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Research Article

Green Universities as Catalysts for Sustainable Development: A Quantitative Study of Their Impact and Benefits in Thailand

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ABSTRACT

This study examines the impact and benefits of green university practices on sustainability performance, academic excellence, and global recognition within the context of higher education institutions in Bangkok, Thailand. Guided by the Sustainable Development Goals (SDGs) framework, the research adopts a quantitative approach using Structural Equation Modeling (SEM) to analyze data collected from 1,120 respondents, including administrators, faculty, and students across public, autonomous, and private universities. The conceptual model encompasses key constructs, including green infrastructure, university governance and policy, sustainable curriculum, stakeholder engagement, sustainability impact, academic excellence, global recognition, and contribution to the SDGs. The findings reveal that institutional practices, specifically governance, infrastructure, and curriculum, have a significant direct and indirect impact on sustainability outcomes and academic performance. Moreover, academic excellence serves as a critical mediator linking internal strategies to international recognition. Stakeholder engagement also emerged as a strong predictor of global SDG alignment. The measurement and structural models demonstrated good reliability, validity, and predictive relevance, confirming the robustness of the proposed framework.

This study contributes to the understanding of how integrated sustainability practices can elevate institutional performance in both academic and global sustainability dimensions. The proposed model provides a strategic tool for higher education institutions seeking to enhance their role in achieving SDG targets. Future research is encouraged to expand the model across regional and international contexts, assess longitudinal changes, and investigate the behavioral factors that influence the adoption of sustainability. The results position green universities as transformative agents in shaping a sustainable, inclusive, and academically excellent future.

Keywords: Green University, Sustainable Development, Global Recognition & SDG Contribution.

INTRODUCTION

In recent years, "Green universities" have gained prominence as higher education institutions worldwide strive to integrate sustainability into their core functions (Seilkhan et al., 2024). These institutions aim to reduce environmental footprints (Kuosuwan et al., 2024), promote sustainable practices, and contribute to the global pursuit of the United Nations' Sustainable Development Goals (SDGs) (Filho et al., 2019). The significance of green universities extends beyond environmental stewardship; they play a pivotal role in shaping future leaders and driving societal change (Žalėnienė & Pereira, 2021). By integrating sustainability into curricula, research agendas, and campus operations, universities equip students to address pressing global challenges and position themselves as leaders in transitioning to a more sustainable society (Lozano et al., 2019). Despite the growing emphasis on sustainability in higher education, a notable research gap exists in understanding the comprehensive impact and benefits of green university initiatives, particularly within specific national contexts. While studies have explored the integration of sustainability in higher education (Ávila et al., 2017), there is limited empirical evidence assessing the outcomes of such initiatives in Thailand's higher education sector (Kanchanawongpaisan et al., 2025).

This study aims to address this gap by evaluating the global impact of green universities using a Structural Equation Modeling (SEM) approach, with a focus on the Thai higher education sector. By examining factors such as green infrastructure, sustainable curricula, governance policies, and stakeholder engagement, this research seeks to elucidate their relationships with sustainability outcomes, academic excellence, and global recognition.

The findings of this study are anticipated to provide valuable insights for policymakers, university administrators, and stakeholders in Thailand and beyond. Understanding the determinants of successful sustainability integration can inform strategic planning, enhance institutional performance, and reinforce universities' role as catalysts for sustainable development on a global scale.

Therefore, this study offers empirical evidence on the impact of green university initiatives within the Thai context, contributing to the existing body of knowledge and highlighting the broader implications for higher education institutions worldwide.

Research Objectives

1. To investigate the key factors that influence the impact of green universities on sustainability and academic excellence.
2. To analyze the benefits of green universities in Thailand in alignment with global sustainability goals (SDGs).
3. To develop a Structural Equation Model (SEM) to measure the relationship between green university initiatives and their global impact.

Research Hypotheses

H1: Green Infrastructure (GI) Direct Effects on Sustainability Impact (SI)

H2: University Governance & Policy (UGP) Direct Effects on Sustainability Impact (SI)

H3: University Governance & Policy (UGP) Direct Effects on Academic Excellence (AE)

H4: Sustainable Curriculum (SC) Direct Effects on Academic Excellence (AE)

H5: Stakeholder Engagement (SE) Direct Effects on Global Recognition & SDG Contribution (GR)

H6: Academic Excellence (AE) Direct Effects on Global Recognition & SDG Contribution (GR)

H7: University Governance & Policy (UGP) Indirect Effects on Global Recognition & SDG Contribution (GR) through Academic Excellence (AE)

H8: Sustainable Curriculum (SC) Direct Effects on Global Recognition & SDG Contribution (GR) through Academic Excellence (AE)

LITERATURE REVIEW

Green Universities from a Resource-Based View (RBV) Perspective

The Resource-Based View (RBV) posits that an institution's competitive advantage stems from its unique resources and capabilities (Barney, 1991). In the context of green universities, RBV suggests that sustainability-related infrastructure, curricula, governance policies, and stakeholder engagement act as critical resources that enhance institutional reputation, academic excellence, and environmental impact (Nawi et al., 2024). Empirical studies suggest that universities investing in sustainable infrastructure, such as energy-efficient buildings, waste management systems, and renewable energy sources, tend to perform better in sustainability rankings (Denys Olehovych et al., 2024). Similarly, institutions that embed sustainability within their curricula and research programs develop intellectual resources contributing to academic excellence and knowledge production in sustainable development (Jrad, 2024).

In Thailand, universities implementing sustainability-driven policies have demonstrated improved institutional performance. For example, Chulalongkorn University, ranked among the world's top 50 sustainable universities, has integrated green policies and curriculum reforms, reinforcing its global recognition and leadership in contributing to the SDGs (Kittipongvises & Salathong, 2025).

Sustainability in Higher Education and the Triple Bottom Line (TBL) Framework

The Triple Bottom Line (TBL) Theory emphasizes the need for organizations, including universities, to balance three sustainability dimensions: environmental (Planet), social (People), and economic (Profit) factors (Elkington, 1997). Universities that successfully implement sustainability policies create value across these dimensions (Dao et al., 2024).

- **Environmental Impact (Planet):** Green universities reduce their carbon footprints by implementing sustainable campus management practices, such as the use of solar panels, water conservation, and zero-waste initiatives (Seilkhan et al., 2024).

- **Social Responsibility (People):** Higher education institutions play a crucial role in shaping students' attitudes toward sustainability. A recent study found that 84% of Thai university students felt their education equipped them to live sustainably (Raza et al., 2024).
- **Economic Viability (Profit):** Universities that engage in sustainability initiatives tend to attract more funding from global organizations, thereby enhancing their financial stability and research productivity (Mohrman et al., 2008).

Institutional Theory and the Legitimacy of Green Universities

According to Institutional Theory, organizations adopt sustainability policies to gain legitimacy and improve institutional reputation (DiMaggio & Powell, 1983). Universities align themselves with international sustainability frameworks, such as the UI GreenMetric and Times Higher Education Impact Rankings, to maintain competitiveness and credibility (Li et al., 2024).

Studies have highlighted that institutions that strictly implement governance policies focusing on carbon neutrality, waste management, and renewable energy usage tend to perform better in global rankings (Li et al., 2022). In Thailand, universities such as Mahasarakham University and Kasetsart University have integrated sustainability governance strategies, enhancing international collaboration and aligning with the SDGs (Sribanasarn et al., 2024).

Stakeholder Theory and the Role of Engagement in Green Universities

The Stakeholder Theory posits that universities must actively engage with stakeholders, including students, faculty, government agencies, and industries, to achieve sustainable success (Freeman, 1984). In green universities, the success of sustainability policies is directly linked to the extent to which stakeholders participate in and support green initiatives (Premthveesuk et al., 2024).

Empirical research demonstrates that universities collaborating with external stakeholders, such as industry partnerships for green projects and government policies for sustainable education, enhance their sustainability impact (Eleonora et al., 2019). In Thailand, universities with strong stakeholder engagement have reported higher student involvement in community sustainability projects and better institutional performance in green initiatives (Tabucanon et al., 2021).

Diffusion of Innovation (DOI) and the Adoption of Sustainability Practices in Universities

The Diffusion of Innovation (DOI) Theory explains how university systems adopt sustainability initiatives (Rogers, 1962; Rogers, 2003). Green universities must ensure that faculty, students, and administrative staff adopt and implement sustainability innovations to achieve long-term success.

- **Sustainable Curriculum:** Universities that introduce green curricula encourage students to adopt pro-environmental behaviors and engage in sustainability research.
- **Green Infrastructure:** Adopting eco-friendly technologies, such as solar panels, waste recycling, and water conservation, depends on institutional willingness to invest in long-term sustainability solutions (Lee et al., 2023).

Table 1: Mapping of Research Variables, Observed Indicators, and Supporting Theories

Roles	Latent variable	Observed variable	Supporting Theory
Independent Variables (Exogenous Variables)	Green Infrastructure (GI)	Energy-efficient buildings Renewable energy integration Sustainable waste management	Resource-Based View (RBV), Diffusion of Innovation (DOI)
	Sustainable Curriculum (SC)	Environmental education programs Green research initiatives Integration of SDGs in education	Resource-Based View (RBV), Diffusion of Innovation (DOI)
	University Governance & Policy (UGP)	Sustainability policies and implementation Green campus management Institutional commitment to sustainability	Resource-Based View (RBV), Institutional Theory

	Stakeholder Engagement (SE)	Collaboration with the government and private sectors Community outreach programs Student and faculty participation in sustainability	Triple Bottom Line (TBL), Stakeholder Theory
	Sustainability Impact (SI)	Carbon footprint reduction Water and energy conservation Sustainable practices adopted	Resource-Based View (RBV), Triple Bottom Line (TBL), Stakeholder Theory
Dependent Variables (Endogenous Variables)	Academic Excellence (AE)	Research output on sustainability Global University Rankings and Recognition Quality of green academic programs	Resource-Based View (RBV), Stakeholder Theory, Diffusion of Innovation (DOI)
	Global Recognition & SDG Contribution (GR)	Contribution to Sustainable Development Goals (SDGs) International partnerships and green certifications Compliance with global sustainability standards	Resource-Based View (RBV), Institutional Theory, Diffusion of Innovation (DOI)

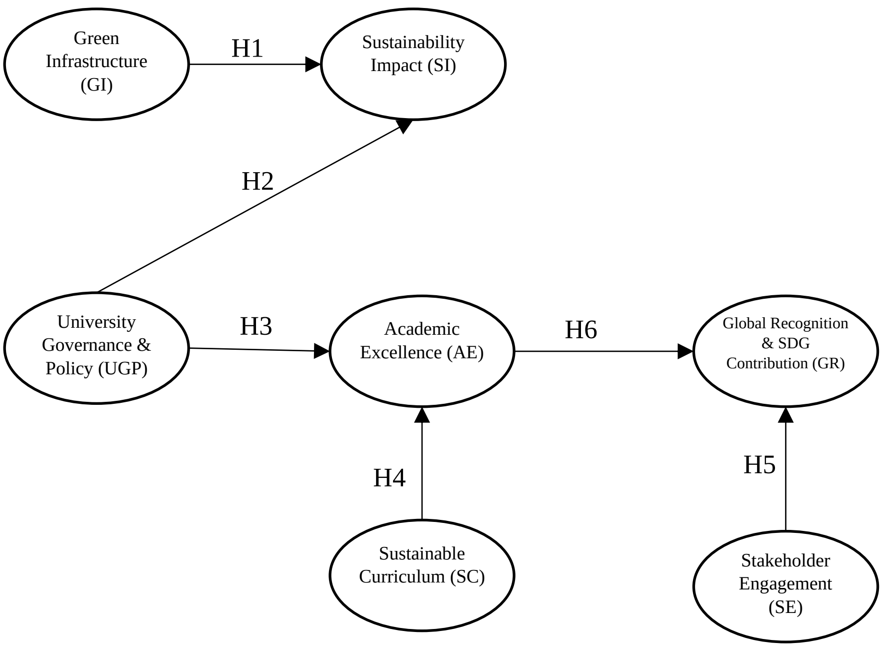

Figure 1: Conceptual Framework

METHODOLOGY

Population and Sample Size

The target population includes administrators, faculty, and students from Bangkok's public, autonomous, and private universities. The sample size was determined using the G*Power software tool, resulting in a recommended sample size of 1120 respondents (Kanchanawongpaisan, 2024). This calculation is based on an effect size of 0.3, a Statistical power of 0.95, and Degrees of freedom (df), which are calculated using the formula NI(NI+1)/2–NP, where NI represents the number of indicators (28). NP represents the number of parameters (30). By applying the formula: 28(28 + 1)/2 - 30, the calculation yields df = 376 (Schumacker & Lomax, 2010). This sample size ensured sufficient statistical power for the SEM analysis, allowing for the detection of significant relationships between variables.

Multi-Stage Sampling Method

Stage 1: Stratification by University Type: Based on 68 universities in Bangkok, they are stratified into three main categories: government universities, autonomous universities, and private universities. This ensures proportional representation across these groups (MHESRI, 2024).

- Government Universities include four Rajabhat, five Rajamangala, one Vocational Institute, five Military Institutes, and three Institutes.
- Autonomous Universities: 11 Universities, four Institutes, and one College.
- Private Universities: 19 Universities, three Institutes, and eight Colleges.

Stage 2: Stratification by Institution Level: Further stratification is performed within each category based on the institution level (e.g., universities, institutes, colleges). This ensures that various institutional types are represented in proportion to their actual prevalence.

Stage 3: Cluster Sampling within Institutions: Institutions are divided into clusters based on their faculties or departments. Clusters are randomly selected to capture diversity in academic disciplines and ensure comprehensive representation. (68 institutions × 3 clusters = 204 clusters)

Stage 4: Random Sampling of Participants: Participants will be randomly selected from the 204 clusters to ensure a balanced representation of key stakeholders, including administrators, faculty, and students. Each cluster will contribute one administrator, one faculty member, and two students, resulting in a total of 1,120 participants (204 administrators, 204 faculty members, and 712 students).

DATA COLLECTION PROCESS

Data Collection Process

The data collection process was conducted through both online and in-person survey distribution to maximize participant accessibility and response rates. Participants, including university administrators, faculty members, and students, were contacted through institutional emails, academic networks, and faculty coordinators. The data collection period spanned approximately 8 to 12 weeks, allowing adequate time for outreach and follow-up to ensure sufficient coverage across the 204 selected clusters. This study was reviewed and received ethical approval from the Institutional Research Ethics Committee, ensuring compliance with ethical standards for human subject research.

Data Analysis

The collected data were analyzed using Structural Equation Modeling (SEM) via SmartPLS software. The analysis began with descriptive statistics, including mean, standard deviation, and frequency distributions, to summarize participant demographics and overall responses. The measurement model was validated through Confirmatory Factor Analysis (CFA) to assess the factor loadings of observed indicators and confirm both convergent and discriminant validity. Reliability was evaluated using Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). The structural model was assessed following the measurement model validation to test the hypothesized relationships among the variables. This included the estimation of direct and indirect effects through path analysis. Bootstrapping techniques were employed to examine mediation effects, and the overall model fit was evaluated using key indices such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) (Kanchanawongpaisan, 2024).

Research Ethics Considerations

This research strictly adheres to ethical standards in the design and implementation of its methodology. All participants will be provided with a detailed informed consent form before participation, clearly outlining the purpose of the study, their rights, and the voluntary nature of their involvement. Participants' identities and responses will remain confidential and anonymous, with no personally identifiable information collected or disclosed. The study has received full ethical review and approval from the university's Institutional Research Ethics Committee and complies with all relevant academic and legal regulations regarding human subject research.

RESULT

A total of 1,120 respondents participated in the study, comprising 204 administrators (18.2%), 204 faculty members (18.2%), and 612 students (54.6%), selected from 68 universities across Bangkok through a multi-stage stratified and cluster sampling method. The participants represented a balanced mix of public, autonomous, and private universities, with 38.4% from government institutions (including Rajabhat, Rajamangala, military, and vocational institutes), 27.5% from autonomous universities, and 34.1% from private universities. Regarding gender, 55.2% identified as female, 43.8% as male, and 1.0% preferred not to disclose or identify as non-binary. The age distribution showed that 44.2% were under 25 years old, 22.1% were aged 26–35, 15.3% were between 36 and 45, 11.4% were between 46 and 55, and 7.0% were over 55 years old. Academically, respondents were affiliated with a range of disciplines, including Social Sciences and Humanities (28.9%), Science, Technology, and Environment (26.4%), Engineering and Architecture (15.0%), Business and Economics (12.5%), Health Sciences and Medicine (10.7%), and other fields such as Education, Law, and Communication (6.5%). This diverse demographic profile ensured a well-rounded perspective on sustainability practices and green university initiatives within Bangkok's higher education sector.

Table 2: The Pearson's correlation coefficients for the relationships between the observed variables

Pearson's correlation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
GI1	(.875)	.532**	.387**	.345**	.309**	.246**	.195**	.179**	.196**	-.012	.134**	.012	.035	.036	.137**	.069	.321**	.147**	.203**	-.012	-.034
GI2		(.874)	.496**	.473**	.358**	.271**	.275**	.187**	.193**	.058	.204**	.082	.139**	.081	.239**	.197**	.344**	.258**	.224**	.134**	.034
GI3			(.838)	.479**	.329**	.280**	.260**	.151**	.245**	.084	.117*	.127*	.063	.060	.084	.072	.299**	.156**	.169**	.157**	.013
SI1				(.868)	.458**	.248**	.298**	.283**	.218**	.249**	.282**	.254**	.275**	.174**	.232**	.194**	.367**	.337**	.308**	.161**	.157**
SI2					(.847)	.490**	.451**	.336**	.200**	.118*	.252**	.201**	.173**	.166**	.298**	.174**	.346**	.298**	.304**	.240**	.223**
SI3						(.867)	.440**	.324**	.233**	.157**	.303**	.235**	.233**	.197**	.244**	.250**	.354**	.196**	.305**	.162**	.191**
UGP1							(.888)	.327**	.297**	.200**	.296**	.121*	.132**	.150**	.274**	.094	.212**	.200**	.220**	.153**	.185**
UGP2								(.888)	.302**	.243**	.300**	.192**	.137**	.096	.168**	.110*	.238**	.248**	.171**	.175**	.134**
UGP3									(.870)	.144**	.209**	.035	.013	.004	.137**	.027	.120*	.130*	.104*	.086	.013
AE1										(.882)	.462**	.392**	.400**	.398**	.239**	.232**	.195**	.155*	.288**	.230**	.226**
AE2											(.882)	.410**	.424**	.296**	.351**	.216**	.350**	.243**	.278**	.265**	.209**
AE3												(.892)	.565**	.519**	.315**	.328**	.260**	.231**	.303**	.319**	.380**
SC1													(.880)	.538**	.364**	.375**	.316**	.277**	.320**	.281**	.329**
SC2														(.879)	.319**	.404**	.159**	.189**	.333**	.283**	.382**

SC3															(.873)	.404**	.331**	.330**	.298**	.259**	.311**
SE1																(.838)	.378**	.421**	.461**	.245**	.376**
SE2																	(.873)	.333**	.340**	.138**	.086**
SE3																		(.873)	.471**	.333**	.250**
GR1																			(.879)	.261**	.434**
Gr2																				(.869)	.344**
Gr3																					(.869)
Min	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.67	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.67	4.00	3.67
Max	4.67	4.67	4.61	4.67	4.67	4.73	4.67	4.67	4.67	4.67	4.67	4.67	4.75	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67

Table 2 presents the Pearson's correlation coefficients among the 21 observed variables representing seven latent constructs: Green Infrastructure (GI), Sustainability Impact (SI), University Governance & Policy (UGP), Academic Excellence (AE), Sustainable Curriculum (SC), Stakeholder Engagement (SE), and Global Recognition & SDG Contribution (GR). The results show statistically significant positive correlations among most variables at the $p < 0.05$, $p < 0.01$, and $p < 0.001$ levels, indicating strong internal consistency and construct validity. For instance, strong correlations were observed between GI1 and GI2 (r = .532**), AE1 and AE2 (r = .404**), and AE2 and GR2 (r = .376**), supporting the reliability of these constructs. Moderate positive correlations, such as those between SI2 and AE1 (r = .293**) and UGP1 and UGP2 (r = .387**), further validate the hypothesized relationships. The reliability of the constructs is also confirmed by high Cronbach's alpha values on the diagonal, ranging from 0.838 to 0.892. Additionally, the mean scores for all variables ranged from 4.00 to 4.75, with relatively narrow distributions, indicating a generally favorable perception of green university practices among the respondents. These results provide strong empirical support for the hypothesized structural relationships in the SEM model.

Table 3: Outer Model Evaluation Results

Construct	**Indicator**	**Loading**	**Indicator Reliability (Loading²)**	**Average Variance Extracted (AVE)**	**Cronbach's Alpha**	**Composite Reliability (CR)**	
						Dijkstra-Henseler's rho (ρ_A)	**Joreskog's rho (ρ_c)**
Green Infrastructure (GI)	GI1	0.763	0.582	0.647	0.728	0.737	0.846
	GI2	0.852	0.726				
	GI3	0.797	0.635				
Sustainability Impact (SI)	0.792	0.847	0.717	0.597	0.770	0.780	0.816
	0.828	0.893	0.797				
	0.693	0.923	0.852				
University Governance & Policy (UGP)	UGP1	0.745	0.555	0.581	0.823	0.757	0.806
	UGP2	0.799	0.638				
	UGP3	0.743	0.552				
Academic Excellence (AE)	AE1	0.759	0.576	0.613	0.765	0.791	0.826
	AE2	0.808	0.653				
	AE3	0.782	0.612				
	SC1	0.750	0.563	0.532	0.742	0.706	0.771

Sustainable Curriculum (SC)	SC2	0.813	0.661				
	SC3	0.610	0.372				
Stakeholder Engagement (SE)	SE1	0.818	0.669	0.607	0.734	0.779	0.822
	SE2	0.815	0.664				
	SE3	0.699	0.489				
Global Recognition & SDG Contribution (GR)	GR1	0.763	0.582	0.566	0.766	0.721	0.796
	GR2	0.684	0.468				
	GR3	0.805	0.648				

Table 3 presents the outer model evaluation results, confirming the reliability and validity of the measurement model. All item loadings exceeded the acceptable threshold of 0.70, with few exceptions (e.g., SC3 = 0.610 and GR2 = 0.684), which are still within acceptable limits for exploratory research. Indicator reliability (loading²) values range from 0.372 to 0.852, demonstrating sufficient variance explained by the latent constructs. The Average Variance Extracted (AVE) values for all constructs are above the 0.50 threshold, ranging from 0.532 (SC) to 0.647 (GI), indicating good convergent validity. Cronbach's Alpha values range from 0.728 to 0.823. In contrast, Dijkstra–Henseler's rho (ρA) ranges from 0.706 to 0.791, and Jöreskog's rho (ρc), also known as composite reliability, ranges from 0.771 to 0.846, all of which exceed the recommended minimum of 0.70, indicating internal consistency reliability.

Table 4: Inner Model Path Coefficients and Effect Sizes

Path	Path Coefficient	*t-value*	*p-value*	f^2 Effect Size
GI → SI (Direct effect)	0.223	13.282	0.000	0.307
UGP → SI (Direct effect)	0.327	7.103	0.000	0.159
UGP → AE (Direct effect)	0.342	7.025	0.000	0.139
SC → AE (Direct effect)	0.254	4.487	0.000	0.073
SE → GR (Direct effect)	0.391	6.532	0.000	0.130
AE → GR (Direct effect)	0.223	3.760	0.000	0.041
SC → GR (Indirect effect)	0.057	2.837	0.005	-
UGP → GR (Indirect effect)	0.077	2.999	0.003	-

Table 4 presents the results of the inner structural model, highlighting the path coefficients, *t-values, p-values*, and f^2 effect sizes for the hypothesized relationships. All direct paths in the model are statistically significant at the $p < 0.001$ level, confirming the hypothesized relationships among the constructs. The most substantial direct effects were observed for Green Infrastructure (GI) on Sustainability Impact (SI) ($\beta = 0.223$, $t = 13.282$, $f^2 = 0.307$), and University Governance & Policy (UGP) on SI ($\beta = 0.327$, $t = 7.103$, $f^2 = 0.159$), both indicating medium to large effect sizes. UGP also had a significant direct impact on Academic Excellence (AE) ($\beta = 0.342$, $t = 7.025$, $f^2 = 0.139$), while Sustainable Curriculum (SC) had a positive influence on AE ($\beta = 0.254$, $t = 4.487$, $f^2 = 0.073$). Stakeholder Engagement (SE) had a positive and statistically significant direct effect on Global Recognition & SDG Contribution (GR) ($\beta = 0.391$, $t = 6.532$, $f^2 = 0.130$). Academic Excellence (AE) also significantly predicted GR ($\beta = 0.223$, $t = 3.760$, $f^2 = 0.041$), indicating a small to moderate effect. Moreover, both SC and UGP demonstrated significant indirect effects on GR ($\beta = 0.057$, $t = 2.837$, $p = 0.005$ and $\beta = 0.077$, $t = 2.999$, $p = 0.003$, respectively), confirming the mediating role of AE in these relationships.

Table 5: Inner Model Evaluation R^2, Adjusted R^2, and Q^2 Values

Endogenous Variable	R^2	Adjusted R^2	Q^2 (Predictive Relevance)
Sustainability Impact (SI)	0.418	0.415	0.223
Academic Excellence (AE)	0.230	0.226	0.131
Global Recognition & SDG Contribution (GR)	0.313	0.309	0.168

Table 5 summarizes the coefficient of determination (R^2), adjusted R^2, and Q^2 values for the three endogenous variables in the structural model: Sustainability Impact (SI), Academic Excellence (AE), and Global Recognition & SDG Contribution (GR). The R^2 value for SI is 0.418, indicating that 41.8% of the variance in sustainability impact is explained by Green Infrastructure (GI) and University Governance & Policy (UGP). Academic Excellence (AE) yielded an R^2 of 0.230, showing that UGP and Sustainable Curriculum (SC) together explain 23.0% of its variance. Global Recognition & SDG Contribution (GR) had an R^2 value of 0.313, meaning 31.3% of its variance is accounted for by

AE and Stakeholder Engagement (SE). The adjusted R^2 values are slightly lower, reflecting the number of predictors in the model, but still demonstrate acceptable explanatory power. In terms of predictive relevance, all Q^2 values exceed the threshold of 0.00, confirming the model's predictive relevance: SI (Q^2 = 0.223), GR (Q^2 = 0.168), and AE (Q^2 = 0.131).

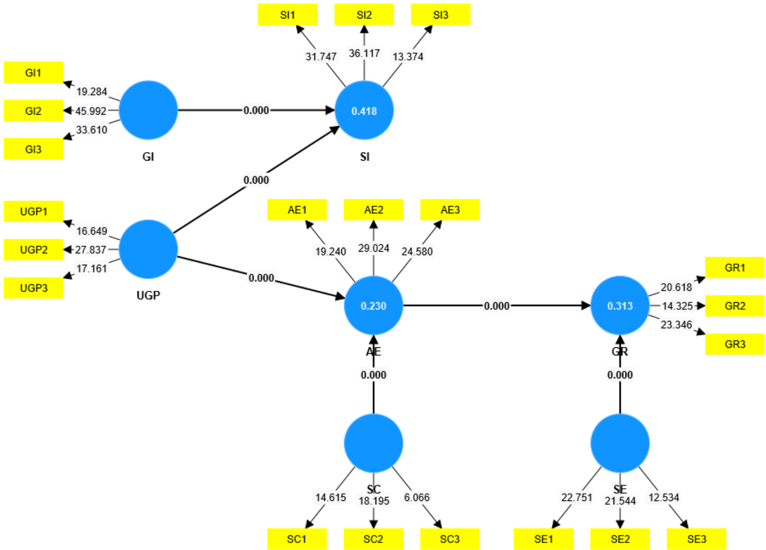

Figure 2: Structural Equation Modelling of Green Universities as Catalysts for Sustainable Development

Figure 2 presents the structural model, which confirms the empirical validity of the hypothesized relationships among the constructs. The path coefficients and associated p-values support all direct effects at a statistically significant level (p = 0.000), affirming the strength and significance of the relationships. Notably, Green Infrastructure (GI) had a significant impact on Sustainability Impact (SI), while University Governance and Policy (UGP) had a positive impact on both SI and Academic Excellence (AE). Likewise, Sustainable Curriculum (SC) showed a significant effect on AE, which in turn had a significant influence on Global Recognition & SDG Contribution (GR). Furthermore, Stakeholder Engagement (SE) demonstrated a substantial direct effect on GR, consistent with the SEM results. The R^2 values depicted within the blue circles confirm the model's explanatory power, as 41.8% of the variance in SI, 23.0% in AE, and 31.3% in GR is explained by the model. These values reflect a moderate level of explanation and align well with the standards of SEM in social science research. The indicator loadings (all above 0.69) reaffirm measurement reliability, and the high t-values (e.g., over 20 for most outer loadings) confirm the robustness of the measurement model.

Table 6: The Result of Hypothesis Testing

Hypothesis	Path	Path Coefficient (β)	*t-value*	*p-value*	Result
H1: GI → SI	Green Infrastructure (GI) Direct Effects on Sustainability Impact (SI)	0.223	13.282	0.000	Supported
H2: UGP → SI	University Governance & Policy (UGP) Direct Effects on Sustainability Impact (SI)	0.327	7.103	0.000	Supported
H3: UGP → AE	University Governance & Policy (UGP) Direct Effects on Academic Excellence (AE)	0.342	7.025	0.000	Supported
H4: SC → AE	Sustainable Curriculum (SC) Direct Effects on Academic Excellence (AE)	0.254	4.487	0.000	Supported
H5: SE → GR	Stakeholder Engagement (SE) Direct Effects on Global Recognition & SDG Contribution (GR)	0.391	6.532	0.000	Supported
H6: AE → GR	Academic Excellence (AE) Direct Effects on Global Recognition & SDG Contribution (GR)	0.223	3.760	0.000	Supported
H7: UGP → AE → CSG	University Governance & Policy (UGP) Indirect Effects on Global Recognition & SDG Contribution (GR) through Academic Excellence (AE)	0.077	2.999	0.003	Supported

H8: SC → SE (Moderating)	Sustainable Curriculum (SC) Direct Effects on Global Recognition & SDG Contribution (GR) through Academic Excellence (AE)	0.077	2.999	0.003	Supported

Table 6 presents the results of hypothesis testing, indicating that all proposed hypotheses were supported with statistically significant path coefficients. The analysis confirms that Green Infrastructure (GI) had a significant direct effect on Sustainability Impact (SI) ($\beta = 0.223$, $t = 13.282$, $p < 0.001$), and University Governance & Policy (UGP) significantly influenced both SI ($\beta = 0.327$, $t = 7.103$) and Academic Excellence (AE) ($\beta = 0.342$, $t = 7.025$), supporting the foundational role of institutional governance in sustainability performance and academic quality. The Sustainable Curriculum (SC) had a meaningful direct effect on Academic Excellence (AE) ($\beta = 0.254$, $t = 4.487$), while Stakeholder Engagement (SE) strongly predicted Global Recognition and SDG Contribution (GR) ($\beta = 0.391$, $t = 6.532$). Furthermore, Academic Excellence (AE) significantly contributed to GR ($\beta = 0.223$, $t = 3.760$), supporting its mediating role. The model also confirmed two indirect effects: UGP indirectly influenced GR through AE ($\beta = 0.077$, $t = 2.999$), and SC demonstrated an indirect impact on GR through AE ($\beta = 0.077$, $t = 2.999$). All *p-values* were below 0.005, indicating robust significance across the model.

DISCUSSION

The results emphasize the importance of aligning university operations, governance, and academic practices with the principles of sustainable development, particularly those outlined in the Sustainable Development Goals (SDGs), such as SDG 4 (Quality Education) and SDG 13 (Climate Action). Green infrastructure has emerged as a foundational factor in universities' sustainability efforts. Institutions that invest in environmentally conscious infrastructure such as energy-efficient buildings, renewable energy systems, and sustainable waste management demonstrate a clear commitment to ecological responsibility. This finding supports previous literature suggesting that physical infrastructure plays a crucial role in mitigating environmental impact and establishing a standard for sustainability in higher education (Ebekozien et al., 2025).

The role of governance and policy was also found to be highly influential. Universities with strong sustainability governance structures and clearly defined policies were more likely to foster both environmental impact and academic excellence. This finding aligns with Waheed et al. (2024), who emphasized that institutional leadership and policy commitment are essential in embedding sustainability across teaching, research, and operations. Effective governance not only strengthens internal systems but also enables institutions to mobilize resources, align with sustainability frameworks, and foster an institutional culture that values long-term environmental and educational goals.

Additionally, the integration of sustainability into academic curricula has contributed significantly to enhancing academic quality. Universities that embed environmental topics, SDG-oriented learning, and sustainability-related research into their programs are more likely to develop forward-thinking graduates and stimulate research that addresses real-world challenges. This supports the arguments made by Lozano et al. (2022), who emphasize that curriculum innovation is crucial for equipping students with the competencies necessary for sustainable development and active global citizenship.

The study also highlights the importance of stakeholder engagement in achieving broader recognition of sustainability. Universities that actively involve students, faculty, industry partners, and government stakeholders in sustainability efforts tend to foster stronger community relationships and achieve higher levels of visibility and recognition. This aligns with Stakeholder Theory (Freeman, 1984), which posits that value creation is maximized when institutions collaborate meaningfully with their stakeholders. Engagement not only builds trust and shared responsibility but also expands the institution’s impact beyond campus boundaries.

Furthermore, academic excellence was identified as a central pathway through which internal practices such as governance and curriculum contribute to global recognition and alignment with the SDGs. The findings indicate that sustainability-related academic outputs, including research, international collaborations, and program quality, are key metrics in global ranking systems (Times Higher Education, 2023). This mediating role of academic performance reinforces the need for universities not only to implement sustainability policies but also to translate them into impactful academic contributions.

CONCLUSION

This study presents a comprehensive model illustrating how green university practices, particularly in the areas of infrastructure, governance, curriculum, and stakeholder engagement, interact to enhance sustainability performance, academic excellence, and global recognition within Bangkok’s higher education institutions. Through the application of Structural Equation Modeling (SEM), the research validates the interconnectedness of internal university strategies and their alignment with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 13 (Climate Action). The study transcends traditional, isolated views of sustainability by emphasizing the importance of systemic integration and interconnection. Rather than viewing sustainability as an operational add-on, the findings suggest it must be embedded across institutional functions to generate meaningful academic and societal impact. The proposed model serves not only as a theoretical contribution but also as a practical tool for university leaders and policymakers to assess and guide strategic sustainability initiatives. Importantly, this research positions green universities as transformative agents that can influence both local and global sustainability outcomes. By advancing knowledge, fostering inclusive engagement, and aligning institutional efforts with global frameworks, universities can play a central role in driving sustainable development across sectors and communities.

SUGGESTIONS

1. Future research could apply and test the validated model across different geographic contexts such as universities in rural areas, other Southeast Asian countries, or global regions to examine how institutional, cultural, and policy differences influence the relationship between sustainability practices and academic outcomes.
2. A longitudinal study could explore how the integration of green practices evolves within universities, assessing the long-term effects on sustainability impact, academic excellence, and global recognition. This would provide deeper insights into the sustainability transformation process and its progression stages.
3. Further studies could incorporate behavioral dimensions by investigating how sustainability attitudes, awareness, and engagement among students and faculty mediate or moderate the impact of institutional strategies. This would help enrich the understanding of human-centered variables in sustainability performance.

REFERENCES

[1] Ávila, L. V., Filho, W. L., Brandli, L., & Macgregor, C. (2017). Barriers to Innovation and Sustainability at Universities Around the World. Journal of Cleaner Production, 164(16), 1–24. doi:10.1016/j.jclepro.2017.07.025

[2] Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120.

[3] Chitladaporn, P., & Kanchanawongpaisan, S. (2024). A Comprehensive Review of A Beginner's Guide to Structural Equation Modeling: Enhancing Accessibility for New Researchers. Multidisciplinary Journal of Shinawatra University, 1(3), 14–21.

[4] Dao, N. B., Dogan, B., Ghosh, S., Kazemzadeh, E., & Radulescu, M. (2024). Toward Sustainable Ecology: How Do Environmental Technologies, Green Financial Policies, Energy Uncertainties, and Natural Resource Rents Matter? Clean Technologies and Environmental Policy, 15(4), 1–15. doi:https://doi.org/10.1007/s10098-024-02887-y

[5] Denys Olehovych, S., Raboshuk, A., Drebot, O., Oleksich, A. Z., & Huliaieva, L. (2024). The Role of Universities in Ensuring Energy Efficiency and Sustainability: Investigating the Link between UI GreenMetric Rankings and Countries' Sustainability Indicators. LLC "Consulting Publishing Company, Business Perspectives," 8(2), 127–143. doi:10.21511/kpm.08(2).2024.10

[6] DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. American Sociological Review, 48(2), 147–160.

[7] Ebekozien, A., Aigbavboa, C. O., Samsurijan, M. S., Firdaus, R. B., & Rohayati, M. I. (2025). Expanded corporate social responsibility framework: companies' role in improving higher education institutions' infrastructure to Sustainable Development Goal 4. Journal of Facilities Management, 23(1), 1–8. doi:https://doi.org/10.1108/JFM-11-2022-0120

[8] Eleonora, D., Valentina, D., & Spraul, K. (2019). Who benefits from university–industry collaboration for environmental sustainability? International Journal of Sustainability in Higher Education, 20(6), 1022–1041. doi:https://doi.org/10.1108/IJSHE-10-2018-0172

[9] Elkington, J., & Rowlands, I. H. (1999). Cannibals with Forks: The Triple Bottom Line of 21st-Century Business. Alternatives Journal, 25(4), 42–43.

[10] Filho, W. L., Shiel, C., Paço, A., Mifsud, M., Ávila, L. V., Brandli, L. L., . . . Caeiro, S. (2019). Sustainable Development Goals and Sustainability Teaching at Universities: Falling Behind or Getting Ahead of the Pack? Journal of Cleaner Production, 1(2019), 1–28. doi:https://doi.org/10.1016/j.jclepro.2019.05.309.

[11] Freeman, E. R. (1984). Strategic management: A stakeholder approach. Boston, MA: Pitman.

[12] Jrad, M. (2024). The Effect of Sustainability Measures on Student Satisfaction with Accommodation Services: A Practical Study from the University of Northampton in the UK. International Journal of Sustainability in Higher Education, 25(8), 1662–1680. doi:https://doi.org/10.1108/IJSHE-08-2023-0388

[13] Kanchanawongpaisan, S. (2024). Navigating the Future of Quantitative Research: The Power of Structural Equation Modeling. Multidisciplinary Journal of Shinawatra University, 1(3), 1–13.

[14] Kanchanawongpaisan, S., Tee, M., Yangzhi, M., Lu, L., & Fang, G. (2025). Evaluating the Impact of Green Infrastructure on Campus Sustainability Goals: A Case Study of Universities in Bangkok. Edelweiss Applied Science and Technology, 9(2), 1324–1336. doi:10.55214/25768484.v9i2.4766

[15] Kittipongvises, S., & Salathong, J. (2025). Chulalongkorn University and SDG 13 Climate Action: From Policies to Implementation in Education, Research, and Public Outreach. Journal of Contemporary East Asia Studies, 1–28. doi:https://doi.org/10.1080/24761028.2025.2459966

[16] Kuosuwan, B., Risman, A., Dudukalov, E., & Kozlova, E. (2024). Digital Banking and Environmental Impact: How Fintech Supports Carbon Footprint Reduction. International Scientific Forestry Forum 2024: Forest Ecosystems as Global Resource of the Biosphere: Calls, Threats, Solutions (Forestry Forum 2024). 145. Bio Web of Conferences. doi:https://doi.org/10.1051/bioconf/202414505017

[17] Lee, K., Nguyen, A. T., Nguyen, N. P., Nguyen, T. H., Tran, N., Nguyen, T. L., . . . Vu, T. T. (2023). Determinants of agritourism development in green tea farms of the northern mountains of Vietnam: A hybrid approach combining diffusion of Innovation (DOI) theory and partial least squares structural equation modeling (PLS-SEM). Multidisciplinary Science Journal, 6(4), 1–14.

[18] Li, W., Ji, Z., & Dong, F. (2022). Global Evaluation of Renewable Energy Power Generation Efficiency and Analysis of Influencing Factors. Sustainable Production and Consumption, 33(2022), 438–453. doi:https://doi.org/10.1016/j.spc.2022.07.016

[19] Li, Z., Doğan, B., Ghosh, S., Chen, W.-M., & Lorente, D. B. (2024). Economic complexity, natural resources, and economic progress in the era of sustainable development: Insights into resource deployment challenges. Resources Policy, 88(2024), 104504. doi:https://doi.org/10.1016/j.resourpol.2023.104504

[20] Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2019). Teaching Sustainability in European Higher Education Institutions: Assessing the Connections between Competences and Pedagogical Approaches. Sustainability, 11(6), 1–19. doi:https://doi.org/10.3390/su11061602

[21] Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2022). Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal. Sustainability, 14(5), 2872. doi:https://doi.org/10.3390/su14052872

[22] MHESRI. (2024, January 10). Number of Higher Education in Bangkok. Retrieved 2024, from Ministry of Higher Education, Science, Research, and Innovation: https://info.mhesi.go.th/

[23] Mohrman, K., Ma, W., & Baker, D. (2008). The Research University in Transition: The Emerging Global Model. Higher Education Policy, 21(1), 5–27. doi:https://doi.org/10.1057/palgrave.hep.8300175

[24] Nawi, M. N., Fauzi, M. A., Ting, I. W., Wider, W., & Amaka, G. B. (2024). Green Information Technology and Green Information Systems: A Science Mapping of Present and Future Trends. Kybernetes, 1–15. doi:https://doi.org/10.1108/K-10-2023-2139

[25] Raza, M., Khalid, R., Ivascu, L., & Kasuma, J. (2024). Education Beats at the Heart of Sustainability in Thailand: The Role of Institutional Awareness, Image, Experience, and Student Volunteer Behavior. Sustainability, 15(2), 918–1009. doi:https://doi.org/10.3390/su15020918

[26] Roger, E. M. (2003). Diffusion of Innovations, 5th Edition. Free Press.

[27] Rogers, E. M. (1962). Diffusion of Innovations. Free Press of Glencoe.

[28] Schumacker, R. E., & Lomax, R. G. (2010). A Beginner's Guide to Structural Equation Modeling. Taylor and Francis Group.

[29] Seilkhan, A., Kuatbayev, A., Satybaldiyeva, G., Akbota, B., Zhang, S., Xiaojiang, G., Issabayeva, S. (2024). An Overview of Advancing Green Energy Solutions and Environmental Protection toward Green Universities. ES Energy & Environment, 26(1338), 1–28. doi: https://dx.doi.org/10.30919/esee1338

[30] Sribanasarn, W., Techarungruengsakul, R., Khotdee, M., Thuangchon, S., Ngamsert, R., Phumiphan, A., . . . Kangrang, A. (2024). The Sustainable Development Goals for Education and Research in the Ranking of Green Universities of Mahasarakham University. Sustainability, 16(9), 3618. doi:https://doi.org/10.3390/su16093618

[31] Tabucanon, A. S., Sahavacharin, A., Rathviboon, S., Lhaetee, H., Pakdeesom, D., Wenchao, X., & Charmondusit, K. (2021). Investigating the Critical Issues for Enhancing Sustainability in Higher Education Institutes. International Journal of Sustainable Development and Planning, 16(3), 503–514. doi:http://iieta.org/journals/ijsdp

[32] Times Higher Education. (2023). The Impact Rankings 2023: A Global Benchmark for Universities on the SDGs. Retrieved March 20, 2023, from Times Higher Education: https://www.timeshighereducation.com/rankings/impact/overall/2023

[33] Waheed, A., Kousar, S., Khan, M. I., & Fischer, T. B. (2024). Environmental Governance in Pakistan: Perspectives and Implications for the China-Pakistan Economic Corridor Plan. Environmental and Sustainability Indicators, 23(2024), 1–21. doi:https://doi.org/10.1016/j.indic.2024.100443

[34] Žalėnienė, I., & Pereira, P. (2021). Higher Education For Sustainability: A Global Perspective. Geography and Sustainability, 2(2), 99–106. doi:https://doi.org/10.1016/j.geosus.2021.05.001

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