

Applicability of LEED assessment criteria for the context of GCC countries



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ABSTRACT

Since the 1980s, the Gulf Co-operation Council (GCC) region has experienced a period of rapid economic growth. This, in turn, has led to the acceleration of urban development that relies totally on the consumption of non-renewable resources (e.g., fossil fuel). It has been claimed that continuing on this way of growth will put our ecosystem under great pressure. However, according to many scientific research papers, the principles of sustainability development (SD) were identified as effective strategies for preserving the world's ecosystem. In the developed world, a number of different sustainability rating schemes such as Leadership in Energy and Environmental Design (LEED) has been developed, attempting to put SD into practice. In fact, it is difficult for any rating scheme to be a globally relevant scheme, as LEED has been strongly criticized as an inappropriate tool for many locations around the world. This is due to many differences, such as climatic conditions, natural resources, and the social, cultural, and economic aspects of each region. Yet, the GCC countries have adapted their own rating schemes. These schemes have also been criticized for being greatly influenced by the LEED rating scheme. Therefore, the purpose of this critical study is to determine the level of applicability of the LEED assessment criteria in the context of the Gulf Cooperation Council countries and to highlight its main weaknesses and inadequacies. Key findings reveal that the objective-based and subjective-based criteria have been combined to provide a single rating expression. This paper, therefore, proposes a framework to differentiate between subjective-based and objective-based criteria in an attempt to improve the accuracy of the overall building assessment within the GCC context.

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1. Introduction

It is now generally accepted that both climate change and global warming are exacerbated by human activities, with a major factor being the development of buildings and urban sprawl. However, the theory of building science has been applied in an attempt to preserve natural resources by improving a building's performance, including in relation to energy and water efficiency (Beyaz and Asilsoy, 2019). Since the early 1980s, Sustainability Assessment Schemes (SAS) has been significantly expanded throughout the globe to minimize the impact of climate change (Cole, 1998; Crawley and Aho, 1999; Ding, 2008; Forsberg and Malmberg, 2004). The developed world has a number of well-

established international schemes, including (1) BREEAM (Building Research Establishment Environmental Assessment Method-UK) (BREEAM, 2019); (2) LEED (Leadership in Energy and Environmental Design-USA) (LEED, 2020); (3) CASBEE (Comprehensive Assessment System for Built Environment Efficiency-Japan) (CASBEE, 2020) and (4) Green Star (voluntary sustainability rating system for buildings-Australia) (GBCA, 2020). These tools have proved successful in promoting the principles of Sustainability Development (SD) (He et al., 2018; Doan et al., 2017).

A number of pioneering projects have been undertaken in the Gulf Co-operation Council (GCC) region that has incorporated SD principles into construction projects in an effective manner (Asif, 2016). This has led Saudi Arabia, the United Arab Emirates (UAE), and Qatar to recognize the importance of developing their own sustainable assessment systems, resulting in initiatives such as the UAE Estidamah pearl rating system and the Qatar Sustainability Assessment System (QSAS) (Zafar, 2017). In addition, various initiatives and studies have sought to identify an applicable system

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for Saudi Arabia, i.e., SAAF and SEAM: Saudi Environmental Assessment Method (Alyami et al., 2013). A number of international SAS have played a significant role in promoting such development, as exemplified in the development and adaptation of new and local SAS for the GCC (Asif, 2016; Alalouch et al., 2016). Thus, a number of international schemes have been adapted to suit the GCC region, including BREEAM Gulf and LEED Emirate. However, these adapted international SAS have been heavily criticized for being too limited to be fully suitable for local considerations of the GCC (Cole and Valdebenito, 2013; Reed et al., 2009; Moussa and Farag, 2017; Al Khalifa, 2019). This paper critically examines the existing SAS in GCC countries in order to identify both the strengths and weaknesses of such tools, while at the same time undertaking a detailed discussion concerning efficient ways of improving the reliability and applicability of existing SAS in the GCC.

2. Literature review

The GCC countries (i.e., Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE) have, over the previous two decades, experienced a number of demographic and social changes. These have been due to rapid economic growth across the GCC region. From 1998, the GDP of the GCC has expanded by an annual average of 5.2% and by a cumulative total of 65% (EIU, 2009). Meanwhile, the population has also experienced a dramatic expansion, from twenty-eight million in 1998 to an estimated of fifty-four million in 2020 (WPR, 2020). This rapid growth has attracted world attention and resulted in considerable investment into many different sectors

2.1. The GCC in 2020

A recent whitepaper stated that construction is one the most rapidly expanding in the GCC, with this sector experiencing a 12% growth in the value of construction projects in 2019. Rising oil prices and government spending on new construction projects powered this boom. It was also expected that spending on buildings, infrastructure, and energy markets would increase to US\$140.5 billion in 2019, compared to US\$125 billion in 2018 (WCT, 2020). However, four out of the five of the most carbon dioxide-emitting countries in the world on a per capita basis are Middle Eastern countries. The GCC region is, therefore, acting to address this through the implementation of SD for the water and energy use of its buildings, in order to eliminate the risk of further environmental degradation. In addition, sustainability has currently been given a high priority globally in order to preserve natural resources from depletion. The GCC region has been influenced by many countries around the world, which have developed domestic schemes to put SD concept into practice, including (1) BREEAM (UK); and LEED (USA); Green Star (Australia, New Zealand, and South Africa); CASBEE (Japan); and Green Mark

(Singapore). These systems promote sustainable buildings and protect the ecosystem from the consequences of construction activities (Cole and Valdebenito, 2013).

Sustainability in the GCC region faces a considerable number of challenges, primarily related to the lack of green benchmarking and guidelines. Firstly, SD cannot be attained without metrics to measure its enhancement, but, until recently, none of the GCC countries have possessed a promising green or sustainable rating system. Developed countries (i.e., the UK and USA) have attempted to establish customized versions of BREEAM and LEED (Sabie et al., 2014; Awadh, 2017). However, these have tended to prove unreliable due either to a lack of provision and support from the original organization or to a lack of suitability and applicability for the local conditions, environment, economy, and customs (Alyami and Rezgui, 2012). This has prompted the GCC to establish its own local rating schemes (Moussa and Farag, 2017; Awadh, 2017; Alobaidi et al., 2015; Alyami et al., 2015), including: (1) the Estidama Pearl Rating System (Estidama, 2020); (2) the Saudi Environmental Assessment (SEA) (Alyami et al., 2013); and (3) GORD (2020) and Mostadam (Mostadam, 2020) for Saudi Arabia housing. This is discussed in further detail in the results and discussion section on these local assessment schemes.

2.2. Sustainability indicators

The performance and design of a sustainable (or 'green') building or city can be measured by a number of typical sustainability indicators (including efficiency) in relation to (1) energy and water; (2) transport; (3) waste management; (4) construction and maintenance; (5) services and infrastructure; (6) and environmental qualities. The main SD indicators and their respective measurements (Mezher et al., 2016) are as follows: (a) Housing, construction, and maintenance. These measures the embodied CO₂/m² per home and embodied CO₂ for all infrastructure work, as well as evaluating the quality of housing in terms of m² per person. (b) Home energy consumption. This measures energy consumption in MWh per year, indicating the number of energy production plants and efficient appliances, as well as calculating the percentage of renewable energy employed. (c) Transport. This evaluates CO₂ emissions from the use of personal transport by each individual per annum. (d) Waste management. This is calculated in terms of tonnes created by occupants on an annual basis, as well as calculating or quantifying the percentage of waste going to recycling or landfill. (e) Environmental quality. This measures and evaluates daily water quality and consumption per capita, along with the percentage of groundwater supply as a proportion of total water use, and connection to the sewage system. (f) Air quality. This is frequently assessed firstly, over the long term, by measuring SO₂ and STP and secondly, over the short term, by measuring O₃,

SO₂, and TSP. (g) Ecological footprint. This assesses surrounding areas of green and open spaces, alongside acoustic performance to address potential levels of noise pollution (Mezher et al., 2016).

2.3. LEED assessment criteria and categories

LEED has developed consensus-based criteria to evaluate various environmental elements related to buildings, with associated services including (1) Location and Transportation (LT); (2) Sustainable Sites (SS); (3) Water Efficiency (WE); (4) Energy and Atmosphere (EA); (5) Material and Resources (MR); (6) Indoor Environment Quality (EQ); (7) Innovation (IN); and (8) Regional Priority (RP). The complete lifestyle of a building can be evaluated from the criteria related to (1) building design and construction, (2) interior design and construction, (3) building operations and maintenance; and (4) neighborhood development (LEED, 2020).

This paper undertakes a critical analysis of the manual of Building Design and Construction (BD and C). The following section is illustrating the criteria applied to all forms of buildings including (1) New Construction Core and Shell; (2) Schools; (3) Retail; (4) Data Centres; (5) Warehouses and Distribution Centres; (6) Hospitality; and (7) Healthcare. A small number of criteria are allocated to a specific building, as demonstrated in the tables set out below.

- Location and Transportation (LT): The assessment criteria of the LEED rating scheme allocate significant credits and weights to the location of a building and its accessibility to associated and close services as well as different modes of transport (Table 1). The ultimate objective of these criteria is to reduce greenhouse emissions and improve occupants' quality of life (USGBC, 2014).

Table 1: Location and transportation (LEED v4)

LT Credit:	LEED for Neighborhood Development Location
LT Credit:	Sensitive Land Protection
LT Credit:	High-Priority Site
LT Credit:	Surrounding Density and Diverse Uses
LT Credit:	Access to Quality Transit
LT Credit:	Bicycle Facilities
LT Credit:	Reduced Parking Footprint
LT Credit:	Green Vehicles

- Sustainable Sites (SS): As shown in Table 2, the criteria for LEED Sustainable Sites have been developed to manage a broader context, with assessments covering a number of key factors, including: (1) the outdoor environment; (2) animal habitat; (3) the availability of open spaces with sustainable hydrologic conditions; (4) light pollution; and (5) the existence of a heat island (USGBC, 2014).
- Water Efficiency (WE): In Table 3 credits related to the water efficiency of building focus on both the internal (indoor) and external (outdoor) control of water consumption, in order to promote various

methods of water management and water-saving practices (USGBC, 2014).

Table 2: Sustainable sites (LEED v4)

SS Prerequisite:	Construction Activity Pollution Prevention
SS Prerequisite:	Environmental Site Assessment
SS Credit:	Site Assessment
SS Credit:	Site Development—Protect or Restore Habitat
SS Credit:	Open Space
SS Credit:	Rainwater Management
SS Credit:	Heat Island Reduction
SS Credit:	Light Pollution Reduction
SS Credit:	Site Master Plan
SS Credit:	Tenant Design and Construction Guidelines
SS Credit:	Places of Respite
SS Credit:	Direct Exterior Access
SS Credit:	Joint Use of Facilities

Table 3: Water efficiency (LEED v4)

WE Prerequisite:	Outdoor Water Use Reduction
WE Prerequisite:	Indoor Water Use Reduction
WE Prerequisite:	Building-Level Water Metering
WE Credit:	Outdoor Water Use Reduction
WE Credit:	Indoor Water Use Reduction
WE Credit:	Cooling Tower Water Use
WE Credit:	Water Metering

- Energy and Atmosphere: The Energy and Atmosphere (EA) category focuses on both the planning and construction of a building, including the use of the highest possible degree of renewable energy, in order to reduce GHG emissions. The goal of this criteria is to promote the efficient design of buildings, particularly in terms of energy conservation and the use of clean energy, as shown in Table 4 (USGBC, 2014).

Table 4: Energy and atmosphere (LEED v4)

EA Prerequisite:	Fundamental Commissioning and Verification
EA Prerequisite:	Minimum Energy Performance
EA Prerequisite:	Building-Level Energy Metering
EA Prerequisite:	Fundamental Refrigerant Management.
EA Credit:	Enhanced Commissioning
EA Credit:	Optimize Energy Performance
EA Credit:	Advanced Energy Metering
EA Credit:	Demand Response
EA Credit:	Renewable Energy
EA Credit:	Enhanced Refrigerant Management
EA Credit:	Green Power and Carbon Offsets

- Materials and Resources (MR): As shown in Table 5, LEED employs the Materials and Resources (MR) category to take a building lifecycle approach (i.e., cradle to grave) to its assessment. This commences with the extraction of the raw materials, followed by their processing and transportation and, subsequently, the construction and maintenance of a building until its final demolition. The aim of this category is to reduce the impact of building materials on the ecosystem (USGBC, 2014).
- Indoor Environmental Quality (EQ): As shown in Table 6, the EQ category focuses on the comfort, health, and wellbeing of a building's occupants, in particular when it comes to issues related to indoor air quality, along with acoustic, thermal comfort and visual aspects of the indoor environment. These have been revealed to exert a significant impact on the occupants' productivity, while at the

same time improving the health-promoting aspects of the building (USGBC, 2014).

Table 5: Materials and resources (LEED v4)

MR Prerequisite:	Storage and collection of recyclables
MR Prerequisite:	Construction and Demolition Waste Management Planning
MR Prerequisite:	PBT Source Reduction—Mercury
MR Credit:	Building Life-Cycle Impact Reduction
MR Credit:	Building Product Disclosure and Optimization—Environmental Product Declarations
MR Credit:	Building Product Disclosure and Optimization – Sourcing of Raw Materials
MR Credit:	Building Product Disclosure and Optimization – Material Ingredients
MR Credit:	PBT Source Reduction—Mercury
MR Credit:	PBT Source Reduction—Lead, Cadmium, and Copper
MR Credit:	Furniture and Medical.
MR Credit:	Design for Flexibility
MR Credit:	Construction and Demolition Waste Management

Table 6: Indoor environmental quality (LEED v4)

EQ Prerequisite:	Minimum Indoor Air Quality Performance
EQ Prerequisite:	Environmental Tobacco Smoke Control
EQ Prerequisite:	Minimum Acoustic Performance.
EQ Credit:	Enhanced Indoor Air Quality Strategies
EQ Credit:	Low-Emitting Materials
EQ Credit:	Construction Indoor Air Quality Management Plan
EQ Credit:	Indoor Air Quality Assessment
EQ Credit:	Thermal Comfort
EQ Credit:	Interior Lighting
EQ Credit:	Daylight
EQ Credit:	Quality Views:
EQ Credit:	Acoustic Performance

- Innovation (In) and Regional Priority (RP): The criteria related to innovation award five credits,

with the aim of motivating building designers to establish further innovative strategies (i.e., not yet included in LEED criteria), leading to the most effective environmental performance. In addition, regional priority is given four credits, which can be awarded on the basis of each region's highest priority when it comes to the protection of its environment and natural resources (USGBC, 2014).

2.4. LEED certification in GCC

Table 7 demonstrates the GBIG Green Building Information Gateway LEED certification activities in GCC countries (GBIG, 2020).

3. Research method

SAS criteria are derived from a multi-criteria basis. It was determined that the qualitative research method would be the most appropriate for this research, being effective for obtaining sufficient in-depth detail to create a comprehensive and holistic assessment scheme. The primary aim of this study was to assess the current practice of international SAS (i.e., LEED), including its influence on local SAS within GCC countries. The expected outcome of this analysis has the potential to assist Architectures Engineering and Construction (AEC) and policymakers to identify any hindrances resulting from the absence of well-defined sustainable assessment conditions for the GCC. It also aimed to identify optimal solutions for developing applicable SAT within the GCC.

Table 7: LEED certifications in GCC countries (GBIG, 2020)

LEED certifications	Distinctive Green Projects
Saudi Arabia	Fifty-three certified activities were recorded, in a total area of 40,35 M sq. Ft. Of these, four globally distinctive sustainable projects were given global awards, including (1) KAUST-2010 awarded AIA/COTE Top Ten Green Projects. (2) KAPSARC-2014 award USGBC Best of Building Awards. (3) Colgate-Palmolive: Dammam-2010 Energy Star Challenge for Industry. (4) King Abdul-Aziz international airport-2010 AIA Twenty-Five Year Awards.
United Arab Emirates	The UAE is the most important GCC country in terms of the number of certified LEED projects. Thus, 252 certified activities were recorded within a total area of 57.93 M sq. Ft. The LEED Gold rating level is the highest level of award, being over 50%. In addition, activities were recorded as being awarded LEED platinum (16%), LEED Silver (21%), and LEED-certified. Moreover, the Sheik Zayed Desert Learning Centre in Abu Dhabi was shortlisted for the WAN Sustainable Building of the Year in 2013.
Qatar	Qatar has a high level of LEED activities, as demonstrated by the forty-six certified activities that have been awarded for a collected area of 13.47 M sq. Ft, including 36% being Platinum awards; 52% being Gold award rating levels; 8% being silver and 2% being the LEED-certified rating level.
Kuwait Oman	There are a similar number of LEED activities in both Kuwait and Oman. However, it can be seen that the level of certified green projects remains low in comparison to Saudi Arabia, UEA, and Qatar. Kuwait has recorded ten certified LEED activities, with eleven recorded in Oman.
Bahrain	GBIG states that Bahrain has the lowest number of LEED activities in all GCC countries, with just two certified silver activities, for an area of 222,251 sq. Ft.

This research seeks to answer the following research questions:

- Q1. What are the mutually sustainable criteria shared by GCC (SAS), and to what extent do these SAT differ from each other?
- Q2. What are the lessons from the use of international SAS in GCC construction projects?

The steps outlined below were carried out in order to answer these questions: (1) a critical review of SAS adapted to the GCC (i.e., the Pearl Rating System, SEAM, QASA, and Mostadam); (2) a critical comparative analysis; and (3) a synthesis of the findings, in order to establish a new SAS plan or framework for the use across the GCC. The process of selecting the known GCC SAS involved a number of processes (i.e., revisiting the official website to select GCC official tools and download the detailed manual

of each scheme) to facilitate the undertaking of a detailed comparative analysis. In addition, the critical analysis was designed to include the key elements required for developing applicable systems, including (1) SAS categories; (2) SAS criteria; (3) supporting building codes and standards; (4) computer-aided software; and (5) the rating system.

4. Findings and analysis

The findings of this study identified that the GCC countries have now begun to establish effective methods of recognizing the benefits of applying sustainable building criteria for their built environment. Various schemes have been adapted, with LEED being widely used by the GCC construction industry and so viewed by many organizations and individuals to be the most effective assessment tool available. However, LEED remains an international rating system lacking an objective-basis to ensure it can be considered fully appropriate for any given region. This section, therefore, critically assesses LEED's categories in relation to local assessment systems within the GCC. This section is divided as follows: (1) the development of well-known GCC schemes, along with assessment categories and weighting systems; (2) LEED assessment categories and weightings; (3) the strength and weakness of LEED; and (4) proposed plans to enhance the assessment of green buildings within the GCC region.

4.1. GCC building assessment schemes

There are a number of different assessment schemes for SD within GCC. This section examines the most cited and well-known schemes. The review

revealed that the Gulf has a large number of assessment schemes in place, including; (1) Estidama; (2) SEAM; (3) GASA; and (4) Mostadam. The key findings of these assessment categories are discussed in detail below.

4.1.1. Estidama (Abu Dhabi 2010)

The government of Abu Dhabi is currently in the process of preparing for future challenges by means of an ambitious 2030 vision for sustainable development. A comprehensive system has been created, containing various criteria the Abu Dhabi government aspires to implement as part of both current and future plans. These employ the principle of SD as the basis for any new development taking place in the Emirate. The capital of Abu Dhabi has developed the Pearl Rating System as a key method of promoting SD in the city. This is a green building rating system developed under the Estidama initiative, capable of being applied to communities, buildings, and villas, with different requirements for each, noted on a scale from 1 to 5 pearls. The Pearl Rating System seeks to apply the development of sustainable practice and improve the quality of life in this Emirate. Fig. 1 reveals that The Pearl Rating System is comprised of a set of assessment categories. Firstly, energy, which aims to promote the application of energy efficiency and the use of renewable energy. Secondly, water, followed by criteria relating to the use of materials and the natural system, in order to reduce unwanted waste and encourage the use of local materials, so as to improve the supply chains and maximize the use of sustainable products and recycled materials (Estidama, 2020).

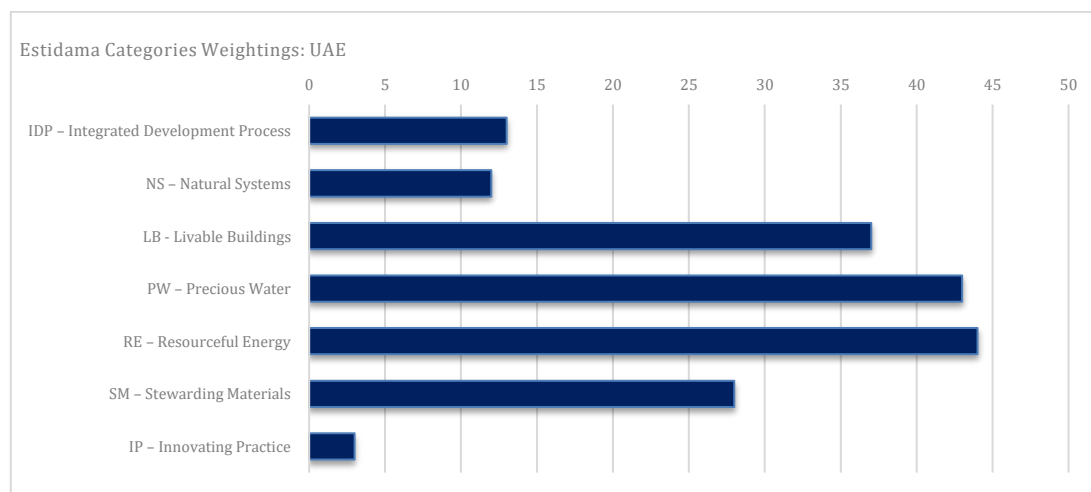


Fig. 1: Estidama assessment categories

4.1.2. SEAM (Saudi Arabia 2011)

The Sustainable Environment Assessment Method (SEAM) was developed by Cardiff University in 2011 as part of a Ph.D. funded scholarship. It promotes sustainable development practices in

Saudi Arabia's construction industry, taking account of various sustainable building categories, including energy and water efficiency, materials, transportation, and other building performance indicators. Fig. 2 illustrates the main categories of SEAM. This reveals that water efficiency is the

highest priority category of sustainable indicators, followed by the remainder of the categories, which

are presented in descending order of significance (Alyami et al., 2013).

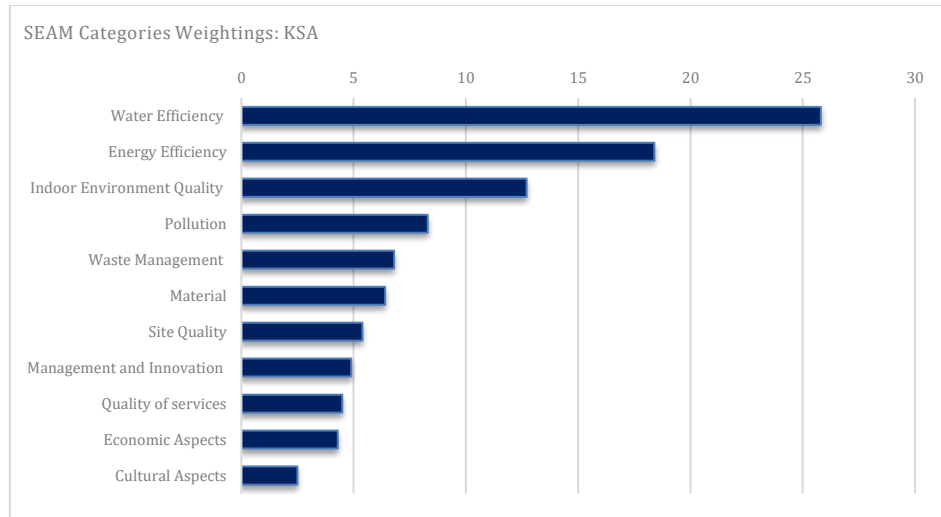


Fig. 2: SEAM assessment categories

4.1.3. GSAS (Qatar 2010)

Gulf Organization developed the Global Sustainability Assessment System (GSAS) (formerly known as QSAS) for Research and Development (GORD, 2020) in 2010, in collaboration with the T.C. Chan Centre at the University of Pennsylvania. GSAS aims to create a sustainable urban environment focused on reducing the environmental impact of

buildings, while simultaneously satisfying local community needs. Fig. 3 demonstrates that GSAS awards greater importance to categories related to water and indoor environment quality. This takes a separate approach to the assessment of energy and materials to the local GCC assessment method (GORD, 2020).

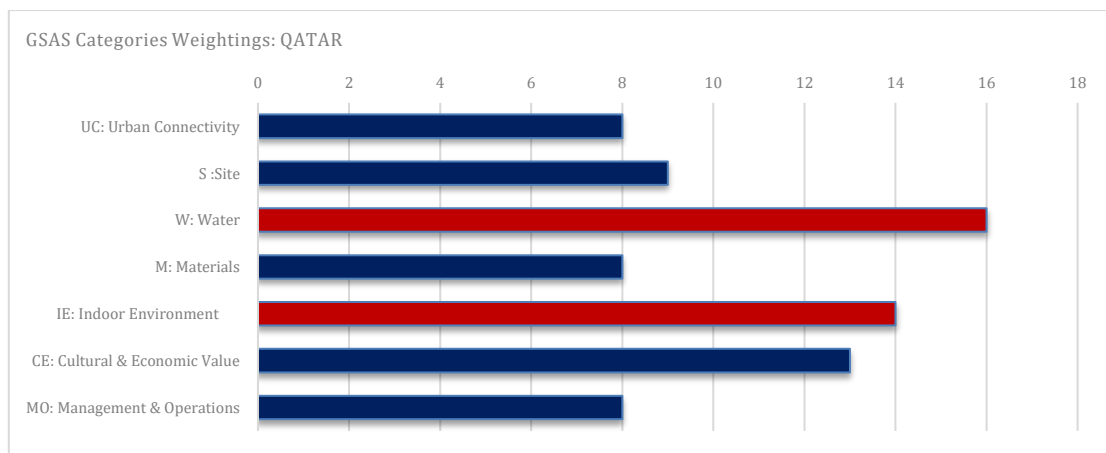


Fig. 3: GSAS assessment categories

4.1.4. Mostadam (Saudi Arabia 2020)

The Ministry of housing in Saudi Arabia has launched Mostadam as a sustainable construction program, with the aim of providing holistic assessment for a number of services contributing to the sustainability of housing units across Saudi Arabia. This program proposes to examine construction quality, prefabricated buildings, and offer a building sustainability assessment scheme. As illustrated in Fig. 4, energy and water are viewed as the most important of the sustainability categories, followed by health and comfort and criteria related to the location and transportation. In addition, Mostadam criteria include some categories of

cultural aspects, along with policy and management (Mostadam, 2020).

4.2. LEED assessment categories

LEED assessment categories and criteria have been developed based on the consensus established by a panel of experts in green and sustainable practices within the construction industry. As illustrated below in Fig. 5, higher weights and credits are given to both energy and atmosphere, indicating that LEED tends to focus on the efficiency of a building. This is followed by the related services (i.e., transportation), potentially due to the impact of energy production and supply on the environment.

The health and wellbeing of occupants also form a key element of LEED, being assessed under the category focussing on the quality of the indoor environment. Water and materials are placed in the

second level categories of the LEED assessment, followed by innovation and regional priority (USGBC, 2014).

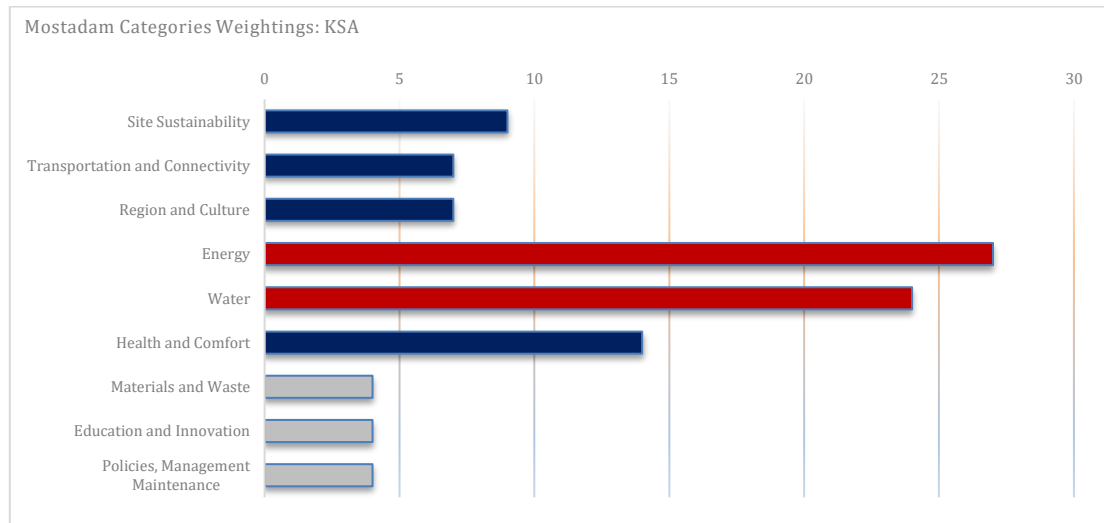


Fig. 4: Mostadam assessment categories

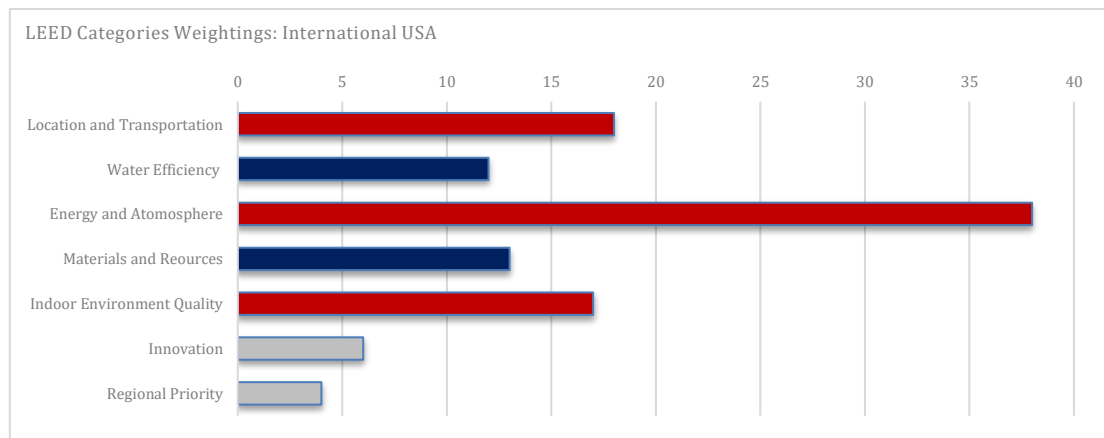


Fig. 5: LEED assessment categories

4.3. The proposed framework to enhance sustainability assessment in the GCC

LEED can be viewed as inappropriate for global use, due to each region having its own specific environmental, economic, and social aspects, resulting in the need to consider a number of relevant factors. The assessment categories are essential to SAS but are presented in different ways by well-known assessment schemes such as LEED and BREEAM. This can lead to differences in the weighting of a set of criteria listed against building techniques and practices. More significantly, the assessment criteria can lack any relevant basis and consistency of approach, being evaluated in a collective manner and fed into the final rating by SAS. Undertaking such sustainability assessments without first establishing well-defined and consistent criteria and weighing systems can lead to inaccuracies, a lack of faith in the results, and ambiguous assessments. This paper suggests, therefore, suggests that GCC assessment categories should be identified based on criteria that are both

consistent and related and fall within four different schemes:

- Scheme A: Scientific category.
- Scheme B: Construction management category.
- Scheme C: Economics category.
- Scheme D: Social aspects category.

These are discussed in detail in the following section. Fig. 6 shows the sustainability assessment criteria framework.

A. Scheme A (Scientific Category): This refers to building science, transport theory, and the science of hydrology, which are applied by sustainability assessment tools to quantify building and environmental performance. These facilitate the creation of a method of evaluating buildings based on a specific quantity, i.e., heat transfer and thermal mass form key indicators of the performance of green buildings. The performance of each aspect of an individual building can, therefore, be assessed, enabling it to be calculated and modeled in a virtual manner, in order to establish its heat transmittance

value (u-value). This can, in turn, provide the assessor with the specific value of CO₂ emissions, enabling the awarding of a rating score. Transportation theory is also based on the calculation of GHG emitted through different modes of transport, in conjunction with the length of the journey. It is, therefore, significant to state that the assessment method has a scientific origin, thus eliminating the degree of subjectivity in the assessment process and final rating. This indicates that it is ineffective to combine all assessment criteria into one scheme, with the aim of providing a single rating for the performance of the entire built environment. This practice can be found in the assessments made by LEED and other global methods, which have been heavily criticized for their lack of objectivity. This confirms that it is ineffective to combine criteria related to scientific basis with

that focus on social and management aspects in order to create establish a final decision when it comes to the assessment of buildings or neighborhoods. There are particular difficulties in creating a single rating score by means of the criteria measuring energy and water through the calculation of scientific equations, followed by merging the results with the social criteria concerning the method of assessing construction management. This section has indicated the need for separate environmental and building assessment criteria, based on the common and desired bottom line of the assessment. In addition, the bottom line of the scientific category concerns the reduction of GHG emissions, thus forming the benchmarking and reference level for the award of credits to the building under evaluation.

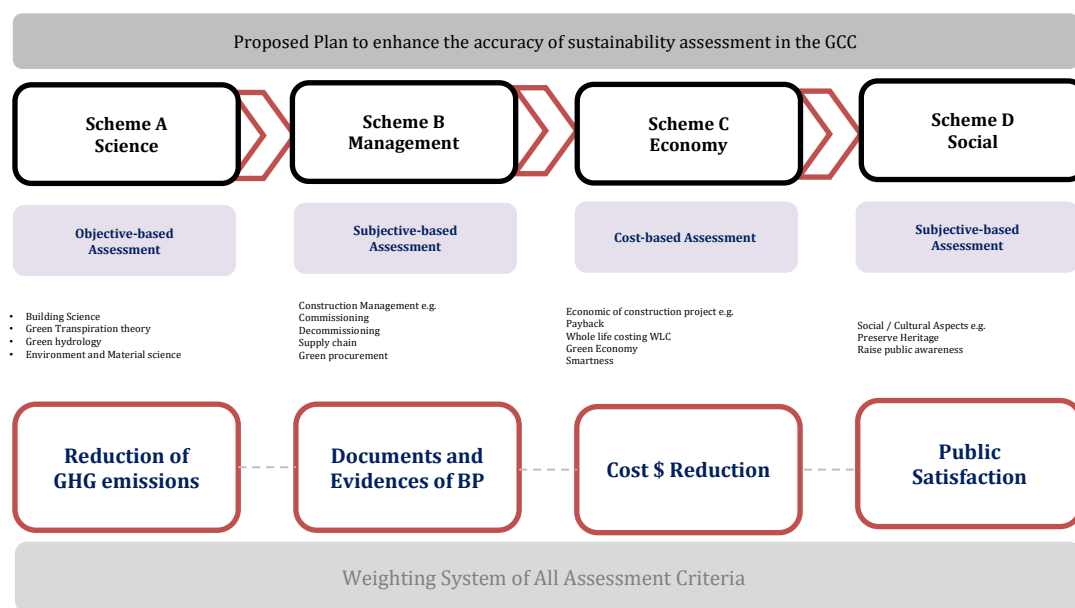


Fig. 6: Sustainability assessment criteria framework

B. Scheme B (Construction Management Category): It is vital in the construction industry to carry out projects following specific measurements and practices in order to meet the desired quality objectives. For instance, important aspects of construction management include (1) commissioning and decommissioning; (2) the supply chain; and (3) green procurements. When it comes to the issue of the assessment of buildings, these aspects of construction management cannot be completely quantified, but are based on evidence such as bills or contract and maintenance agreements. Thus, this vital aspect of the assessment is based on evidence-based assessment. This research, therefore, suggests that all practices related to construction management should be evaluated separately, according to a comprehensive checklist of all relevant criteria supporting SD.

C. Scheme C (Economics Category): Construction economics forms a further significant category, in which all practices are converted into a cost-based evaluation. The complete lifecycle WLC of a building (i.e., the payback period and other significant

financial factors) can be used to assess the built environment against sustainable criteria. It should be noted that financial considerations form a key element of the ability to enhance sustainability. Economic factors exert a significant impact on both developing and developed nations. In the developed world, nations aim to reduce the ecological harm of buildings by maintaining living standards at a high level. However, such living standards are considerably lower in the developing world (Cole and Valdebenito, 2013). This clarifies that economic issues are of greater urgency for developing nations than maintaining a high level of green building and its ecological values. Nonetheless, leading assessment schemes (i.e., LEED and BREEAM) exclude any financial evaluation from their categories, criteria, and compliances. This opposes concepts examining the value of sustainable development, as economic returns are crucial for all actions, and environmentally friendly actions remain costly to implement.

D. Scheme D: Social aspects Category: The attitude, culture, and willingness of a population form the key

drivers of successful schemes. The concept of many assessment criteria has the potential to enable such schemes to surpass their role as a design or assessment tool. For example, key motivating factors ensuring the success of assessment schemes (i.e., meeting the overall objective of (SD) include tackling issues such as financial returns, public awareness, and a willingness to heed to further sustainable development (Beyaz and Asilsoy, 2019). This leads to the conclusion that it is unreasonable to merge social criteria with that of building science. The proposed plan of this current study, therefore, aims to establish a scheme capable of ensuring the inclusion of all related aspects of social criteria.

4.4. Discussion

According to a comprehensive review by Doan et al. from 1998 to 2017, well-known green or sustainable rating schemes have been mentioned in around 400 papers in world-class journals. Most of these publications were conducted to compare and explore similarities, differences, and strengths, weaknesses of international building rating schemes such as BREEAM and LEED (Doan et al., 2017; Suzer, 2015; Awadh, 2017; Wu et al., 2017; 2016). It can be argued that one scheme is better than other according to its use and adaptations across the world, and also according to its number of certified buildings or the assessed areas of neighborhoods (Mao et al., 2009; Thilakaratne and Lew, 2011). Some previous works were taken a different approach by studying the main categories and criteria that constitute these rating schemes, with particular focus on energy, water, and material emphasizing its role of eliminating the risk of global warming and environmental degradation (He et al., 2018). In some studies, one particular category, e.g., energy efficiency, is further investigated to find out the environmental and economic benefits of applying its technical criteria (AbdelAzim et al., 2017; Alyami, 2019).

In addition, the process of establishing and customizing these rating schemes was also a key topic in the literature review. For instance, various papers were conducted to explore the methodology of developing these rating schemes (Al Khalifa, 2019; Suzer, 2019). Concluding that these rating schemes were built based on the deliberation of experts with the goal of reaching the consensus on the main criteria and its allocated credits or weighting system (Alyami and Rezgui, 2012).

In contrast to previous works, this study in hand is unique because it took a critical and in-depth analysis of the assessment criteria with the purpose of establishing more consistent and correlated criteria as it is inaccurate and misleading to combine subjective-based criteria with objective-based criteria to provide one single rating expression that reflects the environmental performance of one certain building or neighborhood. In this case, this study proposes a development framework to improve the evaluation of our built environment.

5. Conclusion

This paper has established that international SAS plays a crucial role in measuring levels of SD. Firstly, it highlighted LEED as an example of a global scheme customized for use in many countries throughout the world. Secondly, it identified the influence of LEED's philosophical and technical building assessment on the GCC region. Thirdly it discussed the fact that assessment criteria and the related weighting system are central to any such scheme. Fourthly, this paper found that both subjective and objective criteria have been merged into a single rating scheme (i.e., gold, silver and certified building assessment), followed by a critical examination of LEED and GCC assessment schemes to identify both strengths and weakness. The above exploration has resulted in the drawing up of a development framework for future improvements to the adapted GCC schemes. The key point of this proposed framework is the establishment of four separate assessment schemes. The first should be based on scientific evidence, the second on managerial evidence, and the third on economic evidence. The final scheme should be based on those on social factors affecting building expansion, along with any related infrastructure.

Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

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