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A Data-Driven Benchmarking Framework for Enhancing Sustainability Performance in UI GreenMetric Rankings: Insights from Saudi Arabian Higher Education Institutions

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Abstract: This study presents an all-inclusive benchmarking framework as a strategic tool for Saudi Arabian higher education institutions (HEIs) aiming to enhance their performance in the UI GreenMetric World University Ranking (UIGWUR), with extended applications for HEIs in other countries. The proposed framework progresses beyond statistical reporting to offer a transferable data-driven tool that could support HEIs worldwide in diagnosing gaps, prioritizing actions and strategically advancing sustainability outcomes. The number and trends of ranking by Saudi Arabian HEIs participated in the UIGWUR between year 2014 and 2024 are quantitatively analyzed to reveal insights into their sustainability performance and areas for improvement. Results from the analysis indicated steady growth in their participation, beginning from one HEI in year 2014 to 14 out of 67 HEIs in year 2024. Four institutions, in particular, could serve as benchmark models for others aspiring to improve their global standing: King Abdulaziz University (KAU) and Princess Nourah bint Abdulrahman University (PNU) have ranked among the top 100 consistently whereas Qassim University (QU) and Imam Abdulrahman Bin Faisal University (IABFU) have also secured top 100 positions in the recent years. To help other HEIs obtain comparable achievement, this study, with a detailed benchmarking analysis from year 2020 onward, identified the minimum performance scores for attaining a top 100 position in year 2025. The study categorized the required levels of effort into Aligned, Low, Medium, and High across different UIGWUR criteria, hence offering a structured roadmap for improvement. It was recommended that approximately 79% of the participated HEIs in year 2024 should invest Medium to High levels of effort to be qualified for top 100 in year 2025. Though the current analysis focused on Saudi Arabian HEIs, the proposed framework could offer a scalable tool applicable to global HEIs to boost their sustainability performance.

Keywords: Sustainable campus; Applied mathematics in sustainability assessment; Education for sustainable development; Global university rankings; Strategic planning in HEIs; Engineering education; Quantitative analysis

1. Introduction

Worldwide sustainability rankings have gained their importance as evaluation tools for aligning HEIs with global sustainability goals and environmental responsibility (Lozano, 2008; Lozano et al., 2013). Among these tools, the UIGWUR has now become a globally recognized framework since its inception in 2010 (UI GreenMetric, 2024). It assesses HEIs based on six key categories including Setting and Infrastructure, Energy and Climate Change, Waste, Water, Transportation, and Education and Research. This ranking system provides a structured methodology for international HEIs to benchmark their sustainability initiatives, track progress, and implement strategic improvement. Sustainability rankings also help HEIs enhance reputation, foster institutional competitions and influence students' and faculty's decisions (Brundiers et al., 2021; Hallinger & Chatpinyakoop, 2019; Machado & Davim, 2023). HEIs that perform well in global rankings could often secure better funding opportunities, research collaborations, and top talent (Abubakar et al., 2020; Alberti et al., 2025; Christou et al., 2024; Muñoz-Suárez et al., 2020; Wajid, 2025b). The UIGWUR provides HEIs with guidance on transparency

and accountability in sustainability reporting, leading institutions to impose their environmental impact. In recent years, global HEIs have deemed sustainability a core component of social responsibility. As climate change and environmental challenges escalate, HEIs should be the role model to integrate sustainable practices into various operations, infrastructure and academic programs (Aina et al., 2019; Alsharif et al., 2020). The participation of HEIs in the UIGWUR, to a certain extent, demonstrates their commitment to the United Nations Sustainable Development Goals (UN-SDGs), resulting in possible improvement of their global positioning.

1.1 Participation of Saudi Arabian HEIs in the UIGWUR

The number of Saudi Arabian HEIs participating in the UIGWUR has significantly increased from one in year 2014 to 14 in year 2024, thus demonstrating a growing commitment to sustainability in line with Vision 2030 (United Nations Saudi Arabia, 2022). The growth was driven by initiatives promoting green infrastructure, renewable energy, and water conservation (Muñoz-Suárez et al., 2020). HEIs including King Abdulaziz University (KAU), Princess Nourah bint Abdulrahman University (PNU), Qassim University (QU), and Imam Abdulrahman Bin Faisal University (IABFU) have consistently ranked among the top 100 worldwide and this showcases the possibility of their adoption of strategies to attain robust sustainability (Al-Ohali & Shin, 2013). Their achievements in the rankings mask persistent and context-specific barriers that require tailored solutions to be discussed in the next section, as globally leading HEIs could maintain their sustainability with effort. Despite the progress of some Saudi Arabian HEIs, there are major recurring challenges that hinder them from obtaining global excellence. Context-specific constraints confronted by Saudi Arabia also distinguish it from temperate-climate countries and these obstacles demand tailored and data driven benchmarking strategies to resolve.

1.2 Contextual Challenges for Saudi Arabian HEIs

The sustainability performance of Saudi Arabian HEIs is limited by several intertwined barriers such as culture, infrastructure, and environment etc. which require greater attention and research-backed analysis to contextualize benchmarking effort. Some challenges are discussed below:

- Waste Management Deficits: Top-performing global HEIs such as ETH Zurich have adopted circular economy models (Wilts et al., 2021) and AI-enabled waste analytics to enhance sorting precision and recycling efficiency (Greater Zurich Area, 2023). The national recycling rate of Saudi Arabia is approximately 21%, with the National Center for Waste Management, Saudi Arabia targeting a 90% landfill diversion by 2040 through integrated waste strategies (National Center for Waste Management, n.d.). However, data on waste management performance of Saudi Arabian HEIs are mostly unrecorded, thus underscoring a critical gap in the institutional reporting and benchmarking.
- Sustainable Transportation Gaps: Survey data showed that 57% female students of Saudi Arabian HEIs depended on private transportation, either cars or vans, whereas only 39% used bus services, hence highlighting gaps in infrastructure and gender-inclusive options (Saleh & Malibari, 2021) in the face of broader cultural and policy constraints. Saudi Arabia can initiate campus mobility reforms such as inclusive transport policies and electric vehicle programs to reduce emissions and enhance access for all student groups, drawing inspiration from inclusive transportation initiatives implemented in Malaysia (Chan, 2021; Tham, 2025).
- Energy Use and Carbon Footprint: The University of Manchester achieved a 36% reduction in scopes 1 and 2 emissions from 2007 to 2023 through retrofitting buildings, investing in renewable energy, and deploying smart systems as documented in its official carbon strategy (University of Manchester, 2023); the institution ranked second worldwide in the Times Higher Education Impact Rankings 2025 (Times Higher Education, n.d.). Similar results achieved by the hybrid model implemented at the University of Coimbra, where scope 3 emissions accounted for 78.38% of the total footprint, helped refine carbon mitigation policies (Deda et al., 2025). Saudi Arabian HEIs could benchmark integrated approaches to strengthen carbon accounting and actively support Saudi Vision 2030 and the Saudi Green Initiative (2021).
- Sustainability Reporting: Global HEIs increasingly report their sustainability performance through platforms such as UI GreenMetric and THE Impact Rankings (Times Higher Education, n.d.; UI GreenMetric, 2024), facilitating greater transparency and alignment with the UN-SDGs (Alberti et al., 2025; Wajid, 2025b). Promising Saudi Arabian HEIs could have opportunities to embrace global best practices by adopting standardized Key Performance Indicators (KPIs) and public disclosures that would elevate benchmarking, foster innovation and accelerate sustainable progress across the higher education sector of Saudi Arabia (General Authority for Statistics, 2022; United Nations Saudi Arabia, 2022).
- Limited Sustainability-Focused Institutional Collaborations: Saudi Arabian HEIs have demonstrated limited engagement in structured sustainability collaborations. This gap presents a unique opportunity for them to take a leadership role in advancing sustainability by strengthening collaborative frameworks, as proposed by Wajid (2025b). While global frameworks like the UIGWUR have imitated the Western models, adapting practices from the West to the distinct climate, campus culture and governance in Saudi Arabia could unlock tailored high-impact

solutions (Alberti et al., 2025).

1.3 Benchmarking as a Strategic Tool for Sustainability Performance of HEIs

Benchmarking is considered a useful data-driven method for improving performance in various fields including the higher education sector. The sustainability rankings help HEIs assess their performance based on the recognized standards and pinpointed areas for improvement (Lozano et al., 2015). This study presents a benchmarking model using data from the UIGWUR spanning year 2020 to 2024. The model enables HEIs to compare their sustainability performance with the minimum scores of the top 100 HEIs listed in the UIGWUR (UI GreenMetric, 2024). Unlike traditional models that use average or median values, this approach adopts category-wise minimum scores among the top 100 globally ranked HEIs in the UIGWUR as attainable reference points. In the context of sustainability rankings, enabling HEIs to assess gaps, learn from high-performing peers, and set realistic targets is of paramount importance. However, existing benchmarking studies often focus on global leaders and did not provide context-sensitive frameworks that guide HEIs with diverse capabilities and starting points (AASHE, 2025). Therefore, a benchmarking tool is introduced based on four-tier effort level classification such as Aligned, Low, Medium, and High using percentage threshold scores (Δ) between the performance of Saudi Arabian HEIs and the qualifying score for year 2025.

1.4 Objectives of the Study and Contributions

While existing studies examine the participation of HEIs in sustainability rankings, few offer a comprehensive benchmarking tool developed by empirical data and adapted to regional contexts. To address this gap, the present study has the following objectives:

- Assess participation and performance trends of Saudi Arabian HEIs in the UIGWUR spanning year 2014 to 2024;
- Develop a benchmarking framework to identify performance gaps and strategic areas for improvement;
- Introduce a tiered effort classification system across six sustainability indicators; and
- Provide evidence-based recommendations to help global and Saudi Arabian HEIs enhance their rankings in the UIGWUR.

This study contributes by:

- Enhancing the methodological toolkit for benchmarking in the context of underrepresented HEIs.
- Offering a scalable model adaptable to HEIs worldwide.

The remainder of the paper is structured as follows. Section 2 introduces the UIGWUR. Section 3 presents a comprehensive methodology explicitly discussing the analytical framework and benchmarking model. Section 4 provides concluding insights and recommendations for the planning and policies of HEIs.

2. UI GreenMetric World University Ranking

The UIGWUR was established in year 2010 with the participation of 301 HEIs worldwide. By the 15th edition in year 2024, the ranking had expanded to 1,476 HEIs from 95 countries, rendering it the most comprehensive global ranking system dedicated to assessing sustainability performance in higher education, as shown in Figure 1.

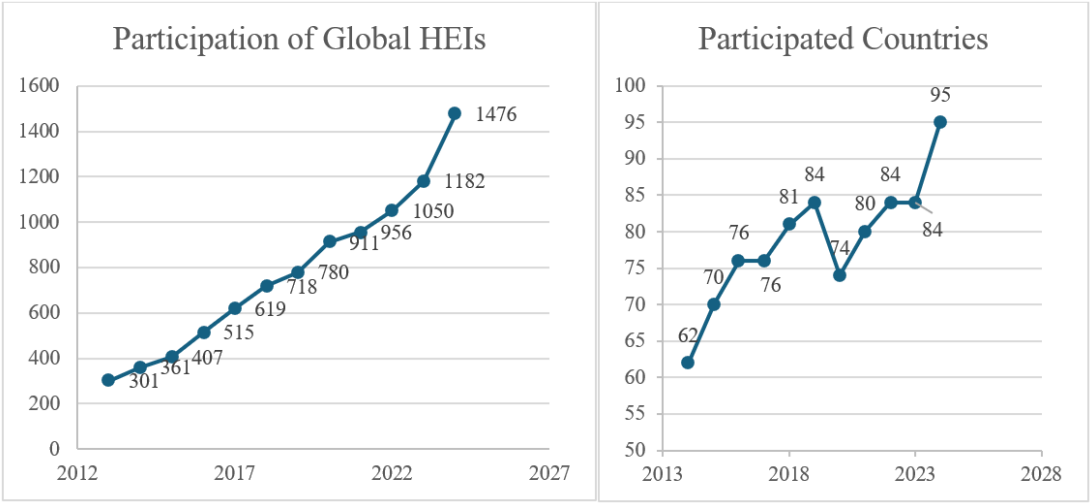

Figure 1. Global HEIs and countries participated in the UIGWUR from year 2014 to 2024

The UIGWUR is based on an online survey designed to evaluate the sustainability effort, policies, and progress of HEIs worldwide. Its primary objective is to draw the attention of leaders and stakeholders of HEIs to the critical global challenges, such as climate change, clean energy, water conservation, waste management, green transportation, and sustainability-focused education and research. Besides, it aims at driving HEIs worldwide towards sustainable future for all through increased awareness and behavioral shifts. To further strengthen this effort, the 2024 edition introduced a new theme, "Doing Sustainable Development Goals in Higher Education: The Story of Our Institution and Society" (UI GreenMetric, 2024). This theme is intended to inspire and attract HEIs worldwide at large by fostering a shared commitment to building sustainable campuses that will benefit future generations.

3. Methodology

The current study employed a data-driven benchmarking approach to quantitatively analyze the trends of participation and sustainability performance of Saudi Arabian HEIs in the UIGWUR from year 2014 to 2024. The methodology is structured into four major sections detailed below:

3.1 Data Acquisition, Preprocessing and Participation Analysis

3.1.1 Source of data

In this study, the data covering the number of Saudi Arabian HEIs participating in the UIGWUR, spanning from year 2014 to 2024 were inherited from the official website: https://greenmetric.ui.ac.id/rankings/rankings-overview of the UIGWUR (UI GreenMetric, 2024). The yearly data of Saudi Arabian HEIs in the UIGWUR were provided in the Appendix, Tables A1-A11.

3.1.2 Reliability of data

This study relied heavily on the accuracy, consistency, and completeness of the dataset and no missing, redundant, or extreme values were found. Furthermore, no inconsistencies were observed in the used data, thus ensuring the reliability of the dataset for trend and performance analysis.

3.1.3 Trend of participation

Figure 2 shows the rising trend of 67 Saudi Arabian HEIs (Ministry of Education—KSA, 2025; Wajid, 2025b), including 29 public and 38 private ones, which participated in the UIGWUR from year 2014 to 2024:

Figure 2 illustrates that in year 2014, there was only one participating HEI but the number of HEIs joining the UIGWUR grew to 14 in year 2024, hence reflecting a steady increase in engagement. Over the period of year 2014 to 2024, there were a total of 17 HEIs participants, with a breakdown of 16 public HEIs and just one private HEI, i.e., AlMaarefa University. The above data are summarized in Tables A1-A11 in the Appendix; despite the growth, 25% of the established HEIs in Saudi Arabia have participated in the UIGWUR while 75%, consisting of 13 public and 37 private HEIs, have not yet joined it.

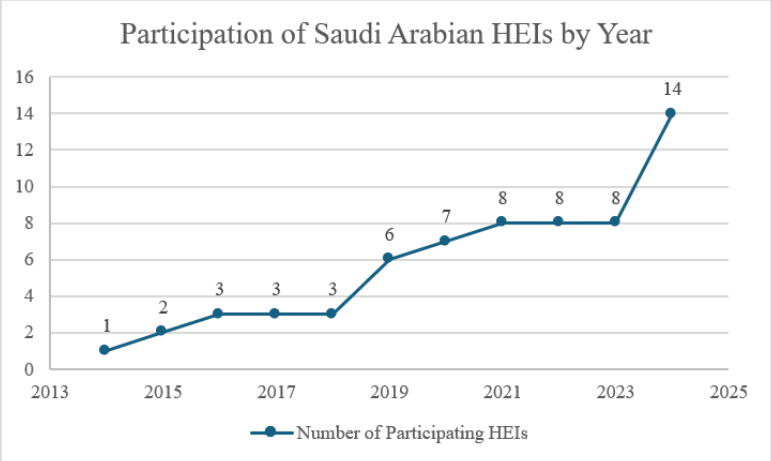

Figure 2. Number of Saudi Arabian HEIs participated in the UIGWUR from year 2014 to 2024

3.2 Performance Analysis of Saudi Arabian HEIs in the UIGWUR

This section presents the comprehensive performance analysis of participating HEIs discussed in the previous

section. Table 1 summarizes the frequency of participation, highest achieved ranking and the frequency of top 100 ranks worldwide by Saudi Arabian HEIs.

Table 1 demonstrates that among all participating Saudi Arabian HEIs:

- 24% of the HEIs, including KAU, PNU, QU, and IABFU achieved top 100 rankings at least once.
- 50% of the HEIs participated more than five times between year 2014 and 2024, reflecting continuous engagement.
- 29% of the HEIs participated once only, highlighting the need for stronger institutional commitment to continuity and strategic sustainability.
- Six HEIs newly joined the UIGWUR, exhibiting a rising trend in the participation of HEIs in year 2024.

The performance assessment underscores the growing institutional momentum toward sustainability in Saudi Arabia while identifying the need for improved consistency, cross-institutional collaboration, and capacity-building to support HEIs with limited experience in the UIGWUR.

Table 1. Performance summary of Saudi Arabian HEIs in the UIGWUR (year 2014 to 2024)

Sr.	Abbreviations of HEIs	Frequency of Participation	Frequency of Top 100 Ranks	Highest Achieved Ranking	Year
1	KAU	9	7	26	2021
2	PNU	7	2	71	2021
3	QU	6	2	48	2024
4	IABFU	6	1	95	2024
5	PSAU	6	0	634	2020
6	KFU	5	0	208	2024
7	KKU	5	0	524	2023
8	UJ	4	0	362	2016
9	TU	3	0	738	2021
10	KSAU-HS	3	0	656	2024
11	IMSIU	2	0	833	2023
12	UM	2	0	1,090	2023
13	TaibahU	1	0	1,066	2024
14	NBU	1	0	645	2024
15	SEU	1	0	778	2024
16	UOHB	1	0	959	2024
17	JU	1	0	1,384	2024

3.3 Performance of Saudi Arabian HEIs Ranked Amongst Global Top 100 in the UIGWUR

This section evaluates the performance of Saudi Arabian HEIs ranked among the top 100 worldwide with details given in Table 2.

Key insights from Table 2 are listed below:

- KAU maintained the top 100 rank from year 2016 to 2022, peaking at 26 in year 2021. Its absence in years 2023 and 2024 may suggest internal policy shifts, changes in data reporting priorities, or reallocation of sustainability resources. This gap highlights the importance of institutional continuity and reporting stability.
- PNU improved steadily between years 2015 and 2021, reaching rank number 71 before dropping out. This may reflect reporting fatigue, leadership transitions or diminished institutional focus despite previous strong performance.
- QU showed significant upward momentum via rising from rank number 342 in year 2019 to number 48 in year 2024, indicating strategic investments and operational alignment with sustainability indicators.
- IABFU improved from rank number 441 in year 2019 to number 95 in year 2024 likely due to targeted enhancements in energy use and mobility infrastructure.

Table 2. Top 100 Saudi Arabian HEIs in the UIGWUR

HEIs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KAU	205	131	46	40	42	44	36	26	38	---	---
PNU	---	179	103	111	185	138	79	71	---	---	---
QU	---	---	---	---	---	342	293	151	153	62	48
IABFU	---	---	---	---	---	441	429	300	311	236	95
Total HEIs	0	0	1	1	1	1	2	2	1	1	2

Although Saudi Arbian HEIs achieved eight top 100 placements from year 2020 to 2024 in the UIGWUR, leadership in this ranking remains limited to a small number of Saudi Arabian HEIs. Inconsistent participation,

particularly among leading HEIs, may weaken long-term visibility and hinder national progress. The variations found emphasize the importance of establishing formal sustainability governance, maintaining regular data reporting and adopting long-term strategies to compete for the rank.

3.4 Benchmarking Scores for Achieving Top 100 Rankings in the UIGWUR

This section identifies benchmarking scores for Saudi Arabian HEIs to qualify among the top 100 ranked HEIs.

3.4.1 Minimum scores for top 100 rankings

To determine minimum qualification scores, the lowest total and category-wise score from the top 100 globally ranked HEIs in the UIGWUR was recorded annually from year 2019 to 2024. Table 3 presents these minimum benchmarking scores.

Key insights from Table 3 are summarized below:

- The total benchmarking scores have increased by 17%, from 7,025 in year 2019 to 8,475 in year 2024, making qualifications more competitive.
- The SI, EC, and TR categories have shown steady growth with
  - SI increased from 75 in year 2019 to 855 in year 2024.
  - EC increased from 900 in year 2019 to 1,335 in year 2024.
  - TR increased from 775 in year 2019 to 1,300 in year 2024.
- WS was observed to follow a fluctuating trend.
- WR and ED followed a steady growth; however, their scores dropped in 2024 WR (from 700 to 600) and ED (from 1,425 to 1,375).
- Importantly, WS, TR and ED have consistently remained above 1,000 since 2020, making them key focus areas for global HEIs.
- SI and WR attained the maximum scores of 855 and 700, respectively as they may not be priortised by HEIs over these years.

Rather than using the average scores, this study adopts a strict benchmarking approach by selecting minimum scores to ensure a realistic yet competitive performance target. The structured benchmarking approach to be illustrated below provides Saudi Arabian HEIs a roadmap to improve sustainability performance and offer explicit targets to qualify for the top 100 in the UIGWUR.

Table 3. Minimum scores for top 100 HEIs ranked by category

Year	Total Scores (TS)	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
2019	7,025	75	900	1,125	425	775	1,050
2020	7,550	275	900	1,275	550	1,050	1,125
2021	7,750	600	975	1,200	550	1,150	1,250
2022	8,200	660	1,235	1,350	650	1,150	1,275
2023	8,350	760	1,335	1,275	700	1,225	1,425
2024	8,475	855	1,335	1,050	600	1,300	1,375

3.4.2 Evaluation of the top 100 HEIs in Saudi Arabia against the benchmarked scores (year 2020 to 2024)

This section evaluates the performance of the top 100 HEIs in Saudi Arabia based on their annual benchmarked scores from year 2020 to 2024. Table 4 presents a comparative analysis of the total scores and category-wise scores against the benchmarked scores. The data indicates that all top 100 HEIs performed consistently above the benchmarked scores, hence providing strong empirical evidence to justify using the minimum scores of the top 100 globally ranked HEIs in the UIGWUR as benchmarks.

3.4.3 Setting the qualifying scores for year 2025

Performance scores is newly introduced to calculate the difference between the benchmarked scores of last year and the scores of the current year. The results revealed that the total scores and the scores of individual categories remained negative for all top 100 HEIs, except for the WS category, where a zero score was observed in some cases. This finding suggests that the performance score can serve as a valuable metric for HEIs worldwide to self-assess their performance annually, identify weak and strong areas and develop targeted strategies to maintain or improve their rankings.

Table 5 provides the required maximum Performance Scores, Benchmarked Scores, and Qualifying Scores for year 2025. It presents the maximum performance scores which are added in absolute value to the benchmarked scores to set a qualifying score for securing a position among the top 100 ranked HEIs in year 2025. The results indicate that HEIs should not fall below the benchmarked scores in both total and category-wise assessments to remain competitive. The qualifying scores establish a performance threshold that HEIs should meet and exceed to

remain competitive in the UIGWUR in year 2025.

Table 4. Evaluation of Saudi Arabian HEIs against the benchmarked scores

Year	Global Ranking	Abbrev. of HEI	Total Scores	SI Scores	EC Scores	WS Scores	WR Scores	TR Scores	ED Scores
Benchmarked Scores for Year 2020			7,025	75	900	1,125	425	775	1,050
2020	36	KAU	8,075	1,050	1,525	1,575	950	1,325	1,650
Performance Scores of KAU			-1,050	-975	-625	-450	-525	-550	-600
2020	79	PNU	7,700	1,025	1,425	1,350	1,000	1,400	1,500
Performance Scores of PNU			-675	-950	-525	-225	-575	-625	-450
Benchmarked Scores for Year 2021			7,550	275	900	1,275	550	1,050	1,125
2021	26	KAU	8,450	1,375	1,400	1,650	950	1,475	1,600
Performance Scores of KAU			-900	-1,100	-500	-375	-400	-425	-475
2021	71	PNU	8,000	1,275	1,450	1,275	1,000	1,450	1,550
Performance Scores of PNU			-450	-1,000	-550	0	-450	-400	-425
Benchmarked Scores for Year 2022			7,750	600	975	1,200	550	1,150	1,250
2022	38	KAU	8,660	1,375	1,635	1,650	900	1,425	1,675
Performance Scores of KAU			-910	-775	-660	-450	-350	-275	-425
Benchmarked Scores for Year 2023			8,200	660	1,235	1,350	650	1,150	1,275
2023	62	QU	8,575	1,225	1,800	1,350	1,000	1,525	1,675
Performance Scores of QU			-375	-565	-565	0	-350	-375	-400
Benchmarked Scores for Year 2024			8,350	760	1,335	1,275	700	1,225	1,425
2024	48	QU	8,750	1,300	1,925	1,350	950	1,525	1,700
Performance Scores of QU			-400	-540	-590	-75	-250	-300	-275
2024	95	IABFU	8,485	1,375	1,560	1,275	950	1,525	1,800
Performance Scores of IABFU			-135	-615	-225	0	-250	-300	-375
Benchmarked Scores for Year 2025			8,475	855	1,335	1,050	600	1,300	1,375

Table 5. Performance, benchmarked scores, and qualifying scores for year 2025

Score Category	Total Scores	SI Scores	EC Scores	WS Scores	WR Scores	TR Scores	ED Scores
Maximum Performance Scores	-135	-540	-225	0	-250	-275	-275
Benchmarked Scores	8,475	855	1,335	1,050	600	1,300	1,375
Qualifying Scores	8,610	1,395	1,560	1,050	850	1,575	1,650

3.4.4 Comprehensive benchmarking analysis (year 2020 to 2024)

Table 6 provides an in-depth benchmarking analysis of all participating HEIs of Saudi Arabia from year 2020 to 2024. Additionally, key strengths, weaknesses and recommended target actions are outlined for each HEI to improve strategically.

Table 6. Comprehensive benchmarking analysis of Saudi Arabian HEIs

Abbreviation of HEI	Year	Rank	TS	SI	EC	WS	WR	TR	ED	Key Insights and Recommended Actions
PNU	2020	79	-675	-950	-525	-225	-575	-625	-450	Fully on track; Resume participation.
	2021	71	-450	-1000	-550	0	-450	-400	-425	
KAU	2020	36	-1050	-975	-625	-450	-525	-550	-600	Fully on track; Resume participation.
	2021	26	-900	-1100	-500	-375	-400	-425	-475	
	2022	38	-910	-775	-660	-450	-350	-275	-425	
QU	2020	293	850	-950	175	0	-525	-400	-125	Consistently improved in all categories; Focused efforts on WS are required to improve further; Currently, fully on track.
	2021	151	-25	-775	-200	-375	-450	-150	-450	
	2022	153	-95	-460	-160	-525	-450	-150	-375	
	2023	62	-375	-565	-565	0	-350	-375	-400	
	2024	48	-400	-540	-590	-75	-250	-300	-275	
IABFU	2020	429	1575	-650	250	-150	-475	25	-100	Consistently improved in TS, EC, and TR; Focused efforts on WS are required to improve further; Currently, fully on track.
	2021	300	850	-725	50	-225	-350	0	-275	
	2022	311	815	-400	15	-300	-250	-100	-175	
	2023	236	590	-540	-275	375	-250	-250	-350	
	2024	95	-135	-615	-225	0	-250	-300	-375	

PSAU	2020	634	2675	-350	-325	825	25	-400	225	On track in SI Lacking in EC, WS, WR, TR, and ED categories; Proper planning and devoted effort are required.
	2021	810	3925	-450	250	975	150	175	450	
	2022	938	4555	-100	430	900	200	400	700	
	2023	939	4180	-40	425	825	150	390	550	
	2024	1050	3890	-15	350	675	300	575	375	
KFU	2020	369	1300	-625	-175	75	-250	-400	0	On track in SI, EC, WR, TR, and ED; Consistent progress: WS; Potential candidate for top 100 rankings.
	2021	221	475	-850	-350	150	-250	-225	-375	
	2022	293	750	-525	-225	75	-150	-175	-275	
	2023	270	750	-565	135	75	-150	-225	-400	
	2024	208	375	-465	-165	-75	0	-250	-300	
KKU	2020	885	5100	-600	825	1125	425	200	450	Target EC, WS, WR, and ED; On track in SI and TR; Proper planning and devoted effort are required.
	2021	705	3225	-575	275	750	50	175	175	
	2022	622	2465	-350	-185	600	100	-25	300	
	2023	524	1890	-515	100	675	50	-225	-75	
	2024	739	2490	-365	200	675	150	-25	225	
TU	2021	738	4100	-675	425	600	400	-125	450	Target and plan all categories and collaborate with benchmarked HEIs.
	2022	825	4165	-370	475	525	390	-35	575	
	2024	1168	3805	160	425	825	680	240	585	
KSAU-HS	2022	894	3630	-210	365	975	-250	565	650	Target EC, WS, TR, and ED; On track in SI and WR.
	2023	820	4840	-245	575	975	-100	175	100	
	2024	656	6150	-255	275	450	-150	50	200	
UM	2023	1090	2830	235	350	1275	440	640	550	Lacking in all categories;
	2024	1335	2830	335	450	1200	490	715	700	
IMSIU	2023	833	3450	130	685	375	340	65	-25	Proper planning and fully devoted effort are required;
	2024	981	3585	145	545	600	300	90	275	
NBU	2024	645	2150	-220	500	450	100	-60	-250	
SEU	2024	778	2650	195	210	225	100	190	100	Collaborate with benchmarked HEIs (KAU, PNU, QU, and IABFU); NBU: lacking only in EC, WS, and WR.
UOHB	2024	959	3470	-225	375	825	190	225	450	
TaibahU	2024	1066	3985	15	585	825	390	140	400	
JU	2024	1384	5910	310	1050	1275	530	515	600	

Note: The Rank column indicates the global ranking of each institution. Rankings are categorized as follows: Top 100, 101–200, 201–400, 401–800, 800+.

3.4.5 Category-wise insights and institutional performance

To enhance readability and eliminate redundancy, the performance of Saudi Arabian HEIs across the six UIGWUR categories has been consolidated into Table 7, which distinguishes institutions that are on track from those that require improvement. The classification is based on consistent multi-year performance derived from Table 6.

Table 7. Category-Wise classification of HEIs based on the trends of performance

Category	% of HEIs	HEIs on Track	% of HEIs	HEIs Requiring Improvement
SI	69%	KAU, PNU, QU, IABFU, PSAU, KFU, KKU, TU, KSAU-HS, NBU, UOHB	31%	UM, IMSIU, SEU, TaibahU, JU
EC	31%	KAU, PNU, QU, IABFU, KFU	69%	PSAU, KKU, TU, KSAU-HS, UM, IMSIU, NBU, SEU, UOHB, TaibahU, JU
WR	25%	KAU, PNU, QU, IABFU, and KFU (since year 2024)	75%	PSAU, KKU, TU, KSAU-HS, UM, IMSIU, NBU, SEU, UOHB, TaibahU, JU and KFU
WS	38%	KAU, PNU, QU, IABFU, KFU, KSAU-HS	62%	PSAU, KKU, TU, UM, IMSIU, NBU, SEU, UOHB, TaibahU, JU
TR	38%	KAU, PNU, QU, IABFU, KFU, KKU, NBU	62%	PSAU, TU, KSAU-HS, UM, IMSIU, SEU, UOHB, TaibahU, JU
ED	38%	KAU, PNU, QU, IABFU, KFU, NBU	62%	PSAU, KKU, TU, KSAU-HS, UM, IMSIU, SEU, UOHB, TaibahU, JU

KAU, PNU, QU, and IABFU consistently led across all categories. However, 69% of HEIs struggled notably with Energy & Climate Change and required further improvement in this area while 75% lagged behind in Water Resources. KFU showed recent progress by reaching “on track” status in Water Resources in year 2024.

Transportation, Waste Management, and Education and Research also presented challenges, with around 60% underperforming HEIs. The gap between a few top-performing HEIs and the rest shows that improvement focusing in the management of energy, waste, and water are urgently required. 75% of the HEIs should put high-level effort in the WR category to sustain water in a circular fashion and should implement region-specific initiatives tailored to the patterns of local water demand in Saudi Arabia (Wajid, 2025a).

3.4.6 Required effort levels for Saudi Arabian HEIs in year 2025

To support Saudi Arabian HEIs in meeting the competitive sustainability benchmarks set for year 2025, a quantitative and data-driven framework is proposed to classify the levels of effort required by Saudi Arabian HEIs across the six core UIGWUR categories. The levels of effort are determined by a two-step process.

Table 8. Percentage threshold scores **(Δ)** for all HEIs participated in year 2024

Sr.	Abbreviation of HEI	Rank in 2024	Category-Wise Percentage Threshold Scores (Δ)						
			TS	SI	EC	WS	WR	TR	ED
1	QU	48	-2	7	-19	-22	-11	3	-3
2	IABFU	95	1	1	0	-18	-11	3	-8
3	KFU	208	8	14	4	-22	21	7	-4
4	NBU	645	39	42	87	27	42	23	-1
5	KSAU-HS	656	40	37	47	27	0	34	35
6	KKU	739	47	24	37	75	55	26	38
7	SEU	778	51	147	39	0	42	52	25
8	UOHB	959	76	42	63	133	67	58	69
9	IMSIU	981	81	127	97	56	113	39	43
10	PSAU	1,050	93	80	58	75	113	142	57
11	TaibahU	1,066	97	87	108	133	174	45	61
12	TU	1,168	126	133	71	133	4,150	60	96
13	UM (private)	1,335	204	228	76	1,300	305	209	128
14	JU	1,384	253	210	447	104,900	400	122	100

Table 9. Tiered levels of effort based on the Δ score

Level of Effort	Descriptions	Δ Range
A (Aligned)	Benchmark exceeded	$\Delta < 0\%$
L (Low)	Minor improvement required	$0\% \leq \Delta < 15\%$
M (Moderate)	Moderate improvement required	$15\% \leq \Delta < 60\%$
H (High)	Critical improvement required	$\Delta \geq 60\%$

Table 10. Recommended levels of effort for participated HEIs in year 2024

Sr.	Abbreviation of HEI	Rank in 2024	Level of Effort	Improvement Level Required					
				SI	EC	WS	WR	TR	ED
1	QU	48	A	L	A	A	A	L	A
2	IABFU	95	L	L	L	A	A	L	A
3	KFU	208	L	L	L	A	M	L	A
4	NBU	645	M	M	H	M	M	M	A
5	KSAU-HS	656	M	M	M	M	L	M	M
6	KKU	739	M	M	M	H	M	M	M
7	SEU	778	M	H	M	L	M	M	M
8	UOHB	959	H	M	H	H	H	M	H
9	IMSIU	981	H	H	H	M	H	M	M
10	PSAU	1,050	H	H	M	H	H	H	M
11	TaibahU	1,066	H	H	H	H	H	M	H
12	TU	1,168	H	H	H	H	H	M	H
13	UM (private)	1,335	H	H	H	H	H	H	H
14	JU	1,384	H	H	H	H	H	H	H

Step 1. Calculating percentage threshold score: The percentage threshold score denoted by Δ is calculated using formula given by:

$$\Delta = \frac{(\text{Qualifying Score}_{2025} - \text{HEI Score}_{2024})}{\text{HEI Score}_{2024}} \times 100\%$$

where, the qualifying score is the target benchmark for year 2025 (see the last row in Table 5), and the HEI score

is the performance score of HEI in year 2024 (Table A1 in the Appendix). Table 8 compiles the Δ values for all participating HEIs in Saudi Arabia. Furthermore, negative Δ indicates that the HEI exceeding the benchmark requires no further improvement while a positive Δ reflects the percentage of improvement needed.

Step 2. Tiered effort level classification: Based on the Δ score calculated using formula above and presented in Table 8, the levels of effort devoted by HEIs are categorized into 4 tiers as in Table 9.

Table 10 details the required levels of effort for each HEI by category and it highlights targeted areas for improvement at different levels to achieve higher rankings in year 2025.

This classification framework directs HEIs with High effort designations to prioritize strategic investments and capacity development while those categorized as Aligned or Low should focus on sustaining progress and setting ambitious goals to lead sustainability transformation in the higher education sector of Saudi Arabia.

4. Conclusions and Recommendations

This study initiated performance evaluation of Saudi Arabian HEIs in the UIGWUR based on the proposed data-driven benchmarking approach. Using a composite performance score and category-wise analysis, the research offered insights into improving the sustainability progress and strategic positioning of Saudi Arabian HEIs.

(1) Key Findings

- Four Saudi Arabian HEIs, namely KAU, PNU, QU, and IABFU, have consistently achieved top 100 global rankings, which could serve as national benchmarks for sustainability practices.
- KAU and PNU demonstrated the highest consistency in frequently ranked among the top 100 HEIs worldwide.
- UJ discontinued its participation after year 2020. This incident was followed by PNU and KAU after years 2021 and 2022, respectively. It was recommended that PNU and KAU should resume their participation in future rankings to maintain the momentum.
- HEIs, such as UJ, JU, and UM require broad institutional improvement whereas PSAU, TU, and UOHB require targeted enhancements across multiple categories.
- KFU, with strong emphasis on water-related sustainability, has been positioned as the potential top 100 entry in 2025.

(2) Gap Analysis and Effort Prioritization

- A novel 4-tier threshold based on the effort classification analysis (Aligned/Low/Moderate/High) was adopted to reveal specific categorical deficits per institution per category, thus allowing targeted actions instead of extensive reforms.
- Overall speaking, 79% of the participated HEIs in year 2024 should dedicate either medium or high levels of effort in anticipation of a position among the top 100 HEIs in year 2025.
- 50% of the participated HEIs in year 2024 should invest a high level of effort in the SI, EC, WS, and WR categories to improve their rankings in year 2025.

(3) Strategic Implications

- HEIs aiming to improve should form alliances with national top performers, e.g., KAU, PNU, QU, and IABFU to exchange best practices, engage in joint research, and co-develop sustainability policies;
- Long-term participation in the UIGWUR should be institutionalized as a strategic part of HEIs planning to ensure performance consistency; and
- National higher education and sustainability policy should incentivize transparent reporting, inter-university collaboration, and category-specific progress tracking.

To sum up, Saudi Arabian HEIs have made remarkable progress in the UIGWUR since several participated HEIs have already achieved top rankings in the previous years. The maintenance and enhancement of global standing in sustainability performance requires sustained effort and targeted strategies. In this regard, Saudi Arabian HEIs could further strengthen their sustainability initiatives by implementing the above recommended actions so as to guarantee continued success in the UIGWUR. Their directions for future improvement could inspire global HEIs to move toward the excellence in sustainability performance.

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Data Availability

The data for this study was obtained from the UI GreenMetric World University Ranking (UIGWUR) official website (https://greenmetric.ui.ac.id/rankings/rankings-overview) (UI GreenMetric, 2024). The dataset covers the participation of Saudi Arabian HEIs from 2014 to 2024, with yearly data provided in Tables A1–A11 in the Appendix.

Conflicts of Interest

The author declares no conflict of interest.

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Appendix

Tables A1-A11 cover the trends of participation by Saudi Arabian HEIs between year 2014 and 2024 (in reverse chronological order). The abbreviatons of Saudi Arabian HEIs are adopted from Wajid (2025b).

Table A1. Performance of Saudi Arabian HEIs in the UIGWUR in year 2024

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
48	QU	8750	1300	1925	1350	950	1525	1700
95	IABFU	8485	1375	1560	1275	950	1525	1800
208	KFU	7975	1225	1500	1350	700	1475	1725
645	NBU	6200	980	835	825	600	1285	1675
656	KSAU-HS	6150	1015	1060	825	850	1175	1225
739	KKU	5860	1125	1135	600	550	1250	1200
778	SEU	5700	565	1125	1050	600	1035	1325
959	UOHB	4880	985	960	450	510	1000	975
981	IMSIU	4765	615	790	675	400	1135	1150
1050	PSAU	4460	775	985	600	400	650	1050
1066	TaibahU	4365	745	750	450	310	1085	1025
1168	TU	3805	600	910	450	20	985	840
1335	UM (private)	2830	425	885	75	210	510	725
1384	JU	2440	450	285	0	170	710	825

Table A2. Performance of Saudi Arabian HEIs in the UIGWUR in year 2023

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
62	QU	8575	1225	1800	1350	1000	1525	1675
236	IABFU	7610	1200	1510	975	900	1400	1625
270	KFU	7450	1225	1100	1275	800	1375	1675
524	KKU	6310	1175	1135	675	600	1375	1350
820	KSAU-HS	4840	905	660	375	750	975	1175
833	IMSIU	4750	530	550	975	310	1085	1300
939	PSAU	4020	700	810	525	500	760	725
1090	UM (private)	2830	425	885	75	210	510	725

Table A3. Performance of Saudi Arabian HEIs in the UIGWUR in year 2022

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
38	KAU	8660	1375	1635	1650	900	1425	1675
153	QU	7845	1060	1135	1725	1000	1300	1625
293	KFU	7000	1125	1200	1125	700	1325	1525
311	IABFU	6935	1000	960	1500	800	1250	1425
622	KKU	5285	950	1160	600	450	1175	950
825	TU	4165	970	500	675	160	1185	675
894	KSAU-HS	3630	810	610	225	800	585	600
938	PSAU	3195	700	545	300	350	750	550

Table A4. Performance of Saudi Arabian HEIs in the UIGWUR in year 2021

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
26	KAU	8450	1375	1400	1650	950	1475	1600
71	PNU	8000	1275	1450	1275	1000	1450	1550
151	QU	7575	1050	1100	1650	1000	1200	1575
221	KFU	7075	1125	1250	1125	800	1275	1500
300	IABFU	6700	1000	850	1500	900	1050	1400
705	KKU	4325	850	625	525	500	875	950
738	TU	4100	950	475	675	150	1175	675
810	PSAU	3625	725	650	300	400	875	675

Table A5. Performance of Saudi Arabian HEIs in the UIGWUR in year 2020

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
36	KAU	8075	1050	1525	1575	950	1325	1650
79	PNU	7700	1025	1425	1350	1000	1400	1500
293	QU	6175	1025	725	1125	950	1175	1175
369	KFU	5725	700	1075	1050	675	1175	1050
429	IABFU	5450	725	650	1275	900	750	1150
634	PSAU	4350	425	1225	300	400	1175	825
885	KKU	1925	675	75	0	0	575	600

Table A6. Performance of Saudi Arabian HEIs in the UIGWUR in year 2019

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
44	KAU	7700	1050	1675	1575	800	1275	1325
138	PNU	6500	1025	1200	1200	950	1225	900
342	QU	5250	750	600	900	950	1125	925
441	IABFU	4675	525	950	900	850	575	875
524	UJ	4275	825	925	600	625	700	600
695	PSAU	2775	525	650	0	500	875	225

Table A7. Performance of Saudi Arabian HEIs in the UIGWUR in year 2018

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
42	KAU	7400	1100	1700	1575	800	1100	1125
185	PNU	5650	675	1125	1125	1000	900	825
485	UJ	4125	825	925	600	475	700	600

Table A8. Performance of Saudi Arabian HEIs in the UIGWUR in year 2017

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
40	KAU	6251	898	997	1551	909	961	935
111	PNU	5600	733	1036	1551	775	961	544
433	UJ	3780	719	831	774	350	811	295

Table A9. Performance of Saudi Arabian HEIs in the UIGWUR in year 2016

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
46	KAU	6332	837	744	1650	909	881	1311
103	PNU	5670	803	916	1551	775	1240	385
362	UJ	3602	727	799	648	350	801	277

Table A10. Performance of Saudi Arabian HEIs in the UIGWUR in year 2015

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
131	KAU	5063	376	839	1575	1000	450	823
179	PNU	4608	441	869	1425	925	834	114

Table A11. Performance of Saudi Arabian HEIs in the UIGWUR in year 2014

Global Rank	Name of HEI	Total Scores	SI Scores (15%)	EC Scores (21%)	WS Scores (18%)	WR Scores (10%)	TR Scores (18%)	ED Scores (18%)
205	KAU	4988	374	1210	1200	940	650	614