscape, accounting for 48.81% of all indicators, which reflects a persistent emphasis on operational eco-efficiency metrics within their indicator structures, although this count-based finding does not account for the final weighted scoring priorities that frameworks may apply. Conversely, the Teaching & Research (TR) and People & Society (PS) dimensions remain significantly underrepresented, comprising only 12.10% and 17.06% of the total indicators, respectively. The entropy analysis further stratifies these tools, revealing that while STARS stands out with a high entropy value ($H_N = 0.970$) accompanied by a genuinely equitable distribution of indicators, others like UI GreenMetric and PICSOU are heavily skewed toward environmental metrics, evidenced by their lower entropy scores.

This study applies Pielou's evenness index to evaluate dimensional proportionality, while frequency counts confirm the dominance of EC metrics. Functioning as a technical foundation for campus sustainability, the UNEP-SUF facilitates the development of an indicator-based assessment and decision-support method. Beyond its theoretical contributions, this research offers practical utility for Science and Technology (S&T) practitioners, serving as an indicator-selection aid for applied engineering in campus energy, water, and waste management. Higher Education Institutions (HEIs) can utilize the classified indicator mapping to audit their internal performance metrics against the comprehensive UNEP-SUF model. By overlaying institutional KPIs with the dimensional classification, administrators can identify critical "blind spots"—particularly in curriculum integration and social equity—that may be obscured by a reliance on operationally skewed ranking systems. Furthermore, this systems approach empowers HEIs to make

informed decisions regarding framework adoption by utilizing hybrid monitoring dashboards that explicitly supplement environmental metrics with substantial academic and social indicators, enabling them to systematically address structural imbalances across all four UNEP-SUF dimensions.

To remedy the identified strategic misalignment, future iterations of sustainability assessment tools should adhere to prescriptive design principles that ensure holistic coverage. First, as a hypothesis for future work, framework developers are encouraged to explore a normative minimum proportional threshold (such as allocating 25% of the total indicator count) for the Teaching & Research (TR) dimension. This 25% benchmark is explicitly based on an equal-share logic across the four UNEP-SUF dimensions. While not empirically derived from the indicator count data of this study, this proposed safeguard aligns with Education for Sustainable Development (ESD) standards, ensuring the academic mission is not overshadowed by operational infrastructure. By implementing this equal-share baseline, sustainability metrics can better support comprehensive, systemic transformation rather than mere operational optimization. Second, future frameworks must enforce mandatory governance indicators within the Administration & Governance (AG) dimension that track budgetary allocation and leadership accountability, thereby moving beyond symbolic policy existence to measurable institutionalization. Finally, reporting mechanisms should visually decouple operational performance from academic impact to prevent high environmental scores from masking deficiencies in education and community engagement, thus fostering a more transparent and multidimensional representation of university sustainability.

The findings of this study should be interpreted within the context of specific methodological limitations. First, the analysis relies on frequency counts of indicators as a proxy for assessment focus, rather than their relative scoring weights. While the entropy analysis assumes that indicator quantity correlates with granularity and attention, it is acknowledged that a framework could theoretically assign high weight to a small number of indicators; therefore, future research should incorporate weighting schemas to refine this assessment. Second, this study evaluates content validity—specifically, the alignment of indicators with the UNEP-SUF—but does not assess outcome validity. This study did not empirically test whether high scores in the TR or PS dimensions correlate with tangible improvements in student sustainability literacy or community well-being. Consequently, future scholarship should move beyond descriptive mapping to empirically validate the correlation

between these framework scores and actual institutional sustainability outcomes.

5. Acknowledgement

The authors would like to thank their home institutions for the support provided during the completion of this research, as well as the reviewers for their constructive feedback which greatly improved the manuscript.

6. References

AASHE. (2024). STARS Technical Manual V 3.0. Retrieved from https://stars.aashe.org/resources-support/stars-3-0/

Alghamdi, N., den Heijer, A., & de Jonge, H. (2017). Assessment tools' indicators for sustainability in universities: an analytical overview. *International Journal of Sustainability in Higher Education*, 18(1), 84–115. https://doi.org/10.1108/IJSHE-04-2015-0071

Amey, L., Plummer, R., & Pickering, G. (2020). Website communications for campus sustainability: An analysis of Canadian universities. *International Journal of Sustainability in Higher Education*, 21(3), 531-556. https://doi.org/10.1108/IJSHE-04-2019-0137

Berzosa, A., Bernaldo, M. O., & Fernández-Sanchez, G. (2017). Sustainability assessment tools for higher education: An empirical comparative analysis. *Journal of Cleaner Production*, 161, 812–820. https://doi.org/10.1016/j.jclepro.2017.05.194

Budihardjo, M. A., Ramadan, B. S., Putri, S. A., Wahyuningrum, I. F. S., & Muhammad, F. I. (2021). Towards sustainability in higher-education institutions: Analysis of contributing factors and appropriate strategies. *Sustainability*, 13(12), 6562. https://doi.org/10.3390/su13126562

Dawodu, A., Guo, C., Zou, T., Osebor, F., Tang, J., Liu, C., Wu, C., & Oladejo, J. (2023). Developing an integrated participatory methodology framework for campus sustainability assessment tools (CSAT): A case study of a Sino-foreign university in China. *Progress in Planning*, 183, 100827. https://doi.org/10.1016/j.progress.2023.100827

Ding, L., Shao, Z., Zhang, H., Xu, C., & Wu, D. (2016). A comprehensive evaluation of urban sustainable development in China based on the TOPSIS-Entropy method. *Sustainability*, 8(8), 746. https://doi.org/10.3390/su8080746

Du, Y., Ye, Q., Liu, H., Wu, Y., & Wang, F. (2023). Sustainable assessment tools for higher education institutions: Developing two-hierarchy tools for China. *Sustainability*, 15(15), 11551. https://doi.org/10.3390/su151511551

Fischer, J., Gardner, T. A., Bennett, E. M., Balvanera, P., Biggs, R., Carpenter, S., Daw, T., Folke, C., … & Tenhunen, J. (2015). Advancing sustainability through mainstreaming a social–ecological systems perspective. *Current Opinion in Environmental Sustainability*, 14, 144–149. https://doi.org/10.1016/J.COSUST.2015.06.002

Horan, W., & O'Regan, B. (2021). Developing a practical framework of sustainability indicators relevant to all higher education institutions to enable meaningful international rankings. *Sustainability*, 13(2), 629. https://doi.org/10.3390/su13020629

Isa, H. M., Singh Sedhu, D., Suzila Lop, N., Rashid, K., Mohd Nor, O., & Iffahd, M. (2021). Strategies, challenges and solutions towards the implementation of green campus in UiTM Perak. *Journal of the Malaysian Institute of Planners*, 19(2), 60-71. https://doi.org/10.21837/pm.v19i16.952

Jiang, Q., & Kurnitski, J. (2023). Performance based core sustainability metrics for university campuses developing towards climate neutrality: A robust PICSOU framework. *Sustainable Cities and Society*, 97, 104723. https://doi.org/10.1016/j.scs.2023.104723

Kioupi, V., & Voulvoulis, N. (2019). Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes. *Sustainability*, 11(21), 6104. https://doi.org/10.3390/su11216104

Konbr, U., Elsayed, M., & Elboshy, B. (2023). A framework for assessing the sustainability of Egyptian university campuses. *Civil Engineering and Architecture*, 11(4), 1909-1939. https://doi.org/10.13189/cea.2023.110419

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159-174. https://doi.org/10.2307/2529310

Lattu, A., & Cai, Y. (2020). Tensions in the sustainability of higher education-the case of Finnish universities. *Sustainability*, 12(5), 1941. https://doi.org/10.3390/su12051941

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., … & Moher, D. (2021). The PRISMA 2020

statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. https://doi.org/10.1136/bmj.n71

Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology, 13*, 131-144. https://doi.org/10.1016/0022-5193(66)90013-0

Purcell, W. M., Henriksen, H., & Spengler, J. D. (2019). Universities as the engine of transformational sustainability toward delivering the sustainable development goals: "Living labs" for sustainability. *International Journal of Sustainability in Higher Education*, 20(8), 1343-1357. https://doi.org/10.1108/IJSHE-02-2019-0103

Rodríguez-García, A. M., Belmonte, J. L., Montoro, M. A., & Moreno-Guerrero, A. J. (2019). Productive, structural and dynamic study of the concept of sustainability in the educational field. *Sustainability*, 11(20), 5613. https://doi.org/10.3390/su11205613

Rosa, M. R. da, Boscarioli, C., & Freitas Zara, K. R. de. (2024). A systematic review of the trends and patterns of sustainability reporting in universities. *International Journal of Sustainability in Higher Education*, 25(3), 556-576. https://doi.org/10.1108/IJSHE-12-2022-0399

Ruiz-Mallén, I., & Heras, M. (2020). What sustainability? Higher education institutions' pathways to reach the Agenda 2030 goals. *Sustainability*, 12(4), 1290. https://doi.org/10.3390/su12041290

Saleh, S. A. K., & Adly, H. M. (2024). Measuring the impact of higher education in promoting Sustainable Development Goals: Analysis of the Arab universities' performance. *Problemy Ekorozwoju*, 19(1), 261-274. https://doi.org/10.35784/preko.5384

Sanghvi, J. (2020). *A sustainability assessment framework for universities* (Master's thesis). Department of Civil Engineering & Management, University of Twente, Enschede, Netherlands. Retrieved from https://purl.utwente.nl/essays/83191

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, 27(3), 379-423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

UI GreenMetric. (2024). UI GreenMetric Guideline 2024 (Instituting UI Greenmetric: The Way Forward). UI GreenMetric Office. Retrieved from https://uigreenmetric.com/wp-content/uploads/2024/06/UI-GreenMetric-Guideline-2024-1.pdf

Ulkhaq, M. M., Wijayanti, W. R., Wiganingrum, R., Dewi, W. R., & Ardi, F. (2018). Assessing university's sustainability programs from the perspective of university

students: A gap analysis. *MATEC Web of Conferences*, 154, 01073. https://doi.org/10.1051/matecconf/201815401073

UNEP. (2021). The UNEP Sustainable University Framework: Defining a sustainable university and creating a global pathway to recognising and becoming one. United Nations Environment Programme (UNEP). Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/36341/USUF.pdf

United Nations. (2023). Sustainable Development Goals (Guidelines for The Use of The SDG Logo Including the Colour Wheel, And 17 Icons). United Nations Department of Global Communications. Retrieved from https://unsdg.un.org/download/7777/497

Wiganingrum, R., Handayani, N. U., & Suliantoro, H. (2018). Framework development of campus sustainability assessment. Case study: Diponegoro University. In Hadiyanto, Maryono, & B. Warsito (Eds.), *Proceedings of the 3rd International Conference on Energy, Environmental and Information System (ICENIS 2018)*, Semarang, Indonesia, 02004. https://doi.org/10.1051/e3sconf/20187302004