Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

A Context-Responsive Green Campus Initiative Framework for South African Universities: A Systematic Integrative Review

Hlanganani, Siduduzo Shange

hlanganiniS@dut.ac.za

Durban University of Technology

Lungelo, Princess Funeka

Durban University of Technology

Systematic Review

Keywords: Green campus initiative, Campus sustainability, Higher education, South Africa, Sustainability governance, Whole-institution approach

Posted Date: September 15th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10668152/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Purpose

– This study identifies the components, enabling conditions, implementation barriers and performance mechanisms required for a context-responsive Green Campus Initiative (GCI) framework for South African universities.

Design/methodology/approach

– A systematic integrative review following PRISMA 2020 examined peer-reviewed primary empirical studies published from January 2005 to 1 August 2026. Fifteen studies were retained after deduplication and staged screening. Methodological quality was appraised using the Mixed Methods Appraisal Tool, and the evidence was integrated through framework and thematic narrative synthesis.

Findings

– The evidence converged on governance, institutional capability, integrated action and assurance as mutually reinforcing implementation requirements. Effective GCIs combine executive mandate and stable resources with staff-student participation, curriculum and research integration, living-laboratory practices, transparent targets and feedback. South African evidence highlights water-energy insecurity, infrastructure inequality, affordability and student-accommodation conditions.

Research limitations/implications

– The evidence is constrained by cross-sectional, self-reported and single-institution designs. Longitudinal and comparative research should test the framework against environmental, financial, educational and equity outcomes.

Practical implications

– The framework provides university leaders with a staged pathway for diagnosing material priorities, assigning accountability, building delivery capability, integrating institutional functions and assuring performance.

Social implications

– Context-responsive GCIs can strengthen equitable access to reliable water and energy, improve student living and learning conditions, develop sustainability capabilities and extend environmental

benefits to surrounding communities.

Originality/value

– The study develops a Context-Governance-Capability-Action-Assurance framework that converts fragmented green-campus activities into a context-responsive, testable and adaptive institutional system for South African universities.

1. Introduction

Higher education institutions (HEIs) occupy a distinctive position in sustainability transitions. They educate future professionals, generate knowledge, procure at scale, operate energy- and water-intensive estates, accommodate large communities and influence surrounding regions. A university campus is therefore both an organisational footprint and a learning environment. When institutional practice contradicts what is taught, sustainability remains an abstract curricular topic; when estates, curricula, research and engagement are connected, the campus can function as a living laboratory for institutional and societal change (Lozano et al., 2015; Jimu and Rennkamp, 2024).

Green Campus Initiatives (GCIs) translate this potential into programmes concerned with energy, water, waste, mobility, biodiversity, procurement, climate literacy, student participation and related sustainability goals. Evidence indicates that GCIs can improve environmental awareness, resource efficiency and the visibility of institutional commitments. However, the label often covers disconnected projects rather than a coherent management system. International syntheses repeatedly identify fragmentation across governance, teaching, research, operations and community engagement, while assessment tools frequently privilege visible environmental metrics over organisational learning, equity and implementation capacity (Lauder et al., 2015) (Nejati and Nejati, 2013; Dagiliūtė et al., 2018; Bulunga and Thondhlana, 2018; Jimu and Rennkamp, 2024).

This implementation problem is acute in South Africa. Universities must pursue decarbonisation and environmental stewardship while responding to electricity insecurity, drought and water stress, ageing infrastructure, constrained public finance, uneven institutional capacity and pressures within student housing. Empirical work at South African universities reports policy–practice gaps, low or uneven awareness, limited finance, unclear responsibility and weak senior-management commitment, alongside promising practices in stakeholder engagement, environmental education, water conservation and green entrepreneurship (Awuzie et al., 2023; Shange et al., 2024, 2025; Musakuro and de Klerk, 2024; Shange and Dlamini, 2026).

Existing frameworks provide valuable building blocks but do not fully solve the contextual design problem. Whole-institution approaches emphasise coherence across governance, curriculum, campus, research, community, communication and capacity building (Jimu and Rennkamp, 2024). Campus sustainability assessment systems offer indicators and benchmarking, yet ranking does not by itself

specify causal implementation mechanisms. The unresolved question is how South African universities can configure mandate, resources, participation, organisational capability, integrated action and accountability into a system that remains viable under unequal local conditions.

Accordingly, this review asks: (1) Which domains and mechanisms consistently underpin effective GCIs? (2) Which barriers and enabling conditions influence implementation? (3) How should global evidence be adapted to South African higher education? and (4) What integrated, testable framework can guide institutional implementation and evaluation? The contribution is a context-responsive framework that links antecedent conditions to institutional mechanisms, action domains, measurable outputs and longer-term sustainability outcomes. Foundational models connect environmental management, participation and institutional strategy (Suwartha and Sari, 2013; Geng et al., 2013), while international evidence demonstrates that implementation must span teaching, research, operations and engagement (Lozano et al., 2015; Leal Filho et al., 2019). Assessment-focused reviews warn that rankings and indicators can obscure context and causal mechanisms (Nejati and Nejati, 2013; Dagiliūtė et al., 2018). Later syntheses confirm an operational bias in campus initiatives and call for integrated governance, behaviour, learning and infrastructure (Aleixo et al., 2018; Bulunga and Thondhlana, 2018; Jimu and Rennkamp, 2024; Gherheș and Cernicova-Bucă, 2025). South African studies add evidence on organisational capacity, finance, awareness, participation and residence-level water practices (Awuzie et al., 2023; Shange et al., 2024, 2025; Musakuro and de Klerk, 2024; Shange and Dlamini, 2026). These 15 sources and their analytical roles are summarised in Table 3 and detailed in Appendix C.

2. Conceptual and theoretical foundations

2.1 Defining a green campus initiative

A Green Campus Initiative (GCI) is defined here as an institutionally coordinated portfolio of policies, capabilities and practices through which a higher education institution reduces environmental harm, strengthens resilience, embeds sustainability learning and contributes to wider sustainable-development outcomes. Suwartha and Sari (2013) conceptualise the sustainable university as a strategic sequence connecting vision, governance, education, research, outreach and operations, whereas Geng et al. (2013) emphasise environmental management, public participation and social responsibility. Consistent with these models, international evidence shows that implementation becomes meaningful when commitment spans multiple university functions rather than isolated projects (Lozano et al., 2015). This definition therefore distinguishes a GCI from a stand-alone recycling campaign or infrastructure intervention and requires feedback through which performance evidence informs subsequent decisions (Leal Filho et al., 2019; Gherheș and Cernicova-Bucă, 2025).

2.2 Whole-institution approach

The Whole Institution Approach (WIA) supplies the review's principal organising logic and aligns institutional practice with Education for Sustainable Development (UNESCO, 2020). Jimu and Rennkamp (2024) characterise WIA as a continuous and participatory process that seeks coherence between

formal curricula and the socio-physical organisation in which learning occurs. In this account, coherence, participation, responsibility, continuous learning and long-term commitment connect governance, curriculum, campus operations, research, community networks, capacity building and communication. Earlier international evidence likewise indicates that institutional commitment must extend across education, research, operations and engagement (Lozano et al., 2015), while later reviews show that operations-only approaches leave substantial integration gaps (Aleixo et al., 2018; Bulunga and Thondhlana, 2018). Applied to GCIs, WIA means that sustainability must influence rules, budgets, routines and performance systems rather than remain an optional programme.

2.3 Institutional and stakeholder mechanisms

Institutional theory explains why universities may adopt formal sustainability structures for legitimacy while everyday routines change slowly. DiMaggio and Powell (1983) distinguish coercive, normative and mimetic pressures that encourage organisational convergence; however, formal adoption does not ensure that policies are translated into roles, budgets, incentives and operating routines. This policy-practice decoupling is visible in South African evidence on limited responsibility, leadership and implementation capacity (Awuzie et al., 2023; Musakuro and de Klerk, 2024). Stakeholder theory adds a relational explanation: Freeman (1984) argues that organisational decisions must account for groups that affect, or are affected by, institutional activity. Students, academic and professional staff, managers, service providers, communities, government and industry consequently contribute different knowledge, authority and interests. Read together, institutional and stakeholder theories predict that symbolic commitment without distributed ownership, decision influence and implementation capability will produce an enduring implementation gap (Geng et al., 2013; Shange et al., 2025).

2.4 Socio-technical transitions and living laboratories

Campuses operate as socio-technical systems in which technologies, infrastructure, user practices, procurement rules, data platforms and institutional norms interact. Geels (2002) shows that transitions arise through changes across interdependent technologies, rules, practices and actor networks rather than through technical substitution alone. Accordingly, retrofits may underperform when maintenance capability, incentives or user behaviour are neglected, while awareness programmes have limited effects where feasible low-carbon or water-efficient alternatives are absent (Bulunga and Thondhlana, 2018; Shange and Dlamini, 2026). Living laboratories provide a mechanism for connecting these elements. Evans et al. (2015) describe university living labs as settings in which campus operations, research and learning are combined through real-world experimentation. In the GCI context, estates problems can therefore become curriculum, research and innovation projects, generating both operational and educational value (Leal Filho et al., 2019; Jimu and Rennkamp, 2024).

3. Methods

3.1 Review design and reporting

A systematic integrative review was selected because the eligible evidence comprised heterogeneous primary empirical studies, including qualitative case studies, quantitative surveys, mixed-methods investigations, comparative assessments and non-randomised intervention studies. Reporting was guided by PRISMA 2020, with search reporting informed by PRISMA-S. PRISMA was used as a reporting standard, not as an instrument for judging study quality. Heterogeneity in designs, settings, interventions and outcomes precluded defensible statistical pooling; structured narrative synthesis and framework synthesis were therefore used. The review question, eligibility rules, extraction domains and synthesis logic were specified before final synthesis, although the review was not prospectively registered. This absence of registration is acknowledged as a limitation. The distinction between reporting quality and methodological appraisal follows PRISMA 2020 (Page et al., 2021), while search reproducibility follows PRISMA-S (Rethlefsen et al., 2021). The source-selection logic is summarised in Table 1, and the database yield is reported in Table 2.

3.2 Search strategy

The evidence window was January 2005 to 1 August 2026. Searches were designed for Scopus, Web of Science Core Collection, ScienceDirect and ERIC, with Google Scholar used for supplementary discovery and backward and forward citation searching. The retained candidate-source register recorded 84 source-level records: Scopus (n = 19), Web of Science Core Collection (n = 18), ScienceDirect (n = 8), ERIC (n = 7) and Google Scholar (n = 32). Search concepts combined (green campus OR sustainable campus OR campus sustainability OR green university) AND (higher education OR university OR universities) AND (implementation OR governance OR framework OR strategy OR assessment OR barrier OR enabler). A contextual search added South Africa, Africa, developing-country and Global South terms without restricting the international evidence base. Appendix A reports database-specific syntax. For each source, the review record documented the search date, platform, query and retained result count; Appendix A reports the source-specific syntax and limits. Table 2 permits direct reconciliation of the source totals with Fig. 1, while Appendix A preserves the executable database syntax.

3.3 Eligibility criteria

Table 1
Eligibility criteria applied during screening.

Criterion	Included	Excluded
Population/context	Universities and other HEIs; multi-country HEI evidence	Schools only; municipalities or firms without HEI evidence
Phenomenon	Institution-level GCI, sustainable-campus implementation, governance, operations, learning, engagement or assessment	Single technical experiment without institutional implementation relevance
Evidence	Peer-reviewed primary empirical studies using qualitative, quantitative, mixed-methods, case-study, comparative, observational or intervention designs	Systematic, scoping, integrative and narrative reviews; conceptual or model-development papers; theoretical essays; editorials, commentaries and studies without original empirical data
Period/language	2005–1 August 2026; English	Outside period; no usable English record
Outcomes	Mechanisms, components, barriers, enablers, indicators or sustainability effects	No extractable implementation-related finding

Table 2
Records identified by search source before deduplication

Source	Records, n
Scopus	19
Web of Science Core Collection	18
ScienceDirect	8
ERIC	7
Google Scholar supplementary search	32
Total source-level records	**84**

As specified in Table 1, eligibility required institution-level implementation relevance and extractable evidence. Table 1 was also used to assign one primary reason for every full-text exclusion.

3.4 Screening and selection

Search results were exported to a master record, normalised by DOI and title, and deduplicated. The lead reviewer screened titles and abstracts and assessed the retained full texts against Table 1. The co-authors checked the eligibility rules, final inclusion decisions and recorded exclusion reasons; differences were resolved through discussion. The final corpus comprised 15 studies. The complete numerical pathway appears in Fig. 1 and is summarised by source in Table 2. Figure 1 distinguishes

records, reports and studies in accordance with PRISMA 2020 (Page et al., 2021). The review record retained the database yields, deduplication decisions, screening outcomes and full-text exclusion reasons needed to reconcile Table 2 with Fig. 1.

3.5 Data extraction and quality appraisal

The lead reviewer applied a structured data-extraction form to all 15 included studies, and the co-authors checked the completed extraction map against the source studies. Extracted information comprised bibliographic details, country and institutional context, design, participants or data sources, data-collection and analysis methods, relevant GCI domain, barriers and enabling conditions, outcomes, limitations and implications for South African universities. The evidence was organised by study and mapped to the review questions and emerging CGCAA domains. Appendix C provides the study-level extraction and citation trail.

Because all included studies were primary empirical investigations with diverse methodological designs, their quality was appraised using the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018). Each study was classified according to the relevant MMAT category represented in the review: qualitative research, quantitative descriptive research, non-randomised research, or mixed-methods research. The two MMAT screening questions were first applied to determine whether each study had clearly stated research questions and whether the data collected were suitable for addressing those questions. The relevant design-specific criteria were then used to assess sampling, data collection and measurement, analytical appropriateness, potential bias or confounding, coherence of findings, and the integration of qualitative and quantitative components in mixed-methods studies.

In accordance with MMAT guidance, no overall numerical score or study level quality grade was calculated. The lead reviewer completed the criterion-level appraisal, which the co-authors checked against the design-specific MMAT criteria; differences were resolved through discussion. Each criterion was recorded as Yes, No or Cannot tell and supported by an explanatory note in Appendix D. No study was excluded solely because of methodological limitations. Instead, the appraisal informed the evidentiary weight assigned during synthesis and the caution used when interpreting claims.

3.6 Synthesis procedure

First-cycle coding used provisional Whole Institution Approach domains while allowing inductive codes for finance, data, infrastructure, behaviour, equity and resilience. Findings were compared across studies rather than counted as independent proof: convergent patterns, contradictory cases, contextual differences and plausible implementation mechanisms were recorded. Second-cycle framework synthesis linked (a) contextual pressures, (b) governance and capability mechanisms, (c) action domains, (d) monitoring and organisational learning, and (e) outcomes. Review findings and conceptual propositions were kept analytically distinct to reduce double counting. Each CGCAA component was retained only when supported by recurring evidence or a clearly identified theoretical mechanism and was then stress-tested against South African constraints. This procedure provides an explicit chain from extracted finding to code, theme, mechanism, framework domain and proposition. This approach follows

framework synthesis logic in which an a priori framework is iteratively revised against extracted data (Carroll et al., 2013), supported by structured narrative synthesis to examine convergence, contradiction and contextual variation (Popay et al., 2006). Table 4 consolidates barriers and mechanisms, Table 5 converts the synthesis into testable propositions, and Appendix E documents the evidence-to-framework chain.

4. Results

4.1 Characteristics and quality of the evidence

The final corpus comprised 15 peer-reviewed primary empirical studies conducted across South Africa, Asia, Europe and multi-country higher education settings. The studies employed diverse methodological approaches, including qualitative case studies, quantitative surveys, mixed-methods investigations, comparative institutional assessments and behavioural interventions. The volume of empirical research increased markedly after 2015, coinciding with the adoption of the Sustainable Development Goals under the 2030 Agenda (United Nations, 2015) and the growing use of university sustainability assessment and ranking systems. Nevertheless, the evidence base was dominated by cross-sectional surveys, single-institution case studies and document-based assessments. Longitudinal studies examining whether particular governance arrangements produce sustained environmental, institutional and educational outcomes remained limited. Overall, the studies provided methodologically adequate evidence for descriptive and interpretive synthesis. However, the transferability and generalisability of the findings were constrained by the prevalence of single-institution designs, reliance on self-reported data and inconsistent definitions and measurement of sustainability outcomes.

As shown in Table 3, the evidence base encompasses institutional case studies, stakeholder surveys, comparative assessments, mixed-methods investigations and behavioural interventions. Early empirical contributions by Suwartha and Sari (2013), Geng et al. (2013), Nejati and Nejati (2013), and Lozano et al. (2015) established important foundations for examining campus sustainability assessment, stakeholder engagement and institutional implementation. Subsequent studies by Dagiliūtė et al. (2018), Aleixo et al. (2018), Bulunga and Thondhlana (2018), Jimu and Rennkamp (2024), and Gherheș and Cernicova-Bucă (2025) identified continuing limitations in sustainability assessment, implementation and impact measurement. Leal Filho et al. (2019) extended the evidence base through a multi-country investigation of sustainability practices in higher education institutions. South African contextual evidence was provided by Awuzie et al. (2023), Shange et al. (2024, 2025), Musakuro and de Klerk (2024), and Shange and Dlamini (2026). Appendix C presents the corresponding study-level extraction and citation trail.

Table 3
Characteristics and principal contributions of the 15 studies included in the framework synthesis.

Study	Design/scope	Primary focus	Contribution to synthesis
Geng et al. (2013)	Institutional case study	Environmental management, participation, teaching/research	Integrated green-university implementation at Shenyang University
Suwartha and Sari (2013)	Indicator-based empirical assessment	Strategy, governance, education, operations	Strategic sequence and sustainability committee
Lozano et al. (2015)	International survey	Institutional commitment and implementation	Commitment must span university functions
Nejati and Nejati (2013)	Quantitative survey	Sustainability assessment tools	Sustainable-university dimensions and validated measurement scale
Dagiliūtė et al. (2018)	Comparative student survey	HEI sustainability impacts	Student perceptions and differences in sustainability performance
Aleixo et al. (2018)	Exploratory stakeholder study	Implemented campus initiatives	Stakeholder understandings, roles, barriers and institutional challenges
Leal Filho et al. (2019)	Multi-country comparative empirical study	Energy efficiency and renewable-energy implementation	Contextually differentiated institutional energy pathways
Bulunga and Thondhlana (2018)	Behavioural intervention study	Sustainable-campus concept	Energy-saving behaviour in Rhodes University residences
Jimu and Rennkamp (2024)	Mixed qualitative case study and survey	Whole-institution approaches	Networked governance and sustainability transition at UCT
Awuzie et al. (2023)	SA qualitative case study	Implementation performance	Resources, staffing and organisational conditions matter
Shange et al. (2024)	SA qualitative study	Finance and green entrepreneurship	Alternative finance and project capability
Musakuro and de Klerk (2024)	SA mixed stakeholder study	Awareness, priorities and leadership	Policy–practice and awareness gaps
Shange et al. (2025)	SA qualitative evidence	Engagement, education, conservation	Formal policy and sustainability education
Gherheș and Cernicova-Bucă (2025)	Communication intervention study	Sustainable campus operations	Changes in student water-use behaviour following a campus campaign

Study	Design/scope	Primary focus	Contribution to synthesis
Shange and Dlamini (2026)	SA student-housing study	Water conservation	Residence-level behaviour and infrastructure

4.2 Theme 1: Governance converts commitment into coordinated action

Suwartha and Sari (2013) identify strategic commitment and a coordinating structure as early requirements for institutional sustainability, while Geng et al. (2013) add environmental management and public participation. Across the wider evidence, governance was therefore the most consistent upstream condition: effective GCIs require a strategic mandate, visible executive sponsorship, cross-functional coordination, assigned operational ownership and stable resourcing. Sustainability offices or committees add value only when connected to decision rights, faculties, professional-service units, capital planning and performance review. Policies without these translation mechanisms tend to produce symbolic compliance and fragmented projects, a pattern also observed in South African accounts of staffing, responsibility and leadership (Awuzie et al., 2023; Musakuro and de Klerk, 2024). Table 4 consolidates these governance barriers and their framework responses.

Governance is therefore not synonymous with centralisation. The evidence supports a federated model: central leadership establishes priorities, standards, targets and accountability, while faculties, residences and operational units adapt interventions to their local settings. Distributed sustainability champions and student structures extend implementation reach, but central coordination remains necessary to prevent duplication, inconsistent data and short-lived campaigns. Table 4 therefore treats fragmented responsibility as a mechanism of failure, not merely a descriptive obstacle, while Proposition P1 in Table 5 specifies the expected governance effect.

4.3 Theme 2: Capability and finance determine implementability

Implementation also depends on capabilities that green-campus checklists often understate: project and change management, facilities expertise, procurement competence, reliable metering, data governance, maintenance capacity, sustainability literacy and bankable business cases. Awuzie et al. (2023) foreground resource, staffing and organisational constraints, whereas Shange et al. (2024) demonstrate the potential contribution of green entrepreneurship and alternative financing. Complementing these South African findings, Leal Filho et al. (2019) demonstrate that institutional energy pathways depend on contextually appropriate technical, organisational and resource capabilities. Green entrepreneurship, circular-economy partnerships, energy-service models and reinvestment of verified savings may diversify resources, but safeguards remain necessary for public value, procurement integrity and environmental performance. Table 4 maps these constraints to capability responses, and Table 6 sequences capability mobilisation after materiality assessment.

Capability also mediates whether external frameworks are useful. A university may adopt UI GreenMetric, STARS or an environmental-management standard yet be unable to improve performance when baseline data are incomplete, accountabilities are diffuse or maintenance is underfunded. Assessment was therefore treated as an organisational learning infrastructure, not merely a ranking exercise. This interpretation is supported by critiques of decontextualised assessment tools (Nejati and Nejati, 2013) and fragmented impact measurement (Dagiliūtė et al., 2018). Proposition P2 in Table 5 consequently treats capability as a mediator between formal commitment and implementation.

4.4 Theme 3: Operations, learning, research and engagement must be integrated

Operational initiatives, including energy efficiency, renewable energy, water conservation, waste and circularity, sustainable mobility, green buildings, biodiversity and procurement, were the most visible GCI activities. Aleixo et al. (2018), however, identify a persistent operational bias in the literature. Lozano et al. (2015) and Jimu and Rennkamp (2024) instead support integration across institutional functions, while Leal Filho et al. (2019) and Bulunga and Thondhlana (2018) show that infrastructure, behaviour and education interact. Sustainability is therefore more durable when operational problems are incorporated into curricula, research and innovation and when staff, students and external partners participate in design and evaluation. Table 3 clarifies the complementary evidentiary roles of these studies.

This integration creates reinforcing value. Metering data can support student projects; residence campaigns can test behavioural interventions; engineering and management researchers can evaluate retrofit performance and business models; and community partnerships can extend learning beyond campus. The living-laboratory approach therefore connects environmental performance to graduate competencies, employability, entrepreneurship and regional development. South African evidence shows how education, engagement, entrepreneurship and residence operations can serve as living laboratories (Shange et al., 2024, 2025; Shange and Dlamini, 2026). The integration claim is formalised as Proposition P3 in Table 5 and operationalised in Stages 4–5 of Table 6.

4.5 Theme 4: Culture and participation shape everyday performance

Geng et al. (2013) position participation as a core component of integrated campus sustainability, and Jimu and Rennkamp (2024) treat it as part of continuous whole-institution learning. The evidence similarly identifies awareness, norms, incentives, trust and perceived ownership as determinants of everyday behaviour. Information campaigns alone are insufficient: participation strengthens when stakeholders can influence priorities, observe results and receive feedback. In South Africa, awareness and policy-practice gaps are particularly evident in Musakuro and de Klerk (2024) and Shange et al. (2025). Co-design, peer champions, residence initiatives, staff recognition, curriculum-linked projects and transparent dashboards may therefore support participation, provided responsibility is not shifted

from institutional systems to individual users. Table 4 links these barriers to co-design and feedback mechanisms.

South African evidence revealed a recurring disconnect between formal policies and stakeholder awareness. This gap is consequential: a policy that is unknown, unresourced or unmeasured cannot reliably influence practice. A sustainability culture is thus both an input and an outcome, initial norms affect implementation, while visible institutional consistency strengthens credibility and future engagement. Proposition P4 in Table 5 captures this relationship by predicting stronger durability where participation includes decision influence and visible feedback.

4.6 Theme 5: Measurement must connect outputs, outcomes and learning

Nejati and Nejati (2013) caution that campus assessment tools can detach indicators from institutional context, while Dagiliūtė et al. (2018) identify fragmented and uneven evidence of higher-education impacts. A mature GCI measurement system consequently moves beyond counts of electricity, emissions, water, waste diversion, green space, transport modes, courses and participation. It should distinguish inputs, processes, outputs, outcomes and impacts and state baselines, denominators, time horizons and organisational boundaries explicitly. Gherheș and Cernicova-Bucă (2025) provide intervention evidence that communication and feedback can influence student water-use behaviour, although the study does not establish a comprehensive institutional measurement system. The minimum indicator set in Appendix B translates this synthesis into governance, capability, environmental, learning, equity and finance measures.

The review also supports mixed evidence. Metered resource data and audited financial results should be complemented by learning outcomes, stakeholder experience and implementation explanations. Public reporting creates accountability, while periodic review enables adaptation. Where rankings are used, universities should avoid gaming visible metrics at the expense of locally material priorities such as water security, student accommodation and maintenance resilience. Table 6 positions assurance, disclosure and adaptation as the final recurring implementation stage, while Proposition P5 in Table 5 predicts that transparent feedback strengthens accountability and organisational learning.

4.7 Barriers and enabling conditions

Table 4 synthesises the recurrent barriers, their mechanisms of failure and corresponding CGCAA responses. Read alongside Table 3, it shows that the framework is grounded in both international synthesis and South African empirical evidence rather than in frequency counts alone.

Table 4. **Cross-study barriers, mechanisms of failure and CGCAA responses.**

Barrier observed across studies	Mechanism of failure	Framework response
Fragmented responsibility	Projects remain isolated; duplicated effort; no owner for cross-cutting outcomes	Executive mandate, GCI steering structure and named domain owners
Short-term or uncertain funding	Pilot projects lapse; maintenance and data systems are neglected	Multi-year portfolio budget, lifecycle costing and verified-savings reinvestment
Weak awareness and participation	Low adoption and credibility; policy–practice gap	Co-design, champions, curriculum links and feedback on results
Poor data and inconsistent indicators	No credible baseline, prioritisation or accountability	Metering plan, data owner, indicator dictionary, audit and dashboard
Infrastructure inequality and maintenance backlog	Technologies underperform or benefit only well-resourced sites	Campus-specific baselines, equity criteria and phased resilience investment
Siloed teaching, research and operations	Missed living-lab and innovation value	Joint challenge portfolio and incentives for cross-functional projects
Leadership turnover and competing priorities	Loss of continuity and symbolic commitment	Policy anchoring, distributed ownership and board/council-level reporting

5. Proposed framework

5.1 The Context Governance Capability Action Assurance framework

The synthesis yields a five-part Context Governance Capability Action Assurance (CGCAA) framework. Context establishes differentiated material priorities. Governance authorises and coordinates action. Capability supplies the people, finance, technology, data and delivery competence required for implementation. Action integrates operations with learning, research and engagement. Assurance measures performance, enables learning and returns evidence to governance. The framework is deliberately cyclical: GCI implementation is an adaptive management process rather than a once-off plan. Figure 2 visualises this recursive architecture: assurance feeds evidence back to context and governance rather than terminating the process. The evidence-to-domain derivation is documented in Appendix E.

5.2 Framework propositions

Table 5 expresses the six principal CGCAA relationships as propositions derived from the cross-study synthesis. Figure 2 shows how these propositions operate within a cyclical rather than linear system.

Proposition	Testable statement
P1	The relationship between formal sustainability commitment and outcomes is mediated by decision rights, accountable ownership and resource allocation.
P2	Institutional capability moderates the effectiveness of technical and behavioural interventions; identical interventions will yield different outcomes across campuses with unequal data, maintenance and delivery capacity.
P3	Integration across operations, curriculum, research and engagement produces stronger and more durable outcomes than isolated projects.
P4	Meaningful stakeholder participation improves legitimacy, contextual fit and sustained behaviour when participants receive influence and performance feedback.
P5	Assurance systems that combine environmental, financial, educational and equity indicators improve adaptive learning and reduce symbolic implementation.
P6	South African contextual pressures, especially water and energy insecurity, infrastructure inequality and student housing conditions, shape priority setting and must be treated as design variables rather than external caveats.

Table 5. Testable propositions derived from the CGCAA framework.

5.3 Implementation pathway

Table 6 translates Figure 2 into six implementation stages, from materiality assessment to assurance and adaptation. It should be read with Appendix B, which supplies candidate indicators for monitoring each stage.

Stage	Required institutional action
1. Diagnose materiality and readiness	Establish campus boundaries; baseline energy, water, emissions, waste, mobility, biodiversity, procurement, learning and equity; assess policy, skills, maintenance and data maturity.
2. Authorise and organise	Adopt a council/executive mandate; define the GCI charter, decision rights, steering structure, domain owners, student participation and reporting route.
3. Prioritise a balanced portfolio	Rank interventions using materiality, lifecycle value, resilience, educational contribution, equity and feasibility; protect quick wins from displacing structural investments.
4. Build capability and finance	Assign multidisciplinary teams; strengthen metering, procurement, project management and maintenance; combine institutional budgets with ethical partnerships and verified-savings mechanisms.
5. Deliver through living laboratories	Connect estates challenges to curriculum, research, innovation, work-integrated learning, entrepreneurship and community partnerships.
6. Assure, disclose and adapt	Use a defined indicator dictionary, baselines and targets; audit material metrics; report progress and failure; review priorities annually and the framework every three years.

Table 6. Staged implementation pathway for the CGCAA framework.

6. Discussion

6.1 Theoretical contribution

The review advances green campus scholarship by linking four perspectives that are commonly treated separately. Building on Jimu and Rennkamp (2024), WIA explains institutional coherence; institutional theory explains policy practice decoupling (DiMaggio and Powell, 1983); stakeholder theory accounts for distributed legitimacy and knowledge (Freeman, 1984); and socio-technical transition theory explains interaction among infrastructure, behaviour, rules and capability (Geels, 2002). CGCAA converts these perspectives into an implementation architecture in which context influences governance and capability; these mechanisms enable integrated action, and assurance closes the learning loop. The framework extends the foundational models of Suwartha and Sari (2013) and Geng et al. (2013), while responding to measurement critiques raised by Nejati and Nejati (2013), Dagiliūtė et al. (2018) and Gherheș and Cernicova-Bucă (2025). Figure 2 makes these theoretical relationships explicit, and Table 5 states their testable implications.

The framework also distinguishes GCI maturity from the number of projects undertaken. A university with many campaigns but no baseline, accountable owner or maintenance plan may be less mature than one undertaking fewer, strategically connected interventions. This distinction addresses the literature's tendency to equate activity with institutionalisation and creates propositions that can be evaluated empirically. The distinction is reinforced by the empirical findings of Aleixo et al. (2018) and Bulunga and Thondhlana (2018), which show that isolated operational activities cannot substitute for systemic

integration, and by Leal Filho et al. (2019), who demonstrate contextual variation in institutional energy pathways. Table 6 therefore emphasises sequencing and readiness rather than project counts.

6.2 Contribution to the South African literature

The South African contribution is not the simple addition of local barriers to an international checklist. Context is placed at the entry point of the model and shapes priorities, sequencing, finance and performance interpretation. Water and energy resilience may justifiably receive greater weight than international ranking systems assign them. Student residences require specific attention because they combine infrastructure, behaviour, wellbeing and educational opportunity. Equity criteria are needed so that benefits, burdens and participation are not concentrated on already advantaged campuses or stakeholder groups. These contextual refinements are supported by Awuzie et al. (2023), Musakuro and de Klerk (2024), Shange et al. (2025), and Shange and Dlamini (2026). Table 4 shows how their reported barriers alter the mechanisms assumed by internationally derived models.

The synthesis further suggests that universities of technology can play a distinctive role. Their applied curricula, work-integrated learning, technical facilities and industry relationships create opportunities to connect sustainability operations with skills development and green entrepreneurship. However, such potential depends on formal interfaces between estates, academic departments, research offices, students and external partners. Shange et al. (2024) demonstrate the financing and entrepreneurship pathway, while Shange et al. (2025) link engagement and education to implementation. Appendix E traces these South African findings to the Capability and Action domains of Fig. 2.

6.3 Practical implications

University councils and executives should govern GCIs as institutional portfolios, not volunteer projects. Annual plans should disclose material baselines, funded priorities, responsible owners, intended beneficiaries and performance against targets. Procurement and capital approval processes should incorporate lifecycle costs, carbon, water, resilience and maintenance. Academic leaders should recognise living-laboratory work in workload, research and curriculum systems. Student participation should extend beyond campaign delivery to agenda setting, project design and evaluation. Table 6 provides a practical sequence for this portfolio approach, and Appendix B supplies the minimum indicators needed to assess whether implementation produces environmental, educational, financial and equity outcomes.

National bodies can support shared indicator definitions, peer learning, procurement frameworks and capability development while allowing differentiated institutional targets. Funders should require credible baselines and maintenance plans but avoid frameworks that penalise historically disadvantaged institutions for inherited infrastructure conditions. Benchmarking should therefore report both absolute performance and improvement relative to a transparent starting point. Proposition P5 in Table 5 and the assurance loop in Fig. 2 support this differentiated benchmarking approach.

7. Limitations and research agenda

The review is limited by heterogeneous terminology and outcome measures. Although the terms “green campus”, “sustainable campus”, “sustainable university” and “whole-institution approach” are conceptually related, they are not interchangeable, creating a possibility that some relevant studies were not retrieved. The English-language restriction may also have excluded relevant evidence published in other languages. In addition, much of the included empirical evidence was based on cross-sectional, single-institution and self-reported designs. Consequently, causal conclusions regarding the long-term environmental, educational, financial and equity effects of Green Campus Initiatives remain premature. Although the CGCAA framework is grounded in the systematic synthesis of international and South African empirical evidence, its proposed relationships require prospective empirical validation.

Future research should undertake longitudinal comparisons of alternative sustainability governance models and quasi-experimental evaluations of resource-efficiency and behaviour change interventions. Further priorities include developing and validating a South African GCI maturity index; examining implementation within historically disadvantaged, rural and multi-campus universities; evaluating residence-specific water and energy interventions; and investigating the distribution of sustainability costs and benefits across institutional and stakeholder groups. Mixed-methods studies should also examine how measured environmental performance relates to curriculum development, graduate capabilities, green entrepreneurship, institutional resilience and community outcomes. Collectively, this research would test, refine and establish the transferability of the CGCAA framework across different South African higher education contexts.

8. Conclusion

Green Campus Initiatives can contribute meaningfully to climate action and institutional sustainability, but projects alone do not constitute transformation. The evidence shows that durable outcomes depend on alignment among context, governance, capability, integrated action and assurance. For South African universities, this alignment must confront water–energy insecurity, finance and infrastructure inequality while leveraging students, applied research, living laboratories and partnerships. The conclusion is supported across the complete corpus summarised in Table 3, while Table 4 identifies the mechanisms that can prevent this alignment.

The CGCAA framework offers a coherent and testable pathway from institutional commitment to impact. Its central claim is straightforward: sustainability becomes institutional when it is authorised, resourced, integrated into how the university teaches and operates, measured transparently and continuously revised through evidence. Adoption should therefore begin with materiality and readiness, proceed through accountable portfolio governance, and culminate in verified environmental, educational, financial and equity outcomes. Figure 2 integrates these relationships, Table 5 makes them testable, and Table 6 makes them actionable.

Declarations

Ethics approval: Not applicable. The study synthesised publicly available literature and did not involve human participants.

Clinical trial number: Not applicable.

Funding: The authors acknowledge funding from South Africa's National Research Foundation (NRF) under the Thuthuka Grant (TTK2204203954).

Conflict of interest: The authors declare that they have no competing interests. The funder had no role in study selection, synthesis, interpretation or manuscript preparation.

Author contributions: Hlanganani Siduduzo Shange: Conceptualisation, Investigation, Project administration, Validation, Visualisation, and Writing- original draft. Methodology, Writing – original draft, and Writing – review and editing. Lungelo Princess Funeka: Funding acquisition, Resources, Supervision, and Writing – original draft. All authors reviewed the manuscript, contributed to the interpretation and discussion of the findings, approved the final version for submission and publication, and accepted responsibility for the integrity of the work.

Data availability: Appendix A provides the reproducible search strategy and source yields; Appendix B provides the framework-validation indicator set; Appendix C contains the 15-study empirical extraction and citation map; Appendix D reports the study-level MMAT appraisal; Appendix E traces empirical findings to the CGCAA framework; and Appendix F provides the PRISMA 2020 and PRISMA-S reporting crosswalk. Appendices A–F provide the search strategy, framework-validation indicators, study-level extraction map, MMAT appraisal, evidence-to-framework matrix and reporting crosswalk.

References

1. Aleixo, A.M., Leal, S. and Azeiteiro, U.M. (2018), "Conceptualization of sustainable higher education institutions, roles, barriers, and challenges for sustainability: an exploratory study in Portugal", *Journal of Cleaner Production*, Vol. 172, pp. 1664-1673, doi: 10.1016/j.jclepro.2016.11.010.
2. Awuzie, B.O., Mafongosi, N.K. and Monyane, T.G. (2023), "Factors influencing green campus implementation performance in a South African University of Technology: a qualitative analysis", *AIP Conference Proceedings*, Vol. 2599, p. 020005, doi: 10.1063/5.0117172.
3. Bulunga, A.A.L. and Thondhlana, G. (2018), "Action for increasing energy-saving behaviour in student residences at Rhodes University, South Africa", *International Journal of Sustainability in Higher Education*, Vol. 19 No. 4, pp. 773-789, doi: 10.1108/IJSHE-07-2017-0107.
4. Carroll, C., Booth, A., Leaviss, J. and Rick, J. (2013), "Best fit framework synthesis: refining the method", *BMC Medical Research Methodology*, Vol. 13, p. 37, doi: 10.1186/1471-2288-13-37.
5. Dagiliūtė, R., Liobikienė, G. and Minelgaitė, A. (2018), "Sustainability at universities: students' perceptions from green and non-green universities", *Journal of Cleaner Production*, Vol. 181, pp. 473-482, doi: 10.1016/j.jclepro.2018.01.213.

6. DiMaggio, P.J. and Powell, W.W. (1983), “The iron cage revisited: institutional isomorphism and collective rationality in organizational fields”, *American Sociological Review*, Vol. 48 No. 2, pp. 147-160, doi: 10.2307/2095101.
7. Evans, J., Jones, R., Karvonen, A., Millard, L. and Wendler, J. (2015), “Living labs and co-production: university campuses as platforms for sustainability science”, *Current Opinion in Environmental Sustainability*, Vol. 16, pp. 1-6, doi: 10.1016/j.cosust.2015.06.005.
8. Freeman, R.E. (1984), *Strategic Management: A Stakeholder Approach*, Pitman, Boston, MA.
9. Geels, F.W. (2002), “Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study”, *Research Policy*, Vol. 31 Nos 8/9, pp. 1257-1274, doi: 10.1016/S0048-7333(02)00062-8.
10. Geng, Y., Liu, K., Xue, B. and Fujita, T. (2013), “Creating a ‘green university’ in China: a case of Shenyang University”, *Journal of Cleaner Production*, Vol. 61, pp. 13-19, doi: 10.1016/j.jclepro.2012.07.013.
11. Gherheș, V. and Cernicova-Bucă, M. (2025), “Reducing water consumption on a student campus through communication campaigns”, *Sustainability*, Vol. 17 No. 2, p. 680, doi: 10.3390/su17020680.
12. Hong, Q.N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M.-P., Griffiths, F., Nicolau, B., O’Cathain, A., Rousseau, M.-C. and Vedel, I. (2018), “The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers”, *Education for Information*, Vol. 34 No. 4, pp. 285-291, doi: 10.3233/EFI-180221.
13. Jimu, T. and Rennkamp, B. (2024), “Science to practice-networked governance of sustainability transitions in an African university”, *International Journal of Sustainability in Higher Education*, Vol. 25 No. 9, pp. 19-39, doi: 10.1108/IJSHE-07-2023-0317.
14. Lauder, A., Sari, R.F., Suwartha, N. and Tjahjono, G. (2015), “Critical review of a global campus sustainability ranking: GreenMetric”, *Journal of Cleaner Production*, Vol. 108, pp. 852-863, doi: 10.1016/j.jclepro.2015.02.080.
15. Leal Filho, W., Salvia, A.L., Paço, A., Anholon, R., Gonçalves Quelhas, O.L., Rampasso, I.S., Ng, A., Balogun, A.-L., Kondev, B. and Brandli, L.L. (2019), “A comparative study of approaches towards energy efficiency and renewable energy use at higher education institutions”, *Journal of Cleaner Production*, Vol. 237, p. 117728, doi: 10.1016/j.jclepro.2019.117728.
16. Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F.J., Waas, T., Lambrechts, W., Lukman, R. and Hugé, J. (2015), “A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey”, *Journal of Cleaner Production*, Vol. 108, pp. 1-18, doi: 10.1016/j.jclepro.2014.09.048.
17. Musakuro, R.N. and de Klerk, N. (2024), “Campus sustainability at Rhodes University, South Africa: perceptions, awareness level, and potential interventions”, *Frontiers in Sustainability*, Vol. 5, p. 1390061, doi: 10.3389/frsus.2024.1390061.
18. Nejati, M. and Nejati, M. (2013), “Assessment of sustainable university factors from the perspective of university students”, *Journal of Cleaner Production*, Vol. 48, pp. 101-107, doi:

10.1016/j.jclepro.2012.09.006.

19. Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D. et al. (2021), “The PRISMA 2020 statement: an updated guideline for reporting systematic reviews”, *BMJ*, Vol. 372, p. n71, doi: 10.1136/bmj.n71.
20. Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K. and Duffy, S. (2006), *Guidance on the Conduct of Narrative Synthesis in Systematic Reviews*, ESRC Methods Programme, Lancaster.
21. Rethlefsen, M.L., Kirtley, S., Waffenschmidt, S., Ayala, A.P., Moher, D., Page, M.J. and Koffel, J.B. (2021), “PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews”, *Systematic Reviews*, Vol. 10, p. 39, doi: 10.1186/s13643-020-01542-z.
22. Shange, H.S. and Dlamini, B.I. (2026), “Green Campus Initiative and water conservation practices in student housing”, *Transformation in Higher Education*, Vol. 11, p. a741, doi: 10.4102/the.v11i0.741.
23. Shange, H.S., Zogli, L.-K.J. and Dlamini, B.I. (2024), “Green entrepreneurship’s role in resolving Green Campus Initiatives challenges in higher education”, *Acta Commercii*, Vol. 24 No. 1, p. a1165, doi: 10.4102/ac.v24i1.1165.
24. Shange, H.S., Zogli, L.-K.J. and Dlamini, B.I. (2025), “Green campus initiatives and strategies for sustainability in higher education”, *Transformation in Higher Education*, Vol. 10, p. a364, doi: 10.4102/the.v10i0.364.
25. Suwartha, N. and Sari, R.F. (2013), “Evaluating UI GreenMetric as a tool to support green universities development: assessment of the year 2011 ranking”, *Journal of Cleaner Production*, Vol. 61, pp. 46-53, doi: 10.1016/j.jclepro.2013.02.034.
26. UNESCO (2020), *Education for Sustainable Development: A Roadmap*, UNESCO, Paris.
27. United Nations (2015), *Transforming Our World: The 2030 Agenda for Sustainable Development*, United Nations, New York, NY.

Figures

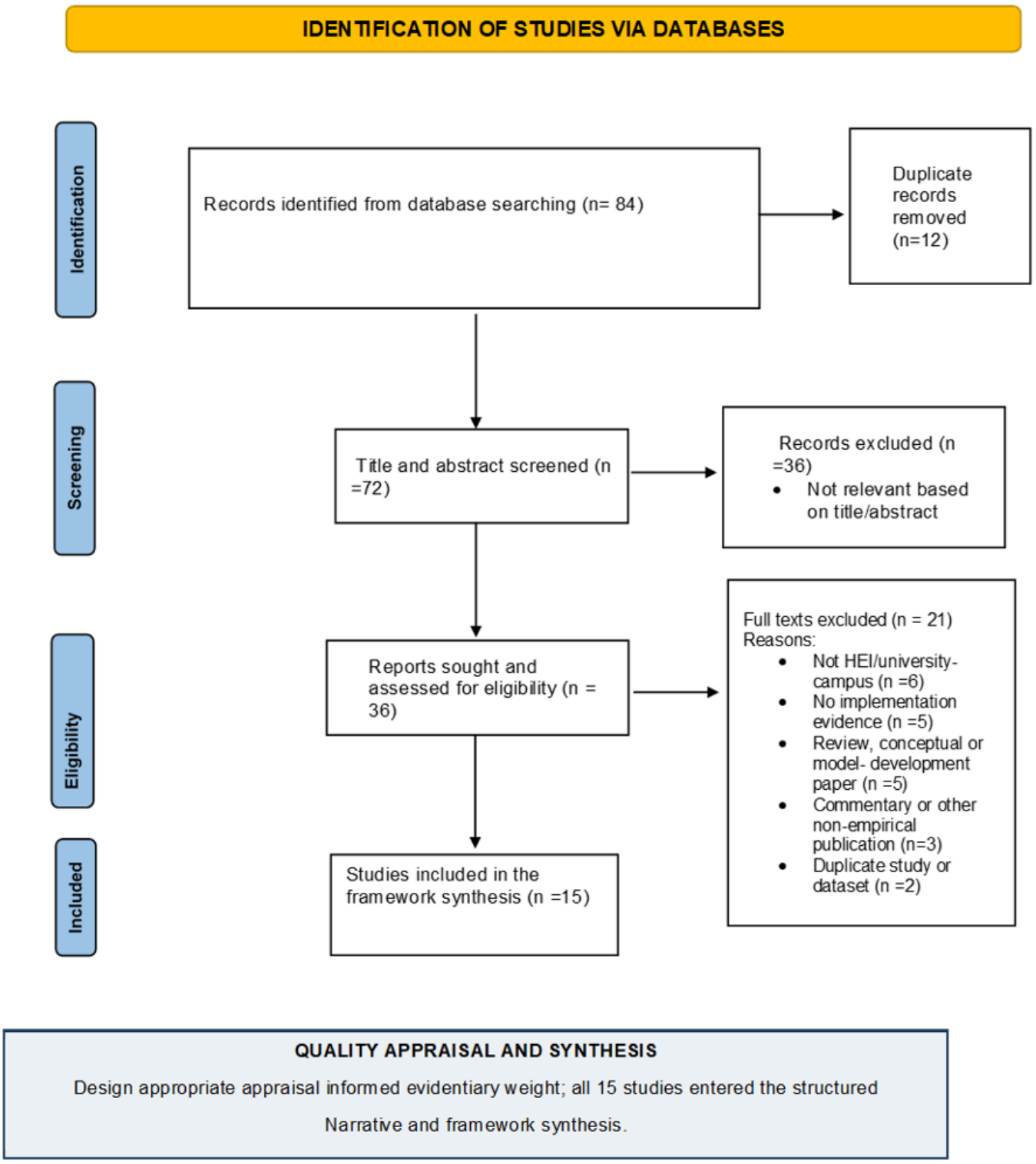


Figure 1

PRISMA 2020 flow of study identification and selection.

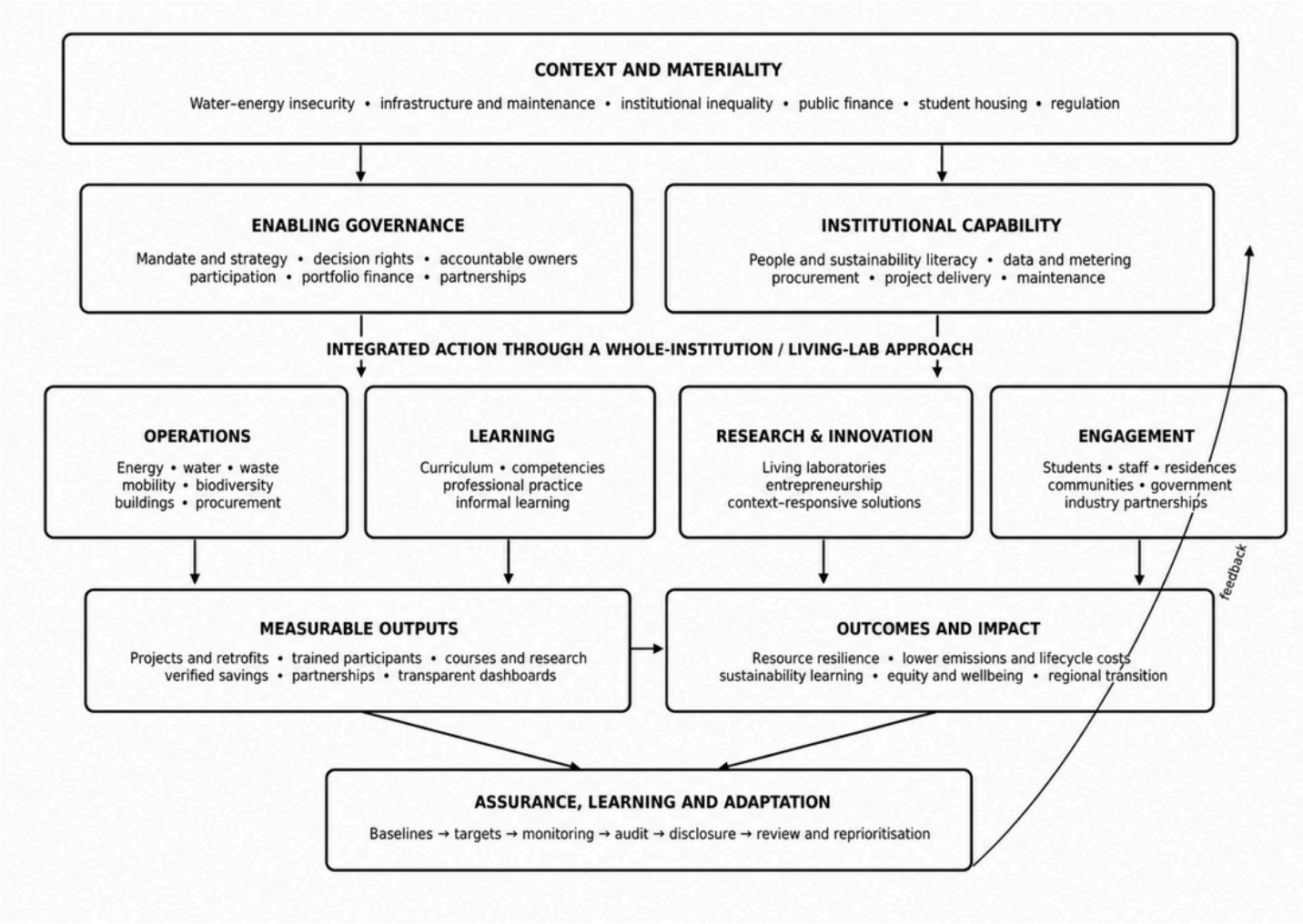


Figure 2

Context Governance Capability Action Assurance framework for Green Campus Initiatives in South African universities (authors' synthesis).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix.docx