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Research Article

Analyzing and Comparing Global Sustainability Standards: LEED, BREEAM, and PBRS in Green Building

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Since the year 2000, a heightened environmental awareness has led to the emergence of global trends in forefront countries, prompting the need for standardized practices in the environmental building industry. This paper explores various experiments on buildings, demonstrating trends through examinations and tests conducted by governmental or private organizations. Notable among these trends are the standards set by global evaluation systems such as BREEAM, LEED, PBRS, and SSBS. The paper highlights the recent adoptaion of Arab standards in Abu Dhabi, positioning the emirate as a pioneer in sustainable development. The research focuses on the city of Kirkuk, where building regulations lack consideration for environmental standards. The study aims to identify applicable international standards, emphasizing the importance of residential standards in comparison to other criteria. The World Green Building Council's universal standards for existing buildings are discussed, with the recognition that these standards may need customization to align with the local environment and architectural characteristics of Kirkuk. The paper delves into the methodology used, employing a theoretical framework, analytical methodology, and a deductive approach to formulate recommendations tailored to meet local standards. The Abu Dhabi experience with the Pearl Rating System is explored, outlining its three evaluation stages and the specific criteria for building assessment. A comparison between sustainability standards reveals disparities in evaluation criteria, emphasizing the challenge in establishing global standards. The study calls for a transparent and globally applicable evaluation basis, considering discrepancies among diverse countries and their respective tools. The paper concludes by underlining the importance of establishing local standards, serving as a benchmark for quality and operational efficiency within the real estate market. It also emphasizes the crucial role of existing residential buildings in proposed solutions for sustainable development, highlighting their significance in local markets.

1. INTRODUCTION

The fundamental principles of sustainability rest upon three pillars: environment, society, and economy. Most sustainability rating systems have been crafted in alignment with these pillars[1]–[3] . As outlined by Brundtland (1987), sustainable development entails meeting present needs while safeguarding resources for future generations[4][5]. Mateus and Bragança (2011) further define sustainable development as achieving the optimal balance among the environmental, social, and economic dimensions, fostering greater compatibility [6]. Discussions surrounding sustainable growth often revolve around strategies that span various temporal and spatial scales, drawing from current practices and future projections [6]. Tools for sustainability assessment play a crucial role in harmonizing these dimensions or pillars—environmental, social, and

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economic—and in bolstering practicality and resilience [7]. Hence, they should be adaptable to constant technological advancements and diverse application scenarios across different levels . Since the year 2000, there has been a growing awareness of the environment, leading to the emergence of several trends in the forefront countries [8]. The environmental building industry emphasizes the need for these trends to be standardized [9][10]. Various experiments on buildings, considering differences in their functions and classifications, have demonstrated these trends [11]. They have been observed through examinations and tests conducted by governmental or private organizations[12] . These assessments aim to analyze buildings, create lists, and propose solutions to enhance building effectiveness[13][14] . The evolution of these experiences has resulted in specific standards being imposed on property owners during registration, transfer, or maintenance activities[15]. Notable among these pioneering experiences are the following.

TABLE I. ASSESSMENT METHOD

No.	Global Standard	Assessment Method	Countries
1	Building Research Establishment Environmental Assessment Method	BREEAM	(UK Standards)
2	Leadership in Energy and Environmental Design	LEED	(US Standards)
3	Pearl Building Rating System	PBRS	(Abu Dhabi Standards)

Among these regulations are the Arab standards, recently ratified by the Abu Dhabi municipality, asserting that 80 of the percent current buildings in the emirate adhere to green standards[16]. This achievement positions the emirate as a pioneer in sustainable development at both regional and Arab levels[17]. The application percentage of green standards varies among buildings, with municipalities enforcing both mandatory and optional legislation to progress towards a green city in the upcoming years [18].These standards and practices extend beyond residential buildings, encompassing all building functions, including offices, schools, and markets [19]. Although the application of green standards originated with housing, it has gradually expanded to cover various building types[20]. Contrastingly, building regulations in Kirkuk lack consideration for these concepts, as they do not specify any environmental standards for buildings, and their provisions remain limited [21]. The objective is to contribute valuable insights into the dynamic and complex world of sustainability standards, with a specific focus on their application and adaptability in diverse global and local contexts, particularly in the city of Kirkuk and is to enhance the quality of social life within these buildings, preventing obsolescence caused by the evolving and growing needs of the population. This, in turn, underscores their importance in local markets.

2. RESEARCH PROBLEM

The World Green Building Council has established universal standards for existing buildings, with each country customizing these standards to suit its specific experiences and development capabilities within set limits[10], [22], [23] . Various countries, including Spain, Italy, and Australia, have introduced their own standards. However, the application of these standards in the city of Kirkuk for global buildings poses challenges, with some proving difficult to implement or failing to meet the required criteria[24] . As a result, there has been a need to tailor these standards to better align with the local environment and architectural characteristics of Kirkuk. It's essential to note that these standards are not fixed; they can evolve with the advancement of systems and environmental developments within the Kirkuk region[25] .It serves as an indicator and guide to the future design direction For buildings to reduce carbon emissions and use Energy in homes and waste disposal and save Precious Water .

2.1 Breeam, Leed, and Pearl

The Pearl Rating System, LEED, and BREEAM are all Total Quality Assessment (TQA) frameworks crafted to assess projects by considering prerequisites and optional credits across diverse categories [26][27]. BREEAM, originating in the UK in 1990, has expanded globally, including versions like BREEAM International for New Construction 2016[28]. Evaluation in BREEAM is quantified as a percentage of success out of total available points, spanning categories like Management, Health & Wellbeing, and Energy[29][30] . LEED, established by the US Green Building Council in 1998, enjoys global recognition and offers certification levels (Certified, Silver, Gold, Platinum) determined by meeting point thresholds across seven evaluation categories [31]. LEED version 4 for New Construction is the latest iteration [32] .The Estidama Pearl Rating System, introduced by the Abu Dhabi Urban Planning Council in 2010, amalgamates elements from LEED and BREEAM while tailoring them to local requirements[33] . Certification levels range from 1 Pearl to 5 Pearl, with points allocated across eight categories, totaling 180 available points.

2.2 A hallmark of excellence

Establishing local standards creates a standardized benchmark that dictates the quality and operational efficiency within the real estate market[34] . These metrics offer crucial insights to potential buyers, aiding them in making informed decisions when purchasing a home[35] . Moreover, it serves as an indicator of distinctive quality, setting certain real estate companies apart from their peers [36]. This research will offer a concise overview, emphasizing the paramount importance of residential standards in comparison to other criteria.

3. RESEARCH IMPORTANCE

than be seen as part of the problem. Disregarding the current residential fabric would mean overlooking a significant aspect of the population's heritage and daily life. Therefore, our current homes should actively play a role in the proposed solutions aimed at addressing the ongoing changes. If these existing models fail to be part of the solution, they inherently become part of the problem. The primary objective is to enhance the quality of social life within these buildings, preventing obsolescence caused by the evolving and growing needs of the population. This, in turn, underscores their importance in local markets.

2.3 Standards for the design and construction process

Building regulations in Kirkuk city must include, such as These standards, especially in terms of achieving the minimum limits imposed on buildings. So these metrics will be It serves as an indicator and guide to the future design direction For buildings to reduce carbon emissions and use Energy in homes and waste disposal and save water.

2.4 Methodology used in the research:

Theoretical Framework: Employed for identifying the criteria under examination, with a subsequent application in research elucidating its fundamental principles. Analytical Methodology: Utilized in the examination of chosen systems, facilitating a comparison to ascertain their applicability within our country. Deductive Approach: Rooted in the analytical scrutiny of a given situation, leading to the formulation of recommendations tailored to meet the standards of the local region.

2.5 Abu Dhabi experience and pearl rating system (Pearl Rating System PRS)

The inaugural Arab standard for building sustainability, fashioned after LEED (Leadership in Energy and Environmental Design), underwent modifications to align with the cultural and civilizational context of Abu Dhabi city [37] . This standard was officially announced in 2008 by the Abu Dhabi Urban Planning Council[38]–[40] . The assessment criteria are tailored to the scale of the project, categorized as follows, Pearl Rating System for Urban Complexes, Pearl Rating System for Buildings, Pearl Rating System for Villas.

4. PEARL RATING SYSTEM FOR BUILDINGS

The Executive Council decision issued in 2014 mandated that new buildings, starting from 2010, must adhere to specific criteria for evaluation[41][42]. To obtain an evaluation, buildings must meet a minimum of one pearl, with government buildings requiring a "two pearl" grade[43]. Subsequent to this decision, the criteria of the Pearl Rating System for buildings were amalgamated with the Abu Dhabi International Building Code[44]. This amalgamation encompasses various building uses, including offices, commercial markets, residential floors, and mixed-use spaces, providing a comprehensive framework for evaluating and regulating building standards[45] . The construction of the Pearl System unfolds through three distinct stages: Pearl Design Rating,Pearl Construction Rating, Pearl Rating for Operation, The Pearl classification system encompasses two types of points: Mandatory Points: Reflecting the requirements set forth by the Abu Dhabi Council[46]. Optional Points: Aimed at enhancing the building's environmental performance[47]. This system is anchored in seven fundamental elements to achieve sustainability[48] . Refer to Table 2 and Table 3 for an elucidation of these points and their respective importance.

TABLE II. TABLE SHOW THE FINAL ASSESSMENT ACCORDING TO PBRS CATEGORIES

Category		Final Assessment level	Maximum points	minim points
1	Integrated Development Process	According to PBRS categories : This system is based on seven basic items to achieve Sustainability	13	7
2	Natural Systems		12	7
3	Livable Buildings		37	21
4	Precious Water		43	23
5	Resourceful Energy		44	24
6	Stewarding Materials		28	16
7	Innovating Practice		3	2

TABLE III. TABLE MANDATORY POINTS AND OPTIONAL POINTS ACCORDING TO PBRS ASSESSMENT

Level	Mandatory Points+ Optional Points	Number of pearls
1	Mandatory Points	1
2	Mandatory Points+60	2
3	Mandatory Points+85	3
4	Mandatory Points+115	4
5	Mandatory Points+140	5

5. RESULT AND ANALYSIS

Sustainability rests on three fundamental pillars: economic viability, social responsibility, and environmental conservation[49] . Achieving equilibrium among these components—referred to as the triple bottom lines—ensures the fulfillment of current and future population needs[50] . A sustainable society secures a quality life for all its members by harmonizing plans, expenditures, and resource consumption across time and space[51] . This balance precludes any single aspect from thriving at the expense of others[52]. For instance, proposed energy-saving methods must not only be cost-effective but also environmentally benign to be deemed truly sustainable[53]. Furthermore, sustainability should elevate societal standards, providing a luxurious, comfortable, and socially acceptable way of life.

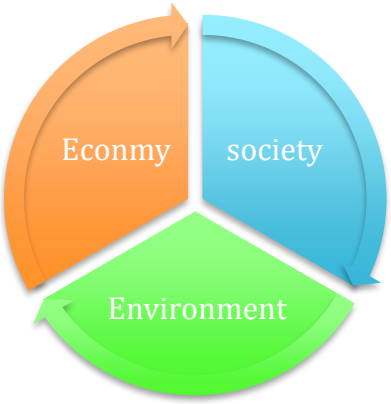


Fig. 1. Fundamental Pillars

Sustainability standards serve as instruments for gauging the sustainability of specific structures by assessing various elements and components[54]. Through specific experiments, calculations, and questionnaires, a comprehensive evaluation is conducted, yielding a final assessment for the entire building[55] . Diverse factors such as life expectancy, environmental conditions, climatic regions, and societal needs contribute to variations in the requirements and clauses of each standard[56]. This diversity has complicated the establishment of universal standards for investigation, given the distinct parameters involved [57].In this study, the comparison process focused solely on sustainability aspects, excluding considerations of implementation mechanisms and associated costs required for obtaining certification[57] [58].Examining the previous table reveals a lack of uniformity and a distinct starting point among preceding systems, particularly in the evaluation criteria. Notably, building code standards in the United States appear lower compared to those in the Kingdom. This discrepancy underscores the challenge in establishing global standards, as adopting any one standard may result in lower property classification in certain countries compared to adherence to locally tailored systems[59]. A study in 2008 confirmed the existence of significant differences among the preceding systems, including variations in the rating levels themselves[60]. For instance, the platinum level in LEED contrasts with the four pearls in Pearl and the fifth level in BREEAM , emphasizing disparities in sustainability attributes and environmental impact assessment[61]. Notably, a building in the United Kingdom obtained a higher rating when assessed against the UK standard than when appraised using the BRE Prime standard[62]. The call for a transparent and globally applicable evaluation basis becomes evident, considering the discrepancies observed[63]. The preceding analysis, rooted in diverse countries with distinct standards and characteristics for each tool, prompts the next step: a direct comparison of key evaluation criteria and their relative importance, quantified as a percentage.

TABLE IV. TABLE OF COMPARISONS BETWEEN STANDARDS

Criteria for Evaluation	BREAM	LEED	PEARL
Administration	10	2	7
Energy	36.4	28	24
CO2			
the health	14	15.5	13
Internal environment			
creativity and innovation		8	2
natural environment	12	16.2	7
Land use			
Materials	7.2	12	16
Excrement	6.4		
pollution	2.8		23
Transport		7.3	
Water	11.2	11	23

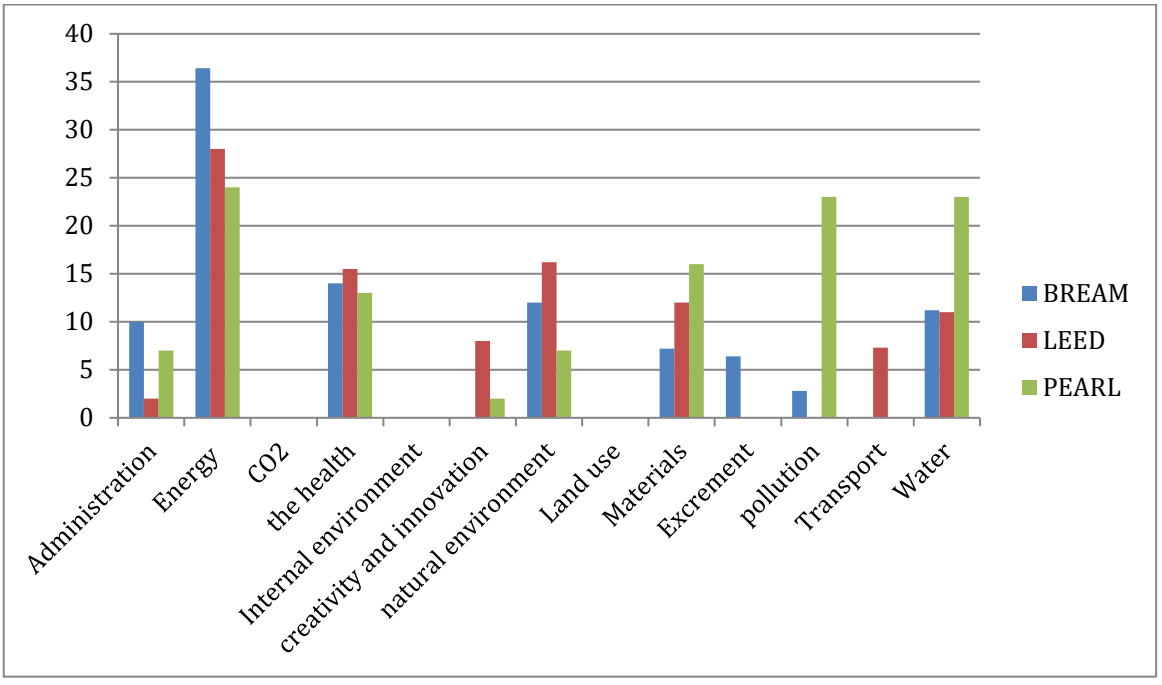


Fig. 2. BREAM LEED PEARL comparition

Upon reviewing the preceding table, it becomes evident that the BMREA standards are the most rigorous, particularly in relation to energy, carbon emissions, pollution, and waste. This alignment closely mirrors the environmental landscape within the UK[64]. Turning our attention to water, the scarcity of these resources is notable, with minimal rainfall and an absence of noticeable waterfalls or rivers[65]. The Pearl stands out as the strictest in this aspect[66].

The prevailing notion regarding LEED is that its prerequisites are typically less demanding compared to those of BREEAM[67]. BREEAM's objectives are often viewed as detailed, clear, and directly tied to particular solutions[67][68]. In contrast, LEED tends to leave the solution to the discretion of the designer, necessitating more rigorous calculations and consequently more effort to attain certification and assessment. In this regard, the Pearl system aligns more closely with LEED than with BREEAM. While Pearl draws from LEED, it cannot be applied interchangeably with LEED in the United States and vice versa. This limitation arises because LEED's measurement standards and methodologies are rooted in Western lifestyles.

For instance, within the Site Sustainability (SS) criterion, adherence to LEED guidelines is essential. Points can be attained by developing areas near transportation hubs and public/community services, prioritizing these over building in regions abandoned or earmarked for reuse. Additionally, avoiding construction near rainwater streams is emphasized, with Pearl standards dictating a maximum annual rainfall rate of 5 mm.Differences arise in how the standards articulate the significance of each element. Some require confirmation of item achievement for licensing purposes, even if points not explicitly listed in the table are pursued[69-71]. Below is a comparison of key (mandatory) elements across the three standards, which are crucial across all certification levels worldwide.

M1: An essential element in all evaluation levels

M2: Minimum limits for each level

TABLE V. TABLE OF PBRS ASSESSMENT

NO	Evaluation points	BREAM	LEED	PEARL
1	Administration			
2	Energy	M2		M1
3	CO2			
4	The Health	M2	M1	M1
5	Internal environment			
6	creativity and innovation			
7	natural environment		M1	
8	Land use			
9	Materials	M1	M1	M1
10	Excrement	M1		
11	pollution			
12	Transport			
13	Water	M1	M1	M1

The Pearl System comprises three evaluation stages. The initial stage involves the Pearl standards' role in project creation, followed by the second stage, and ultimately, the third and conclusive stage—the operational pearl grading system. This grading system applies a minimum 80% resident validation of the construct assessment after two years of building occupancy. During this phase, the Pearl System exhibits a greater alignment with LEED than with BREEAM, which operates on a two-stage basis—encompassing the Design stage and the post-construction stage, unless sought during design and construction.

Pearl standards are adaptable for use in the design phase, ensuring that the project design, as assessed by Pearl's Design Rating, aligns with the objectives of the Fifth Star Sustainability Program. This approach introduces additional obligations to meet the sustainability criteria.

6. CONCLUSION

This global analysis and comparison of sustainability standards illuminate the dynamic landscape of environmental practices within the building industry since the turn of the century. The heightened environmental awareness has spurred global trends, prompting the establishment of standardized practices. Key global evaluation systems, including BREEAM, LEED, PBRS, and SSBS, have played pivotal roles in shaping these practices. The recent adoption of Arab standards in Abu Dhabi positions the emirate as a pioneer in sustainable development, particularly with an impressive 80% adherence to green standards.

The focus on the city of Kirkuk, where building regulations lack environmental considerations, underscores the need for international standards. The study emphasizes the importance of residential standards, recognizing them as crucial benchmarks for quality and operational efficiency in the real estate market. The World Green Building Council's universal standards are acknowledged, with a recognition that customization is essential to align with local nuances.

The methodology employed, incorporating a theoretical framework, analytical methodology, and a deductive approach, facilitates tailored recommendations for local standards in Kirkuk. The Abu Dhabi experience with the Pearl Rating System exemplifies adaptability and offers insights into sustainable development. However, a comparison across global sustainability standards reveals disparities, accentuating the challenge of establishing universally applicable evaluation bases. The call for transparent and globally applicable evaluation criteria arises from the observed discrepancies among countries and their respective tools. Despite variations, the study advocates for local standards, crucial for enhancing social life and preventing obsolescence in existing buildings. Residential standards are underscored as paramount, surpassing other criteria in significance within local markets. The comparison of key evaluation criteria among BREEAM, LEED, and

PEARL emphasizes the need for equilibrium in sustainability pillars: economic viability, social responsibility, and environmental conservation. The variation in standards across different countries highlights the complexity in establishing universal standards, calling for a transparent and harmonized evaluation basis .In essence, this study contributes valuable insights into the challenges and opportunities associated with global sustainability standards, urging for a balance between international benchmarks and tailored local practices. As we move forward, the emphasis on sustainable development must be harmonized globally, acknowledging regional variations and fostering a transparent and inclusive approach to evaluation criteria.

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Conflicts Of Interest

The author's paper explicitly states that there are no conflicts of interest to be disclosed.

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