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ORIGINAL

A comparative study on sustainability assessment level (BREEAM, LEED, and Estidama) to develop better environment sustainability assessment

Un estudio comparativo sobre el nivel de evaluación de la sostenibilidad (BREEAM, LEED y Estidama) para desarrollar una mejor evaluación de la sostenibilidad medioambiental

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ABSTRACT

The terms "Sustainability" and "Green Building" have become concepts of widespread interest. As a result, the research and development of sustainability standards and rating systems became an international trend. This paper evaluated three sustainability assessment standards to develop an overall assessment standard that can be applied worldwide. BREEAM, LEED, and Estidama were chosen as standards, and a scoring system for the developed method was proposed. A proposed assessment method (PAM) was developed with the following factors: energy (23 %), water (15 %), materials (15 %), indoor quality (14 %), land use, ecology, and management (10 %), outdoor quality (9 %), and finally innovation (4 %).

Keywords: Green Building; Traditional Buildings; Sustainable Architecture; International Rating Systems; Energy Efficiency; Sustainability; Rating System.

RESUMEN

Los términos "sustentabilidad" y "construcción ecológica" se han convertido en conceptos de gran interés. Como consecuencia, la investigación y el desarrollo de normas y sistemas de calificación de la sustentabilidad se convirtieron en una tendencia internacional. En este trabajo se examinan tres normas de evaluación de la sustentabilidad con el fin de desarrollar una norma de evaluación global que pueda aplicarse mundialmente. Se eligieron como estándares BREEAM, LEED y Estidama, y se propuso un sistema de puntuación para el método desarrollado. Se elaboró una propuesta de método de evaluación (PAM) con los siguientes factores: energía (23 %), agua (15 %), materiales (15 %), calidad interior (14 %), uso del suelo, ecología y gestión (10 %), calidad exterior (9 %) y, por último, innovación (4 %).

Palabras clave: Construcción Ecológica; Edificio Tradicional; Arquitectura Sustentable; Sistemas Internacionales De Clasificación; Eficiencia Energética; Sustentabilidad; Sistema De Clasificación.

INTRODUCTION

Today, the key concern in architecture revolves around sustainability factors. However, the concept of sustainability cannot be applied to all regions, environments, and human identities worldwide. For example, Laugier's print of the primitive hut has symbolically driven us to rethink architecture.[1]

The father of modern architecture has stressed that architects "do not go against nature—follow nature" (Frank Lloyd Wright, a famous quote from his book - The Natural House). Other architects have also started to examine the meaning of architecture for human habitats, such as Doxiades, Paolo Soleri, and Gaudi, to name a few, which mirrors Western contexts.[2] However, people have already experienced their livelihood in dealing with shelter.[3]

Although in the beginning, humans exploited the naturally existing building materials around them to build shelters, the notion of constructing shelters with materials and creating the masses that meet people's needs remains challenging. Nowadays, the desired goals of architecture are to fit the environment and create a peaceful harmony with the surrounding natural elements.[4]

Traditional buildings have certainly achieved many sustainability principles in ecological, environmental, and economic aspects. In addition, these buildings contributed to energy-saving and promoted appropriate technology that has been discussed by Abdelfattah (2020).[5]

The appropriate technology concept can be defined as a movement that includes technological options and applications that are decentralized, small-scale, labor-intensive, environmentally sound, energy-efficient, and locally autonomous.[6]

Although these ideas cannot be accepted based on the school of architecture guidelines, they have become an alternative "School of Thought" in architecture. Architects, including Hassan Fathy, John F. Turner, Habraken, Nabeel Hamdi, and Rapoport, attracted much attention when presenting an innovative vision of sustainability through appropriate technology.[7]

In this study, three sustainability assessment standards are selected to develop a better overall assessment standard that can be applied to more than one region. These selected systems include: The BREEAM, i.e., the U.K.'s Building Research Establishment Environmental Assessment Method; Energy and Environmental Design Leadership; and Estidama Rating System.

Sustainable Architecture

Sustainable buildings are those that have the least negative impact on the natural and built environments;[8] this can be seen in the building itself, its immediate surroundings, and broader regional and global settings. Also, sustainable buildings are characterized by their building practices. These practices strive for the building's integral quality, or, in other words, how these buildings perform economically, socially, and environmentally from a broader perspective.[9]

As a result, rational use of precious natural resources combined with prudent management of the building stock can preserve scarce resources, reduce energy consumption rates, and improve environmental quality. According to the devised OECD project, five main objectives have been established to build sustainable buildings, as follows:[10]

1. Efficiency of resources.
2. Energy efficiency, which involves reducing emissions of greenhouse gasses.
3. Pollution avoidance, which involves noise abatement and quality of indoor air.
4. Environment harmonization.
5. Systematic and integrated approaches.

Furthermore, sustainable building considers the entire life of the building, including functional quality, environmental quality, and future values.[11,12]

Sustainable architecture takes into account all specializations in order to create the most effective building, ensuring minimum energy consumption, utilizing available resources, and meeting the needs of future generations.[13]

Criteria for Sustainable Architecture

In 1992, the Rio de Janeiro Earth Conference, a key collaboration platform in Rio de Janeiro, Brazil, was held to address issues related to sustainability.[14] These issues, which were addressed and debated at this summit, include:

- Local materials' utilization, in addition to indigenous building resources.
- Incentives for promoting the use of traditional techniques, regional resources, and self-help approaches.
- Management of design principles that are energy efficient.
- Universal information exchange comprises environment-related construction aspects, contractors, architects, and nonrenewable resources.
- Assessment of recycling methods to encourage reusing building materials, particularly those that require intensive energy during manufacturing, and the use of clean technologies in production.[15]

Based on the preceding points, the following specific criterion for sustainable building can be developed:

1) The use of local materials

Sustainable buildings can save great amounts of energy from an economic point of view. Furthermore, using existing materials in the construction will reduce the need for importing materials, lowering the overall construction cost. Using local materials, however, should consider the needs of future generations.

2) The use of traditional techniques in architecture

Trust in the methods used by old builders, as well as the solutions they invented to achieve the best results in architecture, is required for sustainability. They have used traditional construction techniques and strategies, including local materials, which help maintain sustainable architecture by considering the environmental needs and properties.

3) Applying the energy efficiency regulations

Preserving the earth's resources is the most important issue regarding sustainability. As a result, a sustainable building should use the least amount of energy during its lifetime and construction. Thus, the rational use of materials and the perfect orientation will help maintain levels of energy efficiency. Furthermore, a sustainable design for both facilities and infrastructure will consequently avert the destruction of the ecosystem.

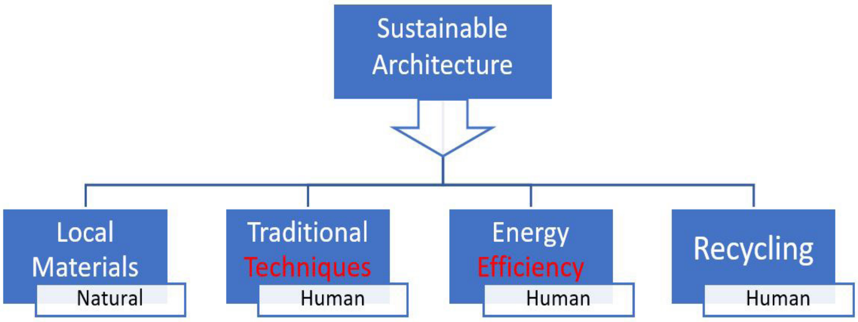

Figure 1. Sustainable Architecture Factors

A Review of the Selected Sustainability Assessment Methods

The Building Research Establishment Environmental Assessment Method (BREEAM)

This method, referred to as the BREEAM assessment method, has been launched in the U.K. BREEAM is regarded as the first established rating scheme for sustainability in the built environment. It has emphasized sustainability in building construction, design, and use.(16)

This assessment method has become a universal guideline, operated by a group of international assessors, operators, and industry professionals. The use of BREEAM universal standards will assist clients in measuring and reducing potential influences on the built environment. This will eventually contribute to lower rates for risky assets and a higher building value. These universally accepted guidelines are used in over 50 countries to validate over 260,000 assessments throughout the building's life cycle.(17)

Table 1 shows BREEAM rating benchmarks, while Table 2 shows BREEAM assessment and rating system areas.

Table 1. BREEAM rating benchmarks(18)

BREEAM Rating	% Score
Outstanding	≥ 85
Excellent	≥ 70
Very Good	≥55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

Table 2. BREEAM areas of assessment and rating system(19)

Area of Assessment	BREEAM AM				
	Credits 100	Score %	Sub-Areas of Assessment	Credits	% Score
Management	12	12 %	Project brief and design	4	33 %
			Life cycle cost and service life planning	4	33 %
			Responsible construction practices	6	50 %
			Commissioning and handover	4	33 %
			Aftercare	3	25 %

Health and Wellbeing	15	**15 %**	Visual comfort	Up to 6	40 %
			Indoor air quality	5	33,3 %
			Thermal comfort	2	13,3 %
			Acoustic performance	Up to 4	26,6 %
			Safety & security	2	13,3 %
Energy	15	15 %	Reduction of energy use and carbon emissions	12	80 %
			Energy monitoring	2	13,3 %
			External lighting	1	6,6 %
			Low carbon design	3	20 %
			Energy-efficient cold storage	2	13,3 %
			Energy-efficient transportation systems	3	20 %
			Energy-efficient laboratory systems	5	33,3 %
			Energy-efficient equipment	2	13,3 %
			Drying space	1	6,6 %
Transport	9	9 %	Public transport accessibility	Up to 5	55,5 %
			Proximity to amenities	Up to 2	22,2 %
			Cyclist facilities	Up to 2	22,2 %
			Maximum car parking capacity	Up to 2	22,2 %
			Travel plan	Up to 2	22,2 %
			Environmental impact materials	1	11,1 %
Water	7	7 %	Water consumption	5	71,4 %
			Water monitoring	1	14,2 %
			Water leak detection	2	28,5 %
			Water efficient equipment	1	14,2 %
Materials	13,5	13,5 %	Life cycle impacts	Up to 6	44,4 %
			Hard landscaping and boundary protection	1	7,4 %
			Responsible sourcing of materials	4	29,6 %
			Insulation	1	7,4 %
			Designing for durability and resilience	1	7,4 %
			Material efficiency	1	7,4 %
Waste	8,5	8,5 %	Construction waste management	4	47 %
			Recycled aggregates	1	11,7 %
			Operational waste	1	11,7 %
			Speculative floor and ceiling finishes	1	11,7 %
			Adaptation to climate change	1	11,7 %
			Functional adaptability	1	11,7 %
Land Use & Ecology	10	10 %	Site selection	2	20 %
			The ecological value of site and protection of ecological features	2	20 %
			Minimizing impact on existing site ecology	2	20 %
			Enhancing site ecology	2	20 %
			Long term impact on biodiversity	2	20 %
Pollution	10	10 %	Impact of refrigerants	3	30 %
			NO x emissions	Up to 3	30 %
			Surface water run-off	5	50 %
			Reduction of night-time light pollution	1	10 %
			Reduction of noise pollution	1	10 %
Innovation		10 %	Additional		

Leadership in Energy and Environmental Design (LEED)

Leadership in Energy and Environmental Design (LEED) is a green national certification system. This evaluation system has been established by the American USGBC. The Green Building Council has introduced this standard to stimulate sustainability building, or, in other words, establish healthy buildings to live in. These buildings should be resource and energy-efficient.[20]

This LEED certification is a universally recognized sustainability achievement. Therefore, it has been the most widely applied green system around the globe so far. It can be applied to buildings, homes, and community projects. LEED can provide a specified framework that aims to create green buildings characterized by being highly efficient, healthy, and cost-effective.[21]

Benefits and Characteristics of LEED

- LEED has been employed in more than 165 countries and regions. It is suitable for all sorts of buildings.
- It utilizes a more robust, performance-based method to achieve an enhanced environmental quality of the building, resulting in increased occupant comfort.
- The focal point of LEED is directed towards the utilized building materials to obtain a deeper insight into these materials and the impact of the components on the environment in general and on human health particularly.
- It emphasizes the advantages of clever grid thinking by providing credits for projects that participate in demand response programs.
- It evaluates overall building water utilization to provide a more vivid picture for achieving water efficiency.
- LEED-certified buildings conserve water, energy, and resources, produce less waste, and promote human health. As a result, such buildings appeal to tenants. Moreover, they are less expensive to run and increase employee retention and productivity.
- Every day, over 2,2 mil square feet of LEED-certified space is approved, with over 92,000 LEED-certified projects.[22]

According to LEED.[23] achieving more points means higher rewards. The LEED rewards are many, including providing healthier spaces for buildings and being cost- and energy-effective (Table 3).

The allocated points determine the degree of LEED certification a project achieves and receives. LEED introduces four certification levels, as follows:

- Certified (from 40 to 49 points)
- Silver (from 50 to 59 points)
- Gold (from 60 to 79 points)
- Platinum (80 points and above).

Table 3. LEED areas of assessment and rating system[23]

Area of Assessment	**LEED AM Method**				
	Credits 100	**Score %**	**Sub-Areas of Assessment**	**Credits**	**% Score**
Location & Linkages	10	10 %	Appropriate site selection	2	20 %
			Infrastructure efficiency	2	20 %
			Ease of access	3	30 %
			Land use efficiency	3	30 %
Sustainable Sites	13	13 %	Minimize site impact	Required	-
			Resource-efficient landscaping	5	38 %
			Shading of home site	1	8 %
			Surface water	5	38 %
			Poison	2	16 %
Water Efficiency	13	13 %	Water re-use	2	15 %
			Irrigation system	4	31 %
			Indoor use	6	47 %
Indoor Environmental Quality	14	14 %	Performance	10	72 %
			Combustion venting	Required	-
			Humidity	1	7 %
			Ventilation	2	14 %
			Containment control	1	7 %
Materials & Resources	16	16 %	Efficiency	2	12,5 %
			Local sources	5	31 %

			Durability	3	19 %
			Improved products	4	25 %
			waste	2	12,5 %
Energy & Atmosphere	29	29 %	HERS Rating **OR**	16	55 %
			Envelope	5	17 %
			Comfort systems	5	17 %
			Water heating	6	21 %
			Lighting	3	10 %
			Appliances	3	10 %
			Renewable	6	21 %
			Ozone	1	3 %
Homeowner Awareness	1	1 %	Guidance	1	100 %
Innovation & Design Process	4	4 %	Innovation in design	4	100 %

Estidama Rating System

Estidama is a sustainability rating system developed in the Middle East context, particularly in the United Arab Emirates (UAE). This Arab country is at the forefront of the Arab world's high-tech development. In Arabic, the word "Estidama" (Lit., Istidamah) is equivalent to "Sustainability".[24]

According to Abu Dhabi Urban Planning Council (2010),[25] Tables 4 and 5 show Estidama categories, assessment areas, and Credit Points.

Table 4. Estidama Categories and the credit distribution[25]

Estidama Categories	Maximum Credit Points
Integrated development	13
Natural and system	12
Livable building	37
Precious of water	43
Resource of energy	44
Steward and materials	28
Innovation and practices	3

Table 5. Estidama areas of assessment and rating system[25]

Area of assessment			Estidama AM Method		
	Credits 180	Score %	Sub-Areas of Assessment	Credits	% Score
Livable buildings outdoor	14	7,7 %	Improved Outdoor Thermal Comfort	2	14,2 %
			Pearl Rated Communities	1	7,1%
			Accessible Community Facilities	1	7,1%
			Active Urban Environments	1	7,1%
			Private Outdoor Space	1	7,1%
			Public Transport	3	21,4 %
			Bicycle Facilities	2	14,2 %
			Preferred Car Parking Spaces	1	7,1%
			Travel Plan	1	7,1%
			Light Pollution Reduction	1	7,1%
Integrated Development Process	13	7,2 %	Life Cycle Costing	4	30,7 %
			Guest Worker Accommodation	2	15,3 %
			Construction Environmental Management	2	15,3 %
			Building Envelope Verification	1	7,6 %
			Re-Commissioning	2	15,3 %
			Sustainability Communication	2	15,3 %

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Natural System	12	6,6 %	Natural Systems Protection	R	
			Natural Systems Assessment	R	
			Natural Systems Design & Management Strategy	R	
			Reuse of Land	2	16,6 %
			Remediation of Contaminated Land	2	16,6 %
			Ecological Enhancement	2	16,6 %
			Habitat Creation & Restoration	6	47 %
Livable Buildings: Indoors	23	12,7 %	Healthy Ventilation Delivery	R	
			Smoking Control	R	
			Legionella Prevention	R	
			Ventilation Quality	3	13 %
			Material Emissions: Adhesives & Sealants	1	4,3 %
			Material Emissions: Paints & Coatings	1	4,3 %
			Material Emissions: Carpet & Hard Flooring	1	4,3 %
			Material Emissions: Ceiling Systems	1	4,3 %
			Material Emissions: Formaldehyde Reduction	2	8,6 %
			Construction Indoor Air Quality Management	2	8,6 %
			Car Park Air Quality Management	1	4,3 %
			Thermal Comfort & Controls: Thermal Zoning	1	4,3 %
			Thermal Comfort & Controls: Occupant Control	2*	8,6 %
			Thermal Comfort & Controls: Modeling	2	8,6 %
			High-Frequency Lighting	1	4,3 %
			Daylight & Glare	2*	8,6 %
			Views	1*	4,3 %
			Indoor Noise Pollution	1	4,3 %
			Safe & Secure Environment	1*	4,3 %
			Minimum Interior Water Use Reduction	R	
Precious Water	43	23,8 %	Exterior Water Monitoring	R	
			Improved Interior Water Use Reduction	15	34,8%
			Exterior Water Use Reduction: Landscaping	8	18,6 %
			Exterior Water Use Reduction: Heat Rejection	8	18,6 %
			Exterior Water Use Reduction: Water Features	4	9,3 %
			Water Monitoring & Leak Detection	4	9,3 %
			Stormwater	4	9,3 %
Resourceful Energy	44	24,4 %	Minimum Energy Performance	R	
			Energy Monitoring & Reporting	R	
			Ozone Impacts of Refrigerants & Fire Suppression Systems	R	
			Improved Energy Performance	15	34 %
			Cool Building Strategies	6	13,6 %
			Energy Efficient Appliances	3	6,8 %
			Vertical Transportation	3	6,8 %
			Peak Load Reduction	4	9 %
			Renewable Energy	9	20,4 %
			Global Warming Impacts of Refrigerants & Fire Suppression Systems	4	9 %
Stewarding Materials	28	15,5 %	Hazardous Materials Elimination	R	
			Basic Construction Waste Management	R	
			Basic Operational Waste Management	R	
			Non-Polluting Materials	3	10,7 %
			Design for Materials Reduction	1	3,5 %

			Design for Flexibility & Adaptability	1	3,5 %
			Design for Disassembly	1	3,5 %
			Modular Flooring Systems	1	3,5 %
			Design for Durability	1	3,5 %
			Building Reuse	2	7 %
			Material Reuse	1	3,5 %
			Regional Materials	2	7 %
			Recycled Materials	6	21,4 %
			Rapidly Renewable Materials	1	3,5 %
			Reused or Certified Timber	2	7 %
			Improved Construction Waste Management	2	7 %
			Improved Operational Waste Management	2	7 %
			Organic Waste Management	2	7 %
Innovating Practice	3	1,6 %	Innovative Cultural & Regional Practices	1	33,3 %
			Innovating Practice	2	66,6 %

Analysis and discussion of the selected assessment methods

The results of the analysis showed the following criteria:

1) Define the assessment principles.
2) Identify the applied criteria.
3) Categorize the areas of the assessment.
4) Establish the recommended rating system

As shown in Figure 1, the assessment areas were almost evaluated with the same credits in LEED and BREEAM. At the same time, ESTIDAMA allocated more credits for the use of water, materials, and energy. This is because preserving water in the Gulf area is a major request for sustainability. Additionally, extra value has been given for materials and energy in ESTIDAMA because it is the most recent assessment method, which has been developed after many recurring calls for energy saving in the region. The three assessment methods were analyzed and found to have the same main assessment areas, which are classified as follows:

- Indoor Quality
- Energy
- Management
- Outdoor Quality
- Materials
- Land Use and Ecology
- Water
- Innovation

All these areas are the main influencing factors that directly or indirectly impact the use of resources. They are related to the phases of the building life, beginning from the design phase, through the construction phase, and culminating with the end of the building's life cycle. This study employs two weighting approaches to assess the sustainability potentials of both case studies in this paper. Environmental impact weightings and the building assessment criteria that affect them exert huge influences on the building's relative scores. In this field, deriving rationale, with credible and defensible weightings of the issues about the environment for various circumstances and regions of use has become increasingly relevant.[26,27]

Both practical and technical requirements can considerably affect the assessment criteria and the details of scoring and weighting of each assessment area. The most effective factors are:

- The assessment criteria' aptitude is applied repeatedly and consistently through self-assessment.
- The significance of the weighting criteria and the evaluation method, in a way that it introduces a general pact about it.
- The assessment criteria' comprehensiveness creates credibility and clear interaction with the evaluation results.

There are many ways for the scoring options:

- The single 'quality score, in which the answer is (Yes, No, or N/A).
- The score depends on experiments or tests. This score must be referenced, such as the evaluation of CO_2 emission, which can include a scoring chart and values.
- The assessment system can also comprise a specific multi-point range, whereby the lowest number on the scale indicates a poor provision level or an allowed minimum of standards.

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The assessment method can have two evaluation methods, according to the review of the evaluation criteria. The first method involves selecting one option among a range of multiple options to accurately identify the specification level in the assessed area. The second method involves selecting from a list of characteristics applicable to the assessed criterion.

Formulation of a Sustainability Assessment Method

This study aims mainly to develop an assessment method for sustainability that can be applied to existing historical buildings to measure their sustainability potential. Developing such an assessment method is a major project requiring considerable assessment. The developed sustainability assessment method should address the following factors:

1) The advanced assessment method should be effective for the Middle East. However, there are different environmental issues in that regions.
2) The developed assessment method should comply with the aforementioned assessment methods and correspond to universal sustainability guidelines.
3) The developed assessment method should correspond to the potentials of any historical area, where advanced building technologies are not innovated.

The three assessment methods in this paper have many limitations to be applied to the case study of this paper.

- Estidama is not suitable for the whole Arab world because it has been developed for the Gulf region, with specific environmental conditions unavailable in Egypt (the country of the first case study).
- LEED and BREEAM are not suitable for the middle east region, because they are related to the requirements of the American and British environments.
- The three assessment methods (BREEAM, LEED, and ESTIDAMA) cannot be applied to historic buildings. In addition, some requirements cannot be achieved due to the lack of the advanced building industry.

Therefore, the developed assessment method will demonstrate the elements which exhibit real sustainability indicators in the regional architecture. Accordingly, developing PAM (i.e., the Proposed Assessment Method) for evaluating the sustainability potentials of traditional as well as contemporary houses in both case studies should require the following:

1) Analysis of the selected assessment methods.
2) Customization of the rating system.
3) Formulation of PAM.

CONCLUSION

Based on the analysis and discussion of the implemented assessment approaches, the assessment criteria's score areas are presented in Table 1 to formulate the PAM (i.e., the proposed assessment method) associated with the suggested rating system. The scoring system will depend on the average value of the assessment areas for the three investigation methods.

The criterion included in one assessment method has not been considered in PAM because it is included in other areas, such as pollution in BREEAM, which is already included in the indoor and outdoor quality criteria in LEED and Estidama.

Moreover, innovation is included as part of PAM. The weighting of the environmental criteria is regarded as a recognized method for assigning comparative significance to the specified environmental performance criterion. The aggregate performance scores are extremely affected by the assigned weightings to the essential criterion.[26,27]

According to the proposed assessment method (PAM), energy is prioritized in weighting (23 %), followed by water (15 %), which is equal to the priority of materials (15 %). Following that, the rating system will assign 14 % to indoor quality, 10 % to land use, ecology, and management, 9 % to outdoor quality, and 4 % to innovation. This proposed categorization is more suitable for the Middle East and the Far East. Since energy is the most important sustainability factor in hot-humid climates, air conditioning massively affects the level of energy consumed. Thus, water and materials have secondary significance according to the rating system of the proposed assessment method.

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CONFLICTS OF INTEREST

None.

FINANCING

None.

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