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Aligning Global and Regional Sustainability Frameworks: A Thematic Comparative Analysis of GSAS 2019 And LEED V5 In the Gulf Region

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Abstract

The Gulf Cooperation Council (GCC) region has seen rapid urbanization, resulting in urgent demands for sustainable construction frameworks that integrate environmental efficiency, socio-cultural identity, and operational resilience. This study conducts a thematic comparative analysis of the Global Sustainability Assessment System (GSAS 2019) and Leadership in Energy and Environmental Design (LEED v5), focusing on Indoor Environmental Quality (IEQ), Cultural–Economic Value (CE), and Operational Management (OM). A mixed-methods approach was utilized, incorporating a comprehensive literature review (2020–2025), an analysis of Qatar's Environmental Impact Assessment (EIA) protocols, and empirical data from GSAS training, site visits, and expert consultations. This method enabled the integration of qualitative cultural and operational elements with quantitative sustainability metrics, ensuring a thorough evaluation. Research indicates that LEED v5 provides superior performance-based requirements, particularly regarding indoor air quality, occupant health, ventilation, and resilience. Nevertheless, its global framework exhibits limited adaptability to hot and arid environments. In contrast, GSAS 2019 demonstrates improved contextual alignment by incorporating socio-cultural values, lifespan assessment, and operational efficacy into its methodology. These findings reinforce the dominant scholarly consensus that sustainability frameworks must extend beyond universal standards to incorporate culturally informed solutions, biophilic design, and adaptive operational management.

The document suggests approaches to harmonizing international standards with regional requirements, thus fostering environmentally sustainable, culturally cohesive, and operationally robust structures in the Gulf region. The findings provide evidence-based recommendations for architects, engineers, and policymakers seeking to improve sustainable practices in hot and arid climates.

Keywords

Global Sustainability Assessment System (GSAS 2019)
Leadership in Energy and Environmental Design (LEED v5)
Indoor Environmental Quality (IEQ)
Cultural–Economic Value (CE)
Operational Management (OM)

Introduction

Green Building Rating Systems (GBRSs) are essential tools for promoting sustainability in the built environment, offering structured frameworks to assess, track, and improve environmental and operational performance [1]; [2]. The Leadership in Energy and Environmental Design (LEED), established by the U.S. Green Building Council (USGBC), is the most prominent global framework, incorporating standards for energy efficiency, water management, material performance, indoor environmental quality (IEQ), and innovation [3]. The latest iteration, LEED v5, signifies a pivotal advancement in sustainable design, incorporating improved mandates for indoor air quality assessment, sophisticated ventilation and filtration techniques, and conformity with standards like ASHRAE 241 [4]; [3]. Moreover, LEED v5 prioritizes decarbonization, human health, equity, and resilience, signifying a transition towards comprehensive sustainability that encompasses environmental, social, and economic aspects.. Despite its international significance, LEED has faced criticism for its inadequate adaptability to regional climatic and cultural contexts, especially in hot and arid areas where the framework's Regional Priority credits fail to adequately consider localized environmental and socio-economic factors [5].

In light of these constraints, the Global Sustainability Assessment System (GSAS), created by the Global Sustainability Assessment System (GSAS), created by the Gulf Organization for Research and Development (GORD), provides a regionally specific framework designed to address the environmental, cultural, and socio-economic contexts of the Gulf Cooperation Council's (GCC) nations.. Updated in 2019, GSAS incorporates comprehensive categories that transcend technical performance, encompassing Urban Connectivity, Site, Energy, Water, Materials, Indoor Environmental Quality (IEQ), Cultural–Economic Value (CE), and Operational Management (OM), thus addressing environmental performance alongside cultural identity [6]. In contrast to LEED, GSAS expressly addresses regional concerns, including extreme climate conditions, fast urbanization, and the protection of cultural assets, thus establishing itself as a more contextually sensitive assessment method for hot and arid regions.

From 2015 to 2025, academic discussions regarding GBRSs have progressively examined the incorporation of technological advancements, including digital twins, artificial intelligence, and smart sensor networks, for the real-time assessment of indoor environmental quality and energy efficiency [7]; [8]. Research has investigated the utilization of integrated operational dashboards to consolidate performance metrics and enhance decision-making processes in building management [9] Although these contributions illustrate progress in operational and environmental monitoring, there is a paucity of research that systematically compares GSAS 2019 and LEED v5 in the areas of Indoor Environmental Quality, Cultural–Economic Value, and Operational Management. This disparity underscores the necessity for a rigorous comparative examination of how global and regionally unique systems tackle both universal sustainability principles and context-specific requirements.

This study addresses this gap by providing a thematic comparison of GSAS 2019 and LEED v5, concentrating on Indoor Environmental Quality, Cultural–Economic Value, and Operational Management. This research utilizes a mixed-methods approach, incorporating a systematic literature review, analysis of Qatar's Environmental Impact Assessment (EIA) protocols, participation in GSAS training programs, site visits, and expert consultations to discern the strengths and limitations of both systems. The aim is to deliver evidence-based recommendations that improve cultural and climatic responsiveness in sustainability assessments, guiding architects, engineers, and policymakers on the contextual suitability of GBRSs in hot and arid areas. The study enhances sustainable architectural practice and operational management by aligning global frameworks with regional goals.

Literature Review

Global Green Building Rating Systems (GBRSs)

The GBRSs serve as essential instruments for promoting sustainability in the built environment by offering quantifiable frameworks to evaluate environmental, social, and operational performance, as shown in**Error! Reference source not found.**. The most internationally acknowledged systems comprise LEED (U.S.), BREEAM (U.K.), DGNB (Germany), CASBEE (Japan), Green Star (Australia), GRIHA (India), and the World Bank Group's EDGE, each embodying unique methodological emphases [1]; [10].

Recent research indicates that these frameworks are aligning in terms of carbon reduction, resilience, and occupant well-being, but differing in technique, geographical adaptation, and focus. LEED v5 (2023–2025) presents substantial revisions, encompassing improved decarbonization routes, indoor air quality monitoring, ventilation and filtration standards, and resilience measures [3]; [4]). BREEAM V7 (2024) enhances its evidence-based framework by incorporating improved lifetime performance and climate resilience, solidifying its preeminence in Europe [11] . Likewise, [12] differentiates itself by assigning equal importance to environmental, economic, and socio-cultural quality, underpinned by comprehensive lifecycle assessment (LCA) and lifecycle costing (LCC) [12].

Alternative systems address particular market demands. EDGE employs a streamlined threshold model necessitating a minimum of 20% reduction in energy, water, and embodied materials, rendering it particularly successful in developing economies . The WELL Building Standard v2, established in 2020, emphasizes occupant health and well-being across areas like air quality, thermal comfort, lighting, and mental well-being, thus enhancing ecologically focused Green Building Rating Systems [13]. Researchers emphasize a tendency towards hybrid sustainability models that integrate environmental frameworks with health- and culture-focused tools to provide more comprehensive performance outcomes [7]; [8].

Notwithstanding these advancements, criticisms endure concerning the restricted adaptability of global GBRSs to regional climatic and cultural contexts, especially in hot and arid regions like the Gulf [14]; [5].

This has prompted the creation of regionally tailored frameworks, including GSAS 2019 in Qatar and Estidama's Pearl Rating System in Abu Dhabi, which incorporate cultural heritage, operational management, and climate-responsive techniques.

Table 1: Comparison between Major Global Green Building Rating Systems (GBRSs). Source: : [15]; [3]; [6]; [12]

GBRS Systems	Initial Release/ Current Version	Scoring Method	Main Strengths	Main Challenges	Best Fit / Usage Context
LEED v5 (USGBC)	Pilot: 1998; Official: 2000 / v5: 2025	Point-based system awarding Certified to Platinum levels; latest version prioritizes carbon neutrality, resilience, human wellness, and updated O&M strategies.	Widely accepted across global markets; enhanced indoor air quality (IAQ) and occupant health focus; aligned with latest ventilation and health standards.	Limited customization for regional climates; documentation can be complex; climate responsiveness may require additional credits.	Globally applicable, especially for ESG-focused investments; often adapted for hot-arid zones with local tools.
BREEAM V7 (BRE)	First issued in 1990 / Current: 2024–25	Percent-based scoring with outcomes ranging from Pass to Outstanding; robust evidence-based framework; includes "In-Use" assessments.	Strong regulatory alignment in the EU; solid post-occupancy evaluation tools; backed by deep technical expertise.	Documentation-heavy; localization can be time-consuming for non-EU users.	Best suited for UK and EU projects; valuable where legal compliance and audit transparency are essential.
DGNB (Germany)	Launched in 2007 / New Construction: 2023	Balanced weighting across ecology, economy, and socio-cultural factors (25% each); uses LCA and LCC as core metrics.	Strong emphasis on whole-life performance; integrates carbon and cost considerations across the building lifecycle.	High data dependency; slower adoption in regions without lifecycle data infrastructure.	Well-matched to European contexts; useful in projects needing lifecycle assessments.
Green Star (GBCA)	Established in 2003 / Latest: 2020s	Points system feeding into star ratings; covers both construction and operational performance phases.	Clear guidance for operations; prioritizes occupant health and building resilience; supported by localized tools.	Designed primarily for Australian codes; may require localization for global use.	Widely used in Australia; adaptable to other regions with similar climate and local expertise.
EDGE (IFC)	Program launched ~2015 / Latest Guidance: 2024	Requires ≥20% savings in energy, water, and materials; includes EDGE, EDGE Advanced, and EDGE Zero Carbon levels.	Affordable, fast-track system; ideal for projects with green financing needs; supported by app-based modeling.	Limited social and cultural evaluation scope; less comprehensive than full-scale GBRSs.	Ideal for emerging markets; widely applied in housing, hospitality, and office sectors.
WELL v2 (IWBI)	Introduced in 2014 / v2 Formalized: 2020	Focuses on health-centered criteria (air, light, thermal, sound, mental well-being); combines preconditions and optional optimizations.	Strong occupant health and comfort benchmarks; complements broader sustainability systems.	Does not cover energy or carbon performance in depth; typically used alongside LEED/BREEAM.	Global applicability; commonly layered to improve IEQ in buildings across all climates.
GSAS 2019 (GORD, Gulf)	Originated 2007 (as QSAS) / Major update in 2019	Weighted evaluation across indoor environment, cultural and economic value, and operational performance; designed with regional sensitivity.	Highly tailored to hot-arid regions; integrates cultural identity, economic impact, and strong commissioning standards.	Limited global visibility; relatively few international examples for benchmarking.	Preferred in GCC countries; used in government/public-sector projects aligned with regional sustainability goals.
CASBEE (IBEC, Japan)	Developed from 2001 / Mature by early 2000s	Efficiency rating calculated as Quality ÷ Environmental Load (Q/L); scored on a 1–5 scale.	Highlights design benefit per environmental impact; valuable for urban and municipal-scale planning.	Technical structure can be difficult to adapt outside Japan; language and system unfamiliar to most global users.	Primarily adopted in Japan; tested in selected global pilot projects requiring efficiency-to-impact frameworks.

LEED: Evolution from v4.1 to v5

Since 2019, the U.S. Green Building Council (USGBC)'s Leadership in Energy and Environmental Design (LEED) has been the leading the global GBRS.

LEED v4.1 (2019–2020) was a significant transitional framework, while LEED v5 [15]; [3] marked a more extensive move towards holistic sustainability. Performance-based approaches, energy and water efficiency standards, and occupant well-being and resilience were prioritised in LEED v4.1 [15]. It updated ventilation rules and made air testing easier, increasing interior air quality. Digital monitoring and occupant comfort measures were encouraged to improve operational performance [16]; [17]. Suzer (2015) stressed LEED's performance benchmarking role, linking certification to occupant happiness and corporate value. *LEED v4.1* evaluated projects in Energy Efficiency, Water Conservation, Indoor Innovation in Design. Point-based certification has four tiers: Certified-40–49, Silver-50–59, Gold-60–79, Platinum80+. Environmental Quality, Materials and Resources, Sustainable Site Development, and LEED's grading systems—BD+C, ID+C, O+M, ND, and Homes—enable adaptability across building categories.

LEED v5 (2025) links certification to global decarbonization goals, embodied carbon monitoring, social equity, and resilience planning (USGBC, 2020). Post-pandemic health concerns have intensified, therefore LEED v5 incorporates ASHRAE 241 requirements to improve indoor air quality [4]. Equity-based credits in LEED v5 require community participation and demonstrate sustainable design diversity [3]. As in ***Figure 1*** LEED's evolution from v4.1 to v5 shows how it expanded beyond resource efficiency to include carbon reduction, human health, and social equality. While LEED is flexible and globally relevant relevance [16]; [17], scholars suggest that its metrics may be limited in hot and arid regions like the Gulf, where GSAS provides better contextual alignment [5].

Focus Area	LEED v4	LEED v5
Carbon Strategy	Energy Efficiency Modeling	Operational + Embodied Carbon Reduction
Climate Resilience	Optional, Limited Scope	Required Prerequisite with Detailed Assessment
Certification Thresholds	Points Only	Points + Mandatory Performance Outcomes for Platinum
Equity and Community	Pilot Credits	Integrated Across Multiple Credits and Prerequisites
Health and Wellbeing	IAQ-Focused	Expanded to Include Mental, Physical, and Social Health
Update Cycle	Unpredictable	Scheduled Every 5 Years

Figure 1: Comparison between LEED v4 &LEED v5. Source: [18]

Strategic Approach to Selecting and Implementing LEED Certification for Building Projects

Owners and project teams are increasingly seeking LEED certification as a benchmarking tool and a means of communicating their sustainability objectives. In addition to offering external validation of environmental performance, LEED establishes a systematic framework for aligning a project's vision, scope, and programmatic objectives with

Figure 1: *Comparison between LEED v4 &LEED v5. Source:* [18]

quantifiable results in energy efficiency, water conservation, indoor environmental quality (IEQ), and occupant well-being [15].

The choice of the appropriate LEED grading system constitutes a pivotal initial decision. Projects that entail new building or significant renovations are often assessed under the Building Design and Building (BD+C) pathway, whereas interior fit-outs are more appropriately categorized within the Interior Design and Construction (ID+C) framework. Existing structures aiming for performance enhancements may implement the Operations and Maintenance (O+M) system, whereas extensive developments and residential projects are more appropriately aligned with Neighborhood Development (ND) or Homes [19]; [3]. This adaptability allows LEED to encompass a diverse array of building typologies while preserving global uniformity. Upon identification of the rating system, project teams must guarantee adherence to the prerequisites specified in the LEED Reference Guide and corroborated by the publicly available LEED credit library. Following the confirmation of feasibility, the subsequent step is to formulate a certification strategy, which entails selecting credits that optimally correspond with the project's regional context, site-specific characteristics, and environmental and financial goals [16]; [17].

This method is fundamentally iterative and adaptable, necessitating teams to reconcile experiential objectives (e.g., occupant comfort, productivity, and health outcomes) with overarching environmental mandates, such as carbon reduction, resilience planning, and lifetime performance monitoring. The LEED credit library offers comprehensive technical assistance, performance measurements, and documentation processes, facilitating evidence-based decision-making for teams. The certification process serves not only as an evaluative instrument but also as a strategic framework that enhances sustainability performance, promotes regional flexibility, and ensures long-term operational resilience [20].

What's New in LEED v5

The forthcoming Leadership in Energy and Environmental Design (LEED v5), set for balloted release in 2025, signifies the most significant overhaul of the framework since its establishment. It transitions from an efficiency-centric model to an extensive sustainability framework that specifically aims for decarbonization, human welfare, and ecological restoration [15]; [3].

LEED v5 is fundamentally centered around three principal impact areas:

1. Decarbonization — Broadening the focus from operational efficiency to encompass embodied carbon, refrigerants, and emissions associated with transportation, so establishing LEED as a comprehensive instrument for lifecycle carbon assessment [15].

2. Quality of Life — Enhancing occupant well-being by integrating novel metrics for health, resilience, and equity, while harmonizing indoor air quality (IAQ) with ASHRAE 241 standards for ventilation and filtration [4]; [7]. This indicates a transition towards sustainability that prioritizes individuals, particularly in post-pandemic scenarios.

3. Ecological Conservation and Restoration — Implementing more stringent mandates for ecosystem services, biodiversity preservation, and regenerative design, promoting initiatives that facilitate environmental restoration rather than merely mitigating harm [21] ; [3].

Alongside these thematic themes, structural improvements characterize LEED v5:
A five-year development cycle guarantees consistent and iterative updates that adapt to technology and market changes [3].

• Continuity throughout the building life cycle, synchronizing indicators from design to operations, accompanied by integrated performance monitoring [16].

• Revised Platinum certification criteria, necessitating elevated benchmarks for energy efficiency, carbon mitigation, and renewable energy incorporation [3].

• Adaptable finance paths, enhancing prospects for regional innovation and adaptability [14].

LEED v5 signifies a definitive transition from a compliance-oriented grading system to a transformative sustainability framework, incorporating climate action, social fairness, and ecological stewardship into the global green building initiative.

GSAS 2019 and Regional Adaptation in the Gulf

The Global Sustainability Assessment System (GSAS), previously referred to as QSAS, is the inaugural performance-based green building grading system designed for the Middle East and North Africa (MENA) area. GSAS, created by the Gulf Organisation for Research and Development (GORD), was designed to connect global sustainability frameworks with the unique climatic, cultural, and socio-economic characteristics of the Gulf region [6]. In contrast to standard grading systems like LEED and BREEAM, GSAS utilizes criteria that specifically address hot-arid environmental challenges, resource limitations, and the cultural values inherent in Gulf countries [22]; [23].

Fundamental Attributes of GSAS 2019

• *All-Encompassing Evaluation Framework:* Projects are evaluated in eight categories—Energy, Water, Materials, Indoor/Outdoor Environment, Site, Urban Connectivity, Cultural & Economic Value, and Management & Operations.

The system encompasses the entire lifecycle from design and construction to operations and maintenance, hence assuring the integration of long-term sustainability [6].

• *Certification Pathways:*

Design & Build (D&B) - assesses sustainability in design and construction. Construction Management (CM) - evaluates sustainability in construction methodologies. Operations (OP) - assesses sustainability throughout occupation.

• *Rating Levels:* D&B: 1–6 Stars CM: Class D–A* OP: Bronze–Diamond.
• *Regional Customization:* GSAS specifically integrates cultural identity and socio-economic factors, a facet frequently overlooked in international frameworks [5].

Advantages and Effects of GSAS

1. Environmental Performance: GSAS-certified projects exhibit energy savings of up to 40%, water conservation of 30%, and trash reduction of 50–70% via integrated recycling initiatives
2. Economic Efficiency: Sustainable buildings diminish operational expenses and augment asset value, hence enhancing their appeal to investors and tenants [14].
3. Indoor Environmental Quality (IEQ): Focus on thermal comfort, daylighting, acoustic management, and air quality, which substantially improves occupant health and productivity [16].

4. Cultural Integration: Incorporating "Cultural & Economic Value" as a performance metric guarantees heritage conservation, community significance, and socio-economic coherence.
5. National Mainstreaming: In Qatar, GSAS has been included into the Qatar Construction Specifications (QCS), making certification obligatory for all public sector projects and numerous private endeavors (GORD, 2019).
6. Prominent Applications: GSAS was notably implemented in the stadiums of the FIFA World Cup Qatar 2022 and in Lusail City, thereby affirming its regional credibility as a mechanism for the sustainable execution of mega-projects [22].

Strategic Methodology for Choosing and Executing GSAS Certification in Construction Projects

The GSAS provides a regional framework for MENA building sustainability assessments. Unlike LEED, GSAS is tailored to Gulf environmental, socio-economic, and cultural conditions **[24]**. GSAS certification must be strategically selected and implemented from project inception through design, construction, and operation. Choosing an Evaluation Path: GSAS has certification programs like LEED. Design & Build (D&B) addresses new construction projects, Construction Management (CM) addresses sustainability, and Operations (OP) addresses building performance **[6]**. Scheme selection must match project scope, lifecycle phase, and operational priorities. Large infrastructure projects in Qatar use GSAS D&B, while retrofits use GSAS OP **[23]**.

The GSAS offers a regionally tailored framework for assessing building sustainability in the Middle East and North Africa (MENA). In contrast to broader systems like LEED, GSAS is specifically designed for the environmental, socio-economic, and cultural contexts of the Gulf region [24]. The strategic selection and execution of GSAS certification necessitates a systematic approach, commencing at the project inception phase and continuing through design, construction, and operational stages.
Choice of Evaluation Trajectory: Like LEED, GSAS has various certification programs. Design & Build (D&B) pertains to new construction initiatives, Construction Management (CM) relates to the sustainability of construction methodologies, and Operations (OP) concerns the long-term performance of buildings [6]. The selection of a scheme must correspond with the project's scope, lifecycle phase, and operational priorities. Large infrastructure projects in Qatar generally utilize GSAS D&B, whereas retrofits frequently leverage GSAS OP [23].
Prerequisites & Criteria Conformance: Project teams must assess the viability of fulfilling GSAS mandatory criteria across its eight categories: Urban Connectivity, Site, Energy, Water, Materials, Indoor/Outdoor Environment, Cultural & Economic Value, and Management & Operations [6]. It is advisable to conduct early alignment workshops to guarantee that criteria, like minimum energy efficiency standards and water-use reduction initiatives, are attainable.
Development of Certification Strategy: Upon establishing compliance with qualifications, teams formulate a credit plan that aligns with area limitations. The Gulf's arid climate necessitates water efficiency and thermal

comfort, while cultural integration highlights architectural history and economic significance.
The GSAS architecture necessitates ongoing monitoring throughout construction and after occupancy to verify performance. Platforms like GSAS gate offer digital assistance for monitoring documentation and guaranteeing compliance (GORD, 2022). Following certification, regular performance assessments enhance alignment with Qatar's National Vision 2030 sustainability goals.

In summary, implementing GSAS serves not merely as a certification process but as a strategic tool for integrating sustainability into regional development, bolstering resilience, minimizing resource consumption, and preserving cultural identity [23]. The GSAS provides a regionally adapted framework for evaluating building sustainability in the Middle East and North Africa (MENA). Unlike more global systems such as LEED, GSAS is explicitly tailored to Gulf environmental, socio-economic, and cultural conditions [23]. The strategic selection and implementation of GSAS certification requires a structured process, beginning at the project conception stage and extending through design, construction, and operations.

What's New in GSAS (2019 Edition)

The GSAS 2019 incorporated substantial enhancements compared to its predecessors, demonstrating practical insights gained from extensive projects in the Gulf and conforming to worldwide sustainability objectives as in Table 2.

1. Certification at the District Level: The Districts Certification Scheme, introduced in GSAS 2019, is a significant innovation that facilitates the evaluation of sustainability at the metropolitan level. This framework allows for the certification of master-planned areas, including mixed-use districts and infrastructural networks, through design-intent scoring and post-construction verification. Individual structures may adopt district-level ratings for particular categories, including energy and water, thus facilitating certification procedures [6]; [23].

2. Enhanced Typology Coverage: GSAS 2019 established specialized typologies for projects like stadiums, healthcare facilities, and district cooling plants, mirroring Qatar's experience with the infrastructure for the FIFA World Cup 2022. These typology-specific guidelines guarantee customized sustainability criteria instead of generic techniques [6]; [23].

3. Sophisticated Digital Instruments: The Energia Suite, designed for energy performance, and the Water Suite, intended for potable water demand, were introduced as approved simulation tools. These applications offer defined metrics—including energy demand coefficient, CO_2 emissions, and indoor water usage—improving transparency and comparability in performance evaluation ([6]; [23]).

4. Relevance to New and Established Districts: In contrast to previous iterations, GSAS 2019 assesses both new masterplans (design and post-construction phases) and existing or revitalized districts based on their built condition and operational efficacy. The dual applicability enhances GSAS's function in urban regeneration.

5. Ongoing Revision and Oversight: GSAS documentation is presently undergoing frequent review cycles to ensure compliance with Qatar Construction Specifications (QCS) and advancing international standards. This adaptive governance paradigm enhances stakeholder confidence and guarantees technical relevance [6]; [23].

Table 2: Summary of the New Features in GSAS 2019. **Source:** [6]

Feature	Description
District-Level Certification	Evaluates master-planned areas; individual building scores can be inherited.
Typology-Specific Licenses	Specialized pathways for sports, healthcare, rail, and other infrastructure.
Energia & Water Tools	Digital calculators for precise energy and water demand performance modeling.
New & Existing Districts	Flexible certification modes—even after construction and for revitalized areas.
Adaptive Documentation Updates	GSAS manuals updated regularly with transparent communication to stakeholders.

Key Comparative Dimensions Indoor Environmental Quality (IEQ), Cultural–Economic Value (CEV), and Operational Management (OM)

The GBRSs function based on unique goals influenced by their institutional foundations, geographical focus, and performance criteria. A comparative analysis of LEED v5 and GSAS 2019 demonstrates divergence and complementarity in three critical areas: Indoor Environmental Quality (IEQ), Cultural–Economic Value (CE), and Operational Management (OM) as in Table 3. These domains are essential in influencing certification outcomes and in shaping the translation of sustainability theory into quantifiable practice.

Indoor Environmental Quality (IEQ): That is prioritized in LEED v5 as fundamental to occupant health and productivity, highlighting the importance of ventilation, air quality assessment, daylight incorporation, acoustic performance, and resilience to external environmental stressors [3]. Its worldwide extent necessitates regional interpretation to tackle individual climate limitations. In contrast, GSAS 2019 expressly incorporates thermal comfort techniques and outdoor-indoor interaction designed for hot-arid Gulf climates, where elevated ambient temperatures, humidity variations, and dust infiltration pose distinct issues [16]. Consequently, although LEED establishes a universally standardized Indoor Environmental Quality (IEQ) benchmark, GSAS implements climate-specific strategies.

Cultural-Economic Value (CE): A key distinction is GSAS's inclusion of Cultural and Economic Value as an official assessment criterion. This indicates a purposeful effort to integrate heritage conservation, socio-economic continuity, and regional identity into sustainability practices [23] LEED, while extensive in environmental performance, lacks a specific cultural dimension. Its methodology implicitly recognizes socio-economic issues via metrics of equity, community resilience, and occupant well-being. GSAS's cultural orientation emphasizes the significance of contextual sustainability, especially in areas where cultural identity converges with contemporary urban growth.

Operational Management (OM): Both LEED v5 and GSAS 2019 emphasize lifecycle performance, however their methodologies differ in specifics. LEED v5 incorporates performance monitoring throughout the building lifecycle, synchronizing data collecting from design to operation with enhanced predictability within a five-year revision cycle [3]. GSAS institutionalizes operational monitoring via a specialized certification pathway (GSAS Operations, OP), featuring rating levels from Bronze to Diamond, specifically intended to evaluate building management practices, resource efficiency, and long-term resilience [6].

Table 3: Comparative Analysis of LEED v5 and GSAS 2019 Across Key Dimensions. Source: [6]; [3]

Dimension	LEED v5	GSAS 2019	Critical Implication
Indoor Environmental Quality (IEQ)	Emphasizes ventilation, air quality testing, daylighting, acoustics, and resilience in global contexts.	Integrates thermal comfort, dust/heat mitigation, and indoor-outdoor interaction for Gulf climates.	LEED offers global adaptability; GSAS provides region-specific performance in arid climates.
Cultural–Economic Value (CEV)	No explicit category; indirectly addressed via equity, resilience, and community credits.	Dedicated category assessing cultural heritage, socio-economic continuity, and regional identity .	GSAS embeds sustainability in cultural frameworks; LEED emphasizes environmental universality.
Operational Management (OM)	Integrated monitoring across lifecycle; continuity from design to operations.	Separate GSAS Operations (OP) certification; Bronze–Diamond scale for post-occupancy sustainability .	LEED ensures lifecycle data consistency; GSAS enforces post-occupancy accountability.

Comparative Analysis of Research Gaps in LEED vs. GSAS

This section presents a comprehensive comparison study of the identified research gaps between the Leadership in Energy and Environmental Design (LEED) and the Global Sustainability Assessment System (GSAS) frameworks throughout the past decade (2015–2025) as in **Error! Reference source not found.**. Although both s ystems seek to promote sustainability in the constructed environment, they vary in scope, regional applicability, and methodological precision. LEED has developed internationally with an increased emphasis on decarbonization, intelligent monitoring, and equity (notably in v5), while GSAS has positioned itself as a regionally adapted framework that addresses the climatic, cultural, and policy conditions specific to the Gulf. Notwithstanding these advancements, some significant research deficiencies persist—especially concerning indoor environmental quality (IEQ), cultural–economic value (CE), and operational management (OM). Additional deficiencies are apparent in domains including carbon measurement, digital technology integration, and policy enforcement.

This comparative analysis underscores the deficiency of longitudinal studies, post-occupancy evaluation frameworks, embodied carbon research in Gulf mega-projects, and hybrid models that could integrate global and regional rating systems. Addressing these deficiencies is crucial for connecting theoretical frameworks with actual applications, improving performance benchmarking, and informing future global sustainable development strategies.

Table 4: Comparative Analysis of Research Gaps in LEED vs. GSAS (2020–2025).

Dimension	LEED (v4.1–v5)	GSAS (2019)	Identified Research Gaps	Key Reference
Indoor Environmental Quality (IEQ)	Strong emphasis on ventilation, IAQ testing, and occupant well-being (LEED v5 adds resilience & equity focus).	Incorporates regional factors such as air quality under hot–humid/arid Gulf conditions, thermal comfort, acoustics, daylighting.	Limited longitudinal studies on long-term health outcomes of occupants in LEED vs. GSAS-certified buildings. Lack of region-specific empirical data on IAQ performance (e.g., sand, humidity).	[17]; [23]; [15]; [5]
Cultural–Economic Value (CEV)	Focuses more on economic/market value recognition and global benchmarking. Cultural integration is minimal and not climate-region specific.	Strong focus on socio-cultural identity, urban heritage, and lifecycle cost-benefit tailored for Gulf projects.	Few comparative studies analyzing socio-cultural integration across global vs. regional systems. Limited cost–benefit analyses at scale (LEED vs. GSAS).	[19] ; [6]; [18]; [7]
Operational Management (OM)	LEED emphasizes continuous monitoring, smart metering, and performance-based metrics (Digital Twin integration in v5).	GSAS Operations assesses energy, water, and waste performance with lifecycle-based benchmarks aligned to Qatar Construction Specifications.	Need for harmonized post-occupancy evaluation (POE) frameworks across LEED & GSAS. Scarcity of empirical data from operational-phase audits in Gulf context.	[2]; [8]; [6]
Decarbonization & Carbon Metrics	LEED v5 adds carbon-focused credits (operational, embodied, refrigerants, transport).	GSAS integrates energy efficiency but lags in embodied carbon tracking.	Lack of comparative carbon accounting models. Insufficient research on embodied carbon in Gulf mega-projects under GSAS vs. LEED.	[15]; [3]; [5]
Technology Integration	Strong adaptability to digital monitoring, smart grids, and AI-driven tools (e.g., LEED Arc platform).	Limited digital integration; GSAS documentation/manual processes are dominant.	Gap in GSAS adoption of AI, IoT, and digital twin technologies for lifecycle optimization. Comparative research on digital adoption is scarce.	[17]; [18]; [8]
Regional Adaptation	Universal framework; adaptable globally but with limited tailoring for Gulf hot-arid climate.	Context-sensitive; integrates Gulf socio-cultural, climatic, and economic factors.	Few cross-regional comparative studies on performance in extreme climates (hot-arid vs. temperate). Need for hybrid frameworks.	[6]; [23]; [7]
Policy & Governance Alignment	Widely recognized by governments globally but requires voluntary adoption in GCC.	Integrated into Qatar Construction Specifications; often mandatory for public projects.	Lack of research on policy drivers and comparative enforcement mechanisms. Few studies on GCC-wide adoption beyond Qatar.	[6]; [2]
Future Sustainability Trends	Moving towards near-zero carbon, resilience, equity, and global harmonization (v5 roadmap 2025).	Focus on energy/water savings, waste reduction, and cultural identity; less explicit carbon neutrality vision.	Need to study convergence opportunities (GSAS + LEED hybrid). Lack of empirical research on integrating biophilic design, digital twins, and AI across both frameworks.	[3]; [7]; [8]

Methodology

This research utilizes a mixed-methods approach that combines systematic literature review, applied assessment protocols, training insights, field observations, and expert involvement. The methodology is designed to produce a comprehensive analysis of GSAS 2019 and LEED v5 in the Gulf region, concentrating on Indoor Environmental Quality (IEQ), Cultural–Economic Value (CE), and Operational Management (OM) as shown in **Error! Reference source not found.**. Data were analyzed using a theme analysis approach, in which codes were derived inductively from observations and deductively linked with LEED and GSAS categories. Themes were organized around three comparison pillars:

1. (IEQ)- Ventilation, air quality, thermal comfort, and daylighting.
2. (CE)– Socio-cultural congruence, heritage conservation, cost-benefit synthesis.
3. OM - Lifecycle oversight, resilience strategy, operational governance.

Table 5: Methodological Framework. Source: The Researcher.

Method	Rationale	Strengths	Limitations	Contribution to Analysis
Systematic Literature Review (2020–2025)	Establishes academic context and synthesizes global GBRS comparisons.	Ensures coverage of recent advancements; peer-reviewed credibility.	Risk of bias towards English-language and indexed journals.	Provides evidence-based foundation for thematic coding of IEQ, CEV, and OM.
Environmental Impact Assessment (EIA) Protocol Benchmarking	Aligns LEED/GSAS with internationally recognized impact assessment frameworks.	Offers standardized baseline for environmental performance.	EIA protocols may not fully capture cultural or economic dimensions.	Highlights strengths/weaknesses of each system in lifecycle carbon, energy, and water performance.
GSAS Training Materials & Manuals (GORD, 2019–2023)	Access practitioner-level interpretation of GSAS criteria.	Contextual accuracy; reflects regionally tailored priorities.	Produced by institutional body → possible promotional bias.	Informs analysis of CEV and OM dimensions within Gulf-region adaptation.
Site Visits (LEED & GSAS projects in Gulf)	Observe real-world implementation and operational performance.	Ground-truth validation; provides data on occupant comfort and operational challenges.	Limited sample size; access constraints to private data.	Adds applied perspective to IEQ outcomes (ventilation, daylight, acoustics) and OM practices.
Expert Lectures & Consultations	Incorporates professional practice insights from sustainability consultants.	Offers tacit knowledge and real-world trade-offs.	Expert opinions may vary; potential subjectivity.	Supports critical evaluation of both systems' adaptability, cost-efficiency, and cultural alignment.

Results and Comparative Analysis

Indoor Environmental Quality (IEQ)

Indoor Environmental Quality (IEQ) is a fundamental criterion in both GSAS 2019 and LEED v5, with each framework focusing on air quality, thermal comfort, lighting, and acoustics.
LEED v5 presents improved performance-oriented methodologies for indoor air quality assessment, ventilation, and resilience against airborne contaminants, especially in post-pandemic scenarios [4]; [3]. The focus on digital monitoring instruments improves the immediate assessment of occupant comfort.
GSAS 2019 assesses Indoor Environmental Quality (IEQ) with a heightened focus on regional climatic adaptation, encompassing desert ventilation techniques, dust and humidity management, and thermal comfort tailored for hot-arid climates [6]; [23].

LEED v5 offers globally rigorous measurements, but GSAS 2019 exhibits localized precision by tackling Gulf-specific indoor environmental quality concerns, including sandstorms and elevated cooling requirements.

Cultural–Economic Value (CEV)

Cultural–Economic Value (CE) represents a unique benefit for GSAS.
LEED v5 emphasizes universal standards in sustainability and fairness; yet, cultural integration is predominantly implicit [19]; [16].
GSAS 2019 specifically incorporates cultural heritage, identity, and socio-economic concerns, linking architectural design with Gulf traditions, including urban connectedness, shading practices, and community engagement **[6]**; **[23]**.

This contextualization improves public acceptance and guarantees that sustainability is both environmentally sound and culturally pertinent, as well as economically feasible.

Operational Management (OM)

Operational Management (OM) pertains to lifespan sustainability, performance evaluation, and maintenance protocols.
LEED v5 implements a life-cycle and performance-oriented paradigm, integrating decarbonization, resilience, and resource efficiency into its operational framework. It encompasses sophisticated criteria for Platinum-level initiatives aimed at achieving net-zero preparedness [15]; [3].

GSAS 2019 incorporates operational management via its Operations (OP) certification, highlighting cost reduction, maintenance efficiency, and regionally tailored resource management (water scarcity, cooling loads). Research indicates energy savings of up to 40% and water reductions of 30% in GSAS-certified projects [6]; [22]. Consequently, LEED v5 excels in worldwide performance monitoring and decarbonization, whereas GSAS 2019 excels in regional operational efficiency.

Thus, the **Error! Reference source not found.** compares GSAS 2019 and LEED v5 in three main areas: Indoor E nvironmental Quality (IEQ), Cultural–Economic Value (CE), and Operational Management (OM). The convergences, divergences, and distinctive regional adaptations reveal how global and regional grading systems approach sustainability priorities.

Table 6: Comparative Synthesis: (IEQ), (CE), and (OM). Source: The Researcher.

Dimension	LEED v5	GSAS 2019	Key Insights
Indoor Environmental Quality (IEQ)	Strong emphasis on IAQ, ventilation, resilience, digital monitoring	Region-specific adaptation: desert ventilation, thermal comfort, sandstorm mitigation	LEED = Global benchmark, GSAS = Local precision
Cultural–Economic Value (CEV)	Focus on universal equity & sustainability; limited explicit cultural embedding	Explicit integration of cultural identity, socio-economic priorities, regional traditions	GSAS provides cultural relevance; LEED provides global recognition
Operational Management (OM)	Lifecycle approach, decarbonization, resilience, advanced Platinum-level requirements	Lifecycle + OP certification, cost reduction, regionalized efficiency (energy 40%, water 30%)	LEED = Global performance, GSAS = Regional efficiency

Project Case Studies: LEED and GSAS-Certified Museums in the Middle East

LEED-Certified Project: Museum of the Future
Created by: Killa Design and Buro Happold.
Geographical Position: Dubai, UAE. Purpose: Advanced Museum and Innovation Center.
Area: Approximately 320,000 square feet.
Certification Level: LEED Platinum.

Environmental sustainability Key Points:
1. Cutting-edge passive solar architecture and energy-efficient technologies.
2. Solutions that minimize water and energy consumption, specifically designed for arid conditions.
The inaugural structure of its type in the Middle East to attain LEED Platinum certification.

Architectural Synopsis: As shown in Figure 2
1. Design Concept: The Museum of the Future, conceived by Killa Design, showcases a toroidal structure representing humanity and the enigmatic. The vacuum signifies the undiscovered future.
2. Structural Framework: The edifice reaches a height of 77 meters and features an adiagrid framework consisting of 2,400 diagonally intersecting steel sections, which support a column-free interior.

Utilized Materials:
1. Facade Panels: The exterior comprises 1,024 distinct fire-retardant composite panels, each encased in 316-grade stainless steel with a 6WL finish. These panels were produced via CNC-milled molds and incorporated molded-in Arabic calligraphy.
2. Glass Integration: More than 10,000 glass pieces were meticulously cut with waterjet technology to conform to the calligraphic designs, facilitating the ingress of natural light into the interior during daylight hours. LEED Lighting System:
1. Illumination Design: The exterior is enhanced by 14,000 meters of programmable LEED lighting,
2. accentuating the Arabic calligraphy during nighttime.
The lighting system employs LINEARlight FLEX DIFFUSELEED strips, OPTOTRONIC LED drivers, and DMX lighting control from Traxone:cue, guaranteeing dynamic and energy-efficient illumination.

Figure 2: Museum of the Future (interior and exterior). Source: [26].

GSAS-Certified Project: National Museum of Qatar

Created By: Ateliers Jean Nouvel Geographical Position: Doha, Qatar. Purpose: National Museum.
Area: Approximately 430,000 square feet. Certification Level: GSAS 4-Star.

Environmental sustainability Key Points:

1. Incorporation of area cultural symbolism (desert rose) into design.
2. Focus on climate-responsive methods, such as sun shading and passive cooling.
3. Sophisticated monitoring systems to evaluate indoor air quality and resource utilization.

Architectural Synopsis: As shown in Figure 3

1. Design Concept: The museum, conceived by Jean Nouvel, is shaped by the desert rose, a natural crystal formation endemic to Qatar's arid landscapes.

2. Structural Framework: The edifice consists of 539 interconnecting disks, forming a complex geometry that encases the restored medieval Palace of Sheikh Abdullah bin Jassim Al Thani

Figure 3: National Museum of Qatar (Exterior and certificates. Source: [25]

Materials Utilized:

Facade Cladding: Approximately 76,000 bespoke panels constructed from Glass Fiber Reinforced Concrete (GFRC) were utilized for the outside. This material provides endurance and resilience against Qatar's severe climate.

2.Structural Support: Stainless steel embeds are integrated into the GFRC panels, linking them to the building's substructure, so assuring structural stability while preserving the aesthetic coherence of the design. Graduate School of Arts and Sciences at the National Museum of Qatar: The National Museum of Qatar has attained a 4-Star GSAS Design & Build certification, demonstrating its dedication to sustainability and environmental efficiency. This certification highlights the museum's commitment to energy efficiency, water conservation, sustainable materials utilization, and overall reduction of environmental effect.

Attributes of Sustainability:

1. GSAS Certification: The NMoQ has attained a 4-Star certification under the Global Sustainability Assessment System (GSAS), signifying its dedication to sustainability and environmental performance.
2. LEED accreditation: Alongside GSAS, the museum has received LEED Gold accreditation, highlighting its compliance with worldwide environmental standards.
3. Energy Efficiency: The interlocking disk configuration offers inherent shade, so diminishing solar heat gain and lessening dependence on artificial cooling systems.
4. Indoor Environmental Quality: Materials exhibiting minimal volatile organic compound (VOC) emissions were chosen for interior finishes, encompassing adhesives, sealants, paints, and coatings. The museum is also equipped with effective air filtering technologies to ensure superior indoor air quality.
5. Water Conservation: Innovative cooling towers have been introduced, resulting in up to 10% water savings relative to conventional systems. Water-efficient fixtures and indigenous planting enhance water saving initiatives.
6. Waste Management: During construction, nearly 98% of waste materials, totaling around 58,350 tons, were diverted from landfills via recycling and reuse activities. This case study emphasizes the National Museum of Qatar's innovative material utilization and its excellent adherence to GSAS principles, establishing a model for sustainable museum design in the region.

The Table 7compares the Museum of the Future (Dubai, LEED Platinum) and the National Museum of Qatar (Doha, GSAS 4-Star + LEED Gold), two distinguished Middle Eastern sustainable museums. It emphasizes their architectural concepts, structural frameworks, materials, lighting systems, sustainability, energy efficiency, water conservation, indoor environmental quality, waste management, cultural–economic value, and operational management. LEED-driven innovation stresses advanced technology and renewable integration, while GSAS promotes climate responsiveness, cultural symbolism, and lifecycle sustainability.

Table 7: Comparative Table: LEED vs. GSAS-Certified Museums in the Middle East. Source: The Researcher.

Dimension	Museum of the Future (Dubai, UAE – LEED Platinum)	National Museum of Qatar (Doha, Qatar – GSAS 4-Star + LEED Gold)	Comparative Insights
Architect/Design Team	Killa Design & Buro Happold	Ateliers Jean Nouvel	Both involve internationally renowned architects; LEED project emphasizes futuristic form, GSAS project emphasizes cultural symbolism.
Location	Dubai, United Arab Emirates	Doha, Qatar	Both in Gulf region; climate-responsive design critical.
Function	Futuristic museum & innovation hub	National heritage museum	Global future-oriented vs. regional cultural preservation.
Size	~320,000 sq ft	~430,000 sq ft	NMoQ is larger in footprint and structural complexity.
Certification Level	LEED Platinum	GSAS 4-Star + LEED Gold	NMoQ integrates both global (LEED) and regional (GSAS) standards.
Architectural Concept	**Torus-shaped** structure representing humanity & unknown future; void = “future yet to be discovered.”	**Desert rose-inspired** interlocking disks symbolizing local geology & heritage.	LEED emphasizes abstract futurism; GSAS emphasizes cultural contextualization.
Structural Framework	77 m tall; diagrid framework of 2,400 steel members; column-free interior.	539 interlocking disks enveloping restored historic palace.	LEED = advanced engineering; GSAS = hybrid (modern + historic integration).
Materials	- 1,024 CNC-milled composite façade panels clad in stainless steel with Arabic calligraphy. - 10,000 precision-cut glass inserts.	- 76,000 GFRC façade panels, durable under harsh climate. - Stainless steel embeds for stability.	LEED = high-tech steel & glass; GSAS = durable, climate-resilient GFRC.

Lighting System	- 14,000 m programmable LED strips. - LINEARlight FLEX DIFFUSE, OPTOTRONIC drivers, DMX control.	- Indirect daylighting via disk geometry. - Reduced artificial lighting demand.	LEED = high-tech programmable façade lighting; GSAS = natural shading for energy reduction.
Energy Efficiency	- Passive solar design, daylighting, insulation. - Solar PV: ~4,000 MWh/year.	- Disk geometry reduces solar gain. - Passive cooling + efficient HVAC.	LEED = renewable integration (PV); GSAS = passive cooling/climate-responsive shading.
Water Conservation	- Low-water solutions tailored for desert climate.	- Cooling towers saving 10% water. - Water-efficient fixtures + native landscaping.	GSAS = more systemic water management; LEED = fixture-based.
Indoor Environmental Quality (IEQ)	- Natural daylight penetration via glass calligraphy. - Enhanced thermal comfort.	- Low-VOC materials (adhesives, paints, sealants). - Advanced air filtration & acoustic comfort.	LEED = daylight & comfort; GSAS = IAQ & health-centric.
Waste Management	Limited published data.	98% construction waste diverted (≈58,350 tons recycled/reused).	GSAS stronger in lifecycle material management.
Cultural & Economic Value (CEV)	- Symbol of Dubai's innovation and global branding. - Showcases future-oriented architecture.	- Preserves cultural heritage (Palace of Sheikh Abdullah). - Regional identity & tourism anchor.	LEED = global innovation identity; GSAS = regional heritage integration.
Operational Management (OM)	- Smart monitoring for energy & water use.	- IAQ monitoring, resource consumption tracking, waste diversion.	GSAS more comprehensive in O&M beyond energy-water.
Iconic Status	First LEED Platinum museum in the Middle East.	FIFA World Cup legacy project; benchmark for GSAS cultural integration.	Both are regional benchmarks: Dubai → technology; Doha → heritage & culture.
Strengths	- World's first LEED Platinum museum. - Futuristic identity. - Strong renewable integration.	- Dual certification (GSAS + LEED). - Cultural symbolism. - Strong IAQ, water & waste management.	Both are sustainability icons; LEED = tech-driven, GSAS = culturally embedded.
Limitations	- High reliance on advanced technology. - Higher upfront costs.	- Complex geometry increases embodied carbon. - GSAS recognition limited globally.	LEED = scalability; GSAS = local contextual strength.

Discussion and conclusion

Theoretical Implications: Global vs. Regional Frameworks

The LEED v5-GSAS 2019 comparison shows the difference between worldwide standardization and regional contextualization. LEED's universality, comparability, and market acceptance help multinational enterprises and governments meet global sustainability standards [3]. However, GSAS incorporates Gulf-specific cultural, climatic, and socio-economic factors such extreme aridity, high cooling loads, and heritage conservation into its regionally adaptive system [23]; [6].
Should sustainability certifications promote scalability and global benchmarking (LEED) or contextual responsiveness and cultural integration (GSAS)? This conflict mirrors environmental governance arguments between universalist and relativist methods.

Practical Implications: Architects, Engineers, and Policymakers

The ramifications for architects and engineers are concrete:

LEED v5 provides organized performance routes that enable the incorporation of digital monitoring, lifecycle carbon accounting, and enhanced material credits, particularly for companies functioning on a global scale.

GSAS 2019 offers enhanced climate-responsive design guidelines, including techniques for solar shading, natural ventilation, and water reuse in arid environments, thereby ensuring projects are both compliant and functionally resilient.

For politicians, LEED certification denotes international credibility, whereas GSAS implementation embodies national and regional interests, especially in Qatar and the wider Gulf region. The incorporation of GSAS into Qatar Construction Specifications illustrates the transformation of sustainability rating systems from voluntary frameworks to regulated instruments [6].

Integration of Biophilic Design, Digital Twins, and Smart Monitoring

The swift progression of biophilic design, digital twins, and intelligent monitoring systems offers prospects for the enhancement of both frameworks.
- Biophilic design corresponds with LEED v5's Quality of Life impact category, emphasizing occupant well-being, whereas GSAS could enhance this aspect by using culturally significant biophilic methods, such courtyard gardens and shaded community areas.
- Digital twins—virtual representations of physical assets—are progressively utilized for predictive maintenance, energy efficiency, and scenario analysis. LEED v5's performance monitoring methodology aligns seamlessly with digital twin technologies, but GSAS can use these tools to enhance its operational management emphasis.
- Smart monitoring technologies for indoor air quality, energy, and water correspond with LEED v5's emphasis on data-driven decarbonization, and their incorporation into GSAS may facilitate real-time regional adaptation [4].

Collectively, these nascent technologies serve as conduits between global and regional frameworks, facilitating the alignment of contextual sensitivity with digital precision.

Challenges and Opportunities for Harmonization

As shown in Table 8, notwithstanding their complementarities, certain hurdles impede harmonization:

Terminological divergence: The credit-based system of LEED against the star/class ratings of GSAS hinders cross-comparisons (Saleh, 2024).

Data asymmetry: LEED's worldwide datasets offer robust benchmarking capabilities, but GSAS's regional databases are underdeveloped, constraining cross-national comparability .

Policy alignment: The implementation of LEED may contradict national requirements unless localized adaptations are implemented, but GSAS is rarely acknowledged beyond the Gulf region .

Nevertheless, opportunities are present: Hybrid frameworks may integrate LEED's stringent decarbonization standards with GSAS's regional flexibility. Collaborative study among USGBC, GORD, and regional institutions could provide unified benchmarks for hot-arid climates.

Policymakers can utilize harmonization to guarantee that sustainability certifications promote climate commitments (e.g., net-zero pledges) while strengthening cultural identity.

Table 8: Comparative conclusion of LEED v5 and GSAS 2019. Source: The researcher.

Dimension	LEED v5 (Global Framework)	GSAS 2019 (Regional Framework)	Challenges	Opportunities for Harmonization
Theoretical Implications (Global vs. Regional)	Universal benchmarking; strong alignment with global decarbonization and resilience agendas.	Context-specific adaptation to Gulf climate, culture, and socio-economic needs.	Paradigmatic tension between universality vs. regionalism.	Development of hybrid systems embedding global rigor + local identity.
Practical Implications (Architects, Engineers, Policymakers)	Provides structured performance pathways; facilitates cross-border comparability; supports international firms.	Integrated into Qatar Construction Specifications; practical for arid climate challenges; supports national policy mandates.	Lack of interoperability between credit-based (LEED) and star/class (GSAS) formats.	Shared compliance tools; cross-certification options for projects in Gulf with global investors.
Integration of Innovations (Biophilic Design, Digital Twins, Smart Monitoring)	Embeds Quality of Life impact category; compatible with digital twins and smart monitoring for decarbonization.	Recognizes cultural dimensions (courtyards, shading, heritage-sensitive design); can benefit from digital twins and biophilic strategies adapted to Gulf context.	GSAS lags in technology integration; LEED less sensitive to cultural adaptation.	Joint innovation programs linking smart monitoring + cultural sustainability.
Harmonization Challenges & Opportunities	Global recognition; large benchmarking datasets; supports international investors.	Regional legitimacy; enhances property value in Gulf markets; promotes cultural-economic values.	Data asymmetry (global vs. regional benchmarks); limited global acceptance of GSAS.	Collaborative research between USGBC & GORD; hybrid credit categories for hot–arid climates; joint training programs for professionals.

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