



Towards green evolution in urban Egypt: assessing Al Rehab City through LEED-ND and BREEAM-communities frameworks

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Abstract

This article provides a comprehensive analysis of the application of green neighborhood rating systems, specifically Leadership in Energy and Environmental Design-Neighborhood Development (LEED-ND) and Building Research Foundation Environmental Assessment Method (BREEAM)-Communities, in the context of Cairo, Egypt, focusing on Al Rehab City, a prominent urban area in New Cairo. The study begins by providing a background on Al-Rehab City, explaining its strategic planning, urban design, and demographic dynamics. It then delves into the current state of sustainable urban planning in Egypt, highlighting the challenges and opportunities that exist in this rapidly urbanizing context. The core of the article includes a comparative analysis of LEED-ND and BREEAM communities, assessing their adaptability and relevance to the Egyptian urban landscape, especially Al Rehab City. It explores many sustainability issues such as smart location, neighborhood pattern and design, green infrastructure, sustainable transportation, energy efficiency, water conservation, waste management, and community engagement. The discussion extends to examine how each of these aspects of sustainability applies to Al Rehab City, complemented by case studies and examples of current sustainable practices in Cairo. Furthermore, the article identifies specific local challenges in implementing these assessment systems, such as economic constraints, policy constraints, and cultural factors. It also suggests opportunities for improvement, including the potential for public-private partnerships, policy reforms, community engagement, technological innovation, and sustainable urban development modeling. In conclusion, the article provides insight into the future prospects of green urban planning in Cairo. The potential impact of adopting comprehensive assessment systems is discussed, with an emphasis on the role of Al Rehab City as a potential model for sustainable urban development in Egypt and the wider MENA region. The article aims to contribute to the discourse on sustainable urban planning, and provide a roadmap for integrating global sustainability standards into the unique context of Egyptian cities.

Keywords Green Urbanism · Egyptian new cities · Sustainable neighborhood · Cairo

1 Introduction

Cairo, Egypt's sprawling capital, stands as a testament to rapid urbanization and an evolving cityscape. Its journey over the centuries has seen it transform from historic neighborhoods into modern urban spaces, making it a central hub of cultural, economic and political activities. However, this rapid urban growth has also created significant environmental challenges. Cairo faces issues such as air pollution, high energy consumption, traffic congestion, and inefficient waste management. These challenges are exacerbated by the city's vulnerability to the effects of climate change, such as rising temperatures and erratic rainfall patterns [1]. In this context, sustainable urban development becomes not just a goal but a necessity for Cairo. The city's future depends on achieving

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a balance between its rich historical heritage and the urgent need for sustainable living environments.

In addressing these urban challenges, green neighborhood rating systems such as LEED-ND and BREEAM-Communities are emerging as pivotal tools. These frameworks offer a comprehensive approach to the design and evaluation of urban spaces that prioritizes sustainability, resilience, and community well-being. By focusing on aspects such as energy efficiency, green building practices, sustainable transportation, and community engagement, these systems guide cities toward a more sustainable future [2]. For Cairo, with its unique blend of ancient heritage and modern aspirations, adopting these systems can lead to innovative solutions that respect its historical context while addressing contemporary environmental concerns. Implementing such frameworks is a roadmap for Cairo to transform into a model for sustainable urban development in the Middle East and North Africa region.

This article aims to analyze Al Rehab City, a prominent urban area in New Cairo, through the lens of green neighborhood principles and evaluation systems. Al Rehab City, known for its unique blend of modern urban planning and high-quality living standards, provides an ideal case study for this exploration. By examining the extent to which Al Rehab City’s development conforms to the criteria set forth in globally recognized green neighborhood assessment frameworks, this article seeks to understand the opportunities and challenges in adapting these systems to the Egyptian urban context. Ultimately, the goal is to provide insights into how cities like Cairo can embark on a path of sustainable urban development, using Al Rehab City as a blueprint for future endeavors in green urban planning.

To understand Al Rehab City’s potential as a model for sustainable development, it is necessary to explore the foundations of green neighborhood evaluation systems. These

systems provide criteria and metrics against which urban areas such as Al Rehab City can be evaluated, and provide insights into sustainability practices and areas for improvement. This leads us to a deeper examination of the background and details of these systems.

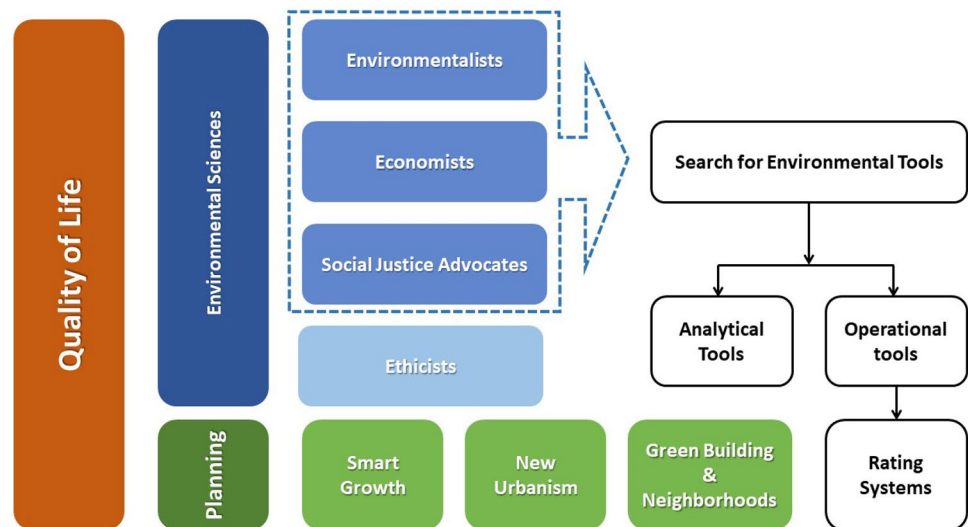
2 Background of green neighborhood assessment systems

Understanding the background of green neighborhood rating systems requires delving into the multifaceted nature of sustainability and its intersections with different thematic areas (Fig. 1). At the core of this understanding lies the interdisciplinary nature of sustainability, which includes ecological perspectives that prioritize the preservation of the natural environment, economic perspectives that focus on sustainable economic growth, social justice that emphasizes the equitable distribution of resources, and ethical considerations that address the ethical principles of sustainability efforts [3].

Urban planning approaches such as New Urbanism and Smart Growth are integral to these evaluation systems. The new Urban Charter calls for the design of walkable, compact and mixed-use urban spaces, promoting sustainable and liveable environments. Likewise, smart growth principles emphasize thoughtful urbanization that revitalizes existing communities, preserves natural spaces, supports social equity, and favors compact, transit-oriented, and pedestrian-friendly developments [4].

The practical application of sustainability is greatly supported by environmental tools, which are categorized into analytical and operational tools. Analytical tools, including life cycle assessment and cost–benefit analysis, help understand the environmental impacts of various practices

Fig. 1 Relationship between rating systems and environmental sciences and planning [5]



or products. Operational tools, especially relevant to green neighborhood assessments, focus on the application of sustainability, including environmental performance assessment and rating systems.

Rating systems for the construction sector are operational tools designed to promote sustainability. Their goal is to integrate sustainability with economic and social benefits. These systems integrate life cycle analysis and address multiple environmental aspects such as energy efficiency, water conservation and waste management. They act as scoring systems that evaluate buildings and neighborhoods against established environmental performance standards [6]. Although they are instrumental in reducing environmental impacts and guiding the sustainable design of neighborhoods, they are sometimes criticized because they may limit innovative design approaches.

One notable challenge in this field is the lack of a standardized approach to designing sustainable neighborhoods. While classification systems provide basic guidelines, their prescriptive nature can be viewed as limitations to creative urban design. In sum, the background of green neighborhood assessment systems is a complex tapestry of multidisciplinary sustainability concepts, urban planning philosophies, and specific environmental tools. These systems play a central role in guiding sustainable urban development but also highlight the complexities and ongoing debates within the field, particularly regarding the balance between standardization and innovation in sustainable design [7].

With this background in green neighborhood rating systems, the stage is set to delve into specific frameworks such as LEED-ND and BREEAM-Communities. Understanding these systems in detail will shed light on how they can be effectively applied in urban areas such as Al Rehab City, demonstrating their role in driving sustainable urban development.

3 Green neighborhood assessment systems

Green neighborhood rating systems represent a pivotal development in urban planning and sustainability. These systems, which have evolved significantly over the years, are tools designed to evaluate and promote sustainable practices in the development of urban spaces. Its importance cannot be overemphasized in the context of growing environmental concerns and the urgent need for sustainable living practices. The green building movement, led primarily by initiatives such as the Building Research Establishment (BRE) in the UK and the US Green Building Council (USGBC) in the USA, has laid the foundation for the development of green neighborhood rating systems. Over the past fifteen years, this movement has expanded its scope from individual buildings to entire neighborhoods. Prominent systems such as LEED

(Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) have evolved to include neighborhood assessments, with LEED-ND and BREEAM-Communities being prime examples [8].

Evidence of global recognition of the importance of sustainable living development is the diversity of assessment systems applied around the world. Countries such as Australia, France, and Germany have developed their own systems, such as Greenstar, HQE, and DGNB, respectively. This diversity reflects not only the global commitment to sustainable development, but also different regional needs and priorities [9]. The shift from building-level to neighborhood-level assessments is a relatively recent phenomenon in both research and practice. This shift is crucial because it recognizes that sustainability goes beyond individual buildings, to include broader aspects such as transportation, community engagement and infrastructure. By focusing on neighborhoods, these systems can address the interconnected nature of urban life and promote inclusive sustainable development.

When comparing systems like LEED-ND and BREEAM Communities, notable differences emerge in terms of standards, popularity, and accreditation processes. LEED-ND, known for its practical nature and online registration process, has gained greater popularity in terms of the number of approved projects. On the other hand, BREEAM stands out in its approach to social impact assessment and community engagement [10]. These differences highlight the ability of evaluation systems to adapt to different priorities and contexts. Green neighborhood rating systems cover a wide range of categories, including smart location, neighborhood style, green infrastructure, and more. These categories are essential in guiding sustainable neighborhood development, ensuring that various aspects of urban life are taken into account, from environmental impact to social cohesion.

Statistics regarding ownership types of LEED-certified projects indicate a balance between public and private sector initiatives. This balance is crucial to the widespread adoption of sustainable practices, ensuring that government policies and private sector investments contribute to the sustainable development of neighborhoods. Green neighborhood rating systems are more than just tools for measuring sustainability; They are catalysts for change in urban development. They encourage the integration of environmental, social and economic considerations into the fabric of neighborhoods [11]. As the world grapples with environmental challenges and the need for sustainable living spaces, these systems provide a structured and comprehensive approach to creating sustainable, livable communities of the future. Its continuous evolution and adaptation to different regional contexts underscores its vital role in shaping sustainable urban landscapes around the world.

As we recognize the importance of green neighborhood classification systems and their ability to adapt, it becomes appropriate to study specific urban projects such as Al Rehab City. Such an examination will shed light on how these frameworks apply in practice and their impact on the sustainability of new urban developments.

4 Background on Al Rehab City, New Cairo

Al Rehab City, viewed as an independent suburban development project, represents a major shift in the urban planning paradigm in Egypt. Developed by the private sector, it represents a transition from traditional state-led urban developments to privately managed urban spaces. The city is strategically located in the eastern extension of Cairo (Fig. 2), close to Cairo International Airport, making it an attractive location for local and international residents.

The urban design of Al Rehab emphasizes a community-focused approach, with neighborhoods organized around central squares and public facilities such as schools, health-care facilities and shopping areas. The city is divided into multiple residential phases, each functioning as a small community with its own set of services [12]. This segmented design aims to reduce traffic within the city and promote a sense of community among residents.

Al Rehab City's population is diverse, covering a wide range of social and economic backgrounds. This diversity has contributed to building a vibrant social fabric, where various cultural and entertainment activities are held throughout the year. The city is designed to meet different lifestyles, offering a range of amenities including sports clubs, cultural centers and green spaces.

Al Rehab City was planned with an emphasis on landscaping and green spaces. Its streets are lined with trees, and there are many parks and open spaces. However, as the city grows, it faces environmental challenges such as

managing water resources efficiently, ensuring sustainable waste management, and addressing the urban heat island effect. The city's development has also raised concerns about the sustainability of such large-scale suburban expansions, particularly in terms of their impact on the surrounding natural environment and resource consumption.

Given these concerns and the unique characteristics of Al-Rehab City, it is necessary to explore how Egyptian urban planning can adapt to sustainability challenges. This exploration will provide a broader context for evaluating Al Rehab City's approach to sustainable development within the broader framework of the evolution of urban planning in Egypt.

5 Sustainability in Egyptian urban planning

The Egyptian urban planning landscape is witnessing a profound and significant transformation, primarily driven by the increasing focus on sustainability as a fundamental pillar of development discourse. This shift represents a departure from traditional urban planning models towards a more future-focused and environmentally responsible approach. The late 1990s were a pivotal period in this transformation, marked by the creation of New Cairo, a fully planned city that stands as a testament to the principles of sustainable living [13].

New Cairo, conceived as a bold response to the overcrowding and infrastructural challenges plaguing central Cairo, was designed not as a mere expansion of urban space but as a reinvention of urban life itself. The aim of this master-planned city was to provide a solution to the severe congestion that had long been a feature of Cairo's central areas. By providing a more spacious, organized and efficiently planned urban environment, New Cairo aims to raise the standard of living for its residents.

Implementing sustainable urban planning in Egypt, especially in new developments such as New Cairo, faces several obstacles. The critical challenge is effective coordination between various stakeholders, including government agencies, private developers and local communities whose lives and livelihoods will be affected by these urban projects [14]. Bridging the gap between these groups requires a shared vision and collaborative strategies aligned with the overarching goal of sustainability.

Furthermore, while there is growing recognition of the importance of sustainable practices, Egypt faces a dearth of technical expertise and implementation capacity. This gap is not only limited to implementing sustainable initiatives, but also maintaining and developing them after implementation.

Cities like Al-Rehab stands on the cusp of becoming models for sustainable urban development in Egypt. The leadership potential of these cities is enormous and can

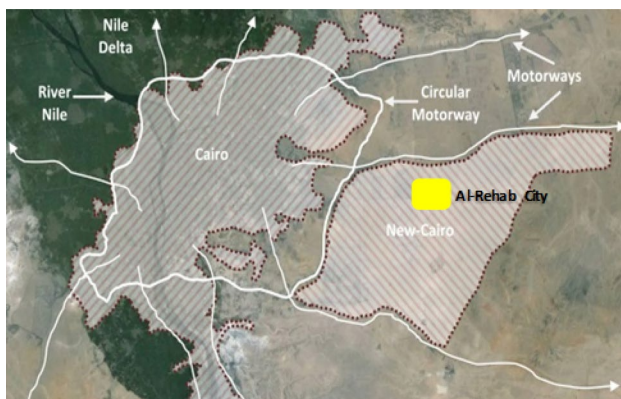


Fig. 2 The location of Al Rehab City

be achieved by adopting the latest sustainable technologies and innovative urban design strategies. Such strategies can enhance walkability, reduce dependence on cars, and enhance the integration of green spaces and building practices that are in harmony with the environment.

To truly integrate sustainability into the urban fabric, these cities must also embrace community engagement as a cornerstone of their development approach. This entails promoting a culture of environmental responsibility among the population and encouraging active participation in sustainability initiatives. Community participation can empower residents as custodians of their environment, ensuring that sustainable practices are not only implemented but also valued and maintained by those who benefit most from them.

The journey towards sustainable urban development in Egypt is a collaborative endeavor that requires a multi-dimensional approach. This includes policy reforms, educational programs to build local expertise, investment in green technologies, and comprehensive community engagement mechanisms [15]. By addressing these vital components, Egypt can chart a course toward a future in which urban development is synonymous with environmental stewardship and where cities like New Cairo and Al Rehab become beacons of sustainable living. The pursuit of this goal is not only about shaping the physical world, but also about forging a community ethos that places sustainability at the heart of Egypt's urban development.

With this understanding of the broader trends in Egyptian urban planning, we can now focus on a comparative analysis of specific sustainability frameworks like LEED-ND and BREEAM-Communities within the context of Al Rehab City. This analysis will help us understand how these global standards are adapted and implemented in a unique urban setting like Al Rehab City.

6 Comparative analysis of LEED-ND and BREEAM-communities in the context of Al Rehab City

The following discussion offers a comparative analysis of the LEED-ND and BREEAM-Communities frameworks within Al Rehab City, Cairo, focusing on their adaptability to local climate, culture, and economy (Table 1). It aims to explore how these sustainability standards can be tailored to enhance urban resilience and livability in a context-specific manner.

6.1 Adaptation to Cairo's context

When evaluating the application of LEED-ND and BREEAM-Communities in Al Rehab City, it's imperative to recognize and address the unique characteristics and

challenges presented by Cairo's environment, culture, and economy.

6.1.1 Climate and environmental adaptation

LEED-ND's focus on sustainable site development and green infrastructure can be highly advantageous for Al Rehab City in combating Cairo's hot and arid climate. Implementing green roofs, urban green spaces, and shaded walkways can help mitigate the urban heat island effect, reducing temperatures and enhancing the city's livability. This is crucial in a city where extreme heat is a recurrent issue [16].

On the other hand, BREEAM-Communities' emphasis on sustainable land use and ecology could translate into preserving natural habitats and biodiversity within the urban context. In Cairo, this might mean creating urban parks that serve as green lungs for the city, promoting urban agriculture on available lands, and using native, drought-resistant plant species for landscaping. These strategies not only enhance the city's ecological balance but also contribute to improving air quality and overall well-being.

6.1.2 Cultural and social integration

LEED-ND advocates for mixed-use development and diverse communities. In the case of Al Rehab City, this could involve the creation of spaces that reflect Egyptian culture and foster community interaction. For instance, communal courtyards inspired by traditional Egyptian architecture and local market areas could be integrated into the urban fabric. Such spaces can become hubs for cultural exchange and community bonding.

BREEAM-Communities places a strong emphasis on community engagement and social well-being. In Cairo, this could involve the incorporation of traditional neighborhood concepts such as the "Mahallah" or small neighborhood units. Ensuring easy access to cultural and religious facilities and providing ample spaces for community gatherings and events can help preserve and strengthen the rich social fabric of the city [17].

6.1.3 Economic accessibility and viability

Adapting both LEED-ND and BREEAM-Communities to the economic constraints typical in Cairo is essential. This involves developing cost-effective, sustainable building practices and infrastructure solutions that are financially accessible to a wide range of residents in Al Rehab City.

Strategies may include the use of locally sourced materials, which not only supports the local economy but also reduces the carbon footprint associated with transportation of construction materials. Promoting local employment in

Table 1 Comparative analysis of LEED-ND and BREEAM-communities

Criteria/aspect	LEED-ND	BREEAM-communities
Adaptation to Cairo's context		
Climate and environmental adaptation	Focuses on sustainable site development with green roofs, urban green spaces, and shaded walkways to mitigate urban heat island effect	Emphasizes sustainable land use and ecology, aiming at preserving natural habitats and biodiversity within the urban context
Cultural and social integration	Advocates for mixed-use development reflecting Egyptian culture and fostering community interaction through communal courtyards and local market areas	Concentrates on sustainable urban development while adapting to local cultural values, promoting diverse and inclusive community spaces that cater to the needs of all residents
Economic accessibility and viability	Involves developing cost-effective sustainable building practices and infrastructure that are financially accessible, using locally sourced materials and promoting local employment	Similar focus on economic adaptability through cost-effective sustainability practices, supporting local economy and providing incentives for green practices
Comparative metrics adaptation		
Site selection and urban density	Encourages compact development and reduced sprawl to optimize land use and infrastructure, promoting higher-density areas with adequate green spaces	Focuses on sustainable land use complementing LEED-ND's approach by guiding integration with the natural environment and promoting urban biodiversity
Transportation and connectivity	Principles include enhancing public transit accessibility, creating pedestrian-friendly streets, and encouraging cycling	Emphasizes reducing the carbon footprint of transportation, potentially integrating electric vehicle charging stations and promoting car-sharing schemes
Energy efficiency and water management	Stresses energy-efficient building designs, renewable energy use like solar panels, and smart technologies for energy management. Implements water conservation techniques considering Cairo's water scarcity	Aligns with LEED-ND in energy management and sustainable resource use, focusing on energy consumption patterns and efficient water management strategies
Community engagement and social aspects	Advocates a community-centric approach with active resident participation in sustainability initiatives and community-based planning	Stresses the importance of community engagement, involving residents in decision-making processes, and fostering a sense of ownership for sustainable practices

sustainable development projects can enhance economic opportunities for Cairo's residents while contributing to social sustainability. Additionally, offering incentives for developers and residents to adopt green practices, such as tax breaks or reduced utility costs for sustainable buildings, can help drive the adoption of sustainable principles [18].

6.2 Comparative metrics adaptation

In the context of Al Rehab City, adapting the comparative metrics of LEED-ND and BREEAM-Communities is crucial to ensure the successful implementation of sustainable practices that cater to the specific needs and challenges of Cairo. Below, we delve into the adaptation of key metrics from both frameworks.

6.2.1 Site selection and urban density

LEED-ND encourages compact development and reduced sprawl, which can optimize land use and infrastructure. In Al Rehab City, this might involve planning for higher-density areas while ensuring there are adequate green spaces and public amenities. By strategically locating higher-density developments near transportation hubs and essential services, the city can promote walkability and reduce the need for private vehicle usage [19].

BREEAM-Communities' focus on sustainable land use complements this approach by guiding the integration of Al Rehab City's development with the surrounding natural environment. This encourages the preservation of natural landscapes, promoting urban biodiversity and minimizing land consumption. Efforts to protect and restore nearby natural habitats can enhance the overall ecological resilience of the city.

6.2.2 Transportation and connectivity

Al Rehab City could implement LEED-ND's principles on sustainable transportation by enhancing public transit accessibility, creating pedestrian-friendly streets, and encouraging cycling. This includes developing efficient public transportation networks and safe, dedicated cycling lanes to reduce dependence on cars.

Under BREEAM-Communities, the emphasis could be placed on reducing the carbon footprint of transportation even further. This might involve the integration of electric vehicle charging stations, promoting car-sharing schemes, and incentivizing the use of electric or hybrid vehicles. By prioritizing sustainable transportation options, the city can reduce air pollution, ease traffic congestion, and improve overall quality of life [20].

6.2.3 Energy efficiency and water management

Both frameworks have strong components on energy efficiency and sustainable resource use. For Al Rehab City, this might mean installing solar panels on rooftops and employing energy-efficient building designs to harness the abundant sunlight and reduce reliance on fossil fuels. Smart technologies for energy management can optimize energy consumption and reduce waste.

Water conservation techniques such as rainwater harvesting, greywater recycling, and efficient irrigation systems are crucial adaptations for Al Rehab City, considering Cairo's water scarcity issues. By maximizing water efficiency, the city can alleviate the strain on existing water resources and ensure a more sustainable water supply for its residents.

6.2.4 Community engagement and social aspects

LEED-ND and BREEAM-Communities both stress the importance of a community-centric approach. In Al Rehab City, this could involve active resident participation in sustainability initiatives, community-based planning, and the provision of public spaces that cater to diverse groups. Engaging residents in decision-making processes and involving them in sustainable practices fosters a sense of ownership and responsibility for the city's future [21].

In summary, adapting LEED-ND and BREEAM-Communities to the context of Al Rehab City in Cairo requires a holistic approach that considers climate, culture, economy, and social aspects. By tailoring these sustainability frameworks to meet the city's unique challenges and opportunities, Al Rehab City can create a more resilient, livable, and sustainable urban environment for its residents and future generations.

In order to effectively evaluate Al Rehab City's progress and its commitment to the principles of sustainable urban development, a set of clear and comprehensive evaluation criteria is needed. Rooted in scientific principles and urban studies, these criteria will provide a systematic approach to assessing Al Rehab City's compliance with the sustainability goals set by frameworks such as LEED-ND and BREEAM-Communities [22].

7 Assessment criteria

In the realm of sustainable development, the effectiveness of assessment Criteria is often derived from established metrics such as those set by LEED and BREEAM. This section explores how the practical application of case study assessment Criteria extends from these well-defined metrics (Fig. 3), signifying a tangible extension of sustainability principles into the fabric of urban development.

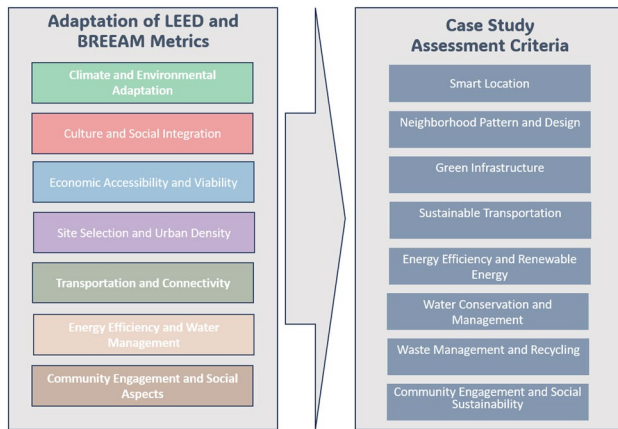


Fig. 3 The relationship between LEED and BREEAM metrics and assessment Criteria

Smart Location: The concept of smart location extends the cultural and economic considerations wrapped into the LEED and BREEAM standards. A smart location is not just a dot on a map, but rather a network of cultural, social and economic threads that form the fabric of community life. It is where theoretical ideas about economic accessibility and social integration are translated into lived experiences, shaping the daily interactions and economic transactions that determine the vitality of a community.

Neighborhood Pattern and Design: Careful planning and design of neighborhood pattern is a direct embodiment of the principles of site selection and urban density. The goal here is to create cohesive, walkable communities compatible with human-scale development. This consensus ensures that the spatial organization of neighborhoods contributes to a sustainable urban form that enhances social interaction and cultural enrichment.

Green Infrastructure: The concept of green infrastructure is emerging as a practical response to the urgent need for climate and environmental adaptation. It embodies a commitment to sustainable urban ecosystems, and provides tangible benefits such as improved air quality, natural rainwater management, and enhanced biodiversity. This infrastructure becomes a living laboratory for resilience and sustainability.

Sustainable Transportation: Sustainable transportation systems reflect the basic principles of transport and communication from sustainability standards. These systems emphasize multimodal networks that support economic growth and connect people to opportunities, while minimizing environmental impacts. The focus on sustainable transportation underscores a greater shift towards mobility solutions that prioritize efficiency, accessibility and sustainability.

Energy Efficiency and Renewable Energy: Energy efficiency and renewable energy are the cornerstones of

modern sustainable practices, and are directly linked to the energy and water management standards of LEED and BREEAM. These evaluation Criteria are not just about conserving resources, but about rethinking how energy is produced, distributed and consumed. They represent a commitment to a future in which buildings and communities are powered by clean, renewable sources.

Water Conservation and Management: Through the water management strategies identified by the Sustainability Benchmarks, the focus on water conservation and management in the case studies is clear. This approach goes beyond simply reducing consumption; It involves a comprehensive vision of water as a precious resource that must be managed wisely, ensuring its availability and quality for future generations.

Waste Management and Recycling: The inclusion of waste management and recycling as an assessment factor acknowledges the essential role waste reduction plays in the sustainable lifecycle of a development project. This factor is intrinsically linked to the energy efficiency and water management metric of sustainability standards, which, while focusing on conservation of resources, also implies the efficient use and reuse of materials.

Community engagement and Social Sustainability: Community participation and social sustainability are the beating heart of sustainable development. These Criteria are rooted in the community engagement and social aspects of LEED and BREEAM, and translate into practices that prioritize inclusion, equity, and community well-being. They reflect a belief that sustainable development is not just about green buildings, but also about fostering strong and resilient communities.

These criteria serve as a blueprint for informed urban planning, ensuring that development is not only environmentally conscious but also socially and economically viable. The insights from this analysis provide a solid foundation for future urban planning endeavors, aligned with global standards such as LEED-ND and BREEAM-Communities, and pave the way for sustainable urban transformations.

In the next section, Al Rehab City will be examined according to these criteria in order to assess its compatibility with the principles of sustainable urban development. This evaluation will take into account how well the city has integrated smart site planning, neighborhood design, green infrastructure, sustainable transportation, and other key elements. The goal is to identify strengths, areas for improvement and potential strategies to enhance the sustainability image of Al Rehab City, making it a model for environmentally responsible, socially inclusive and economically sound urban development.

8 Issues covered and their application in Al Rehab City

8.1 Smart location

In Al Rehab City, smart location strategies play a crucial role, emphasizing strategic urban planning to efficiently connect the city with the broader Cairo region (Fig. 4). This involves developing robust public transportation systems that link Al Rehab City with key areas in Cairo, thereby reducing reliance on private vehicles. Essential to this approach is ensuring that residents have easy access to healthcare, education, and retail services within a reasonable distance, effectively reducing the need for long commutes. Additionally, optimizing land use to balance

residential, commercial, and recreational spaces creates a cohesive urban environment.

8.2 Neighborhood pattern and design

The design of neighborhoods in Al Rehab City is focused on enhancing community living and sustainability. This includes creating pedestrian-friendly environments with safe, well-lit sidewalks and pedestrian zones (Fig. 5). The integration of residential areas with commercial and recreational spaces in mixed-use developments reduces travel needs and fosters a vibrant community atmosphere. Moreover, designing public spaces like plazas, parks, and community centers encourages social interaction and community activities.

8.3 Green infrastructure

Incorporating green infrastructure is another key aspect, with the development of parks and gardens (Fig. 6) that provide recreational areas, improve air quality, and serve as habitats for local wildlife. The implementation of green roofs on buildings enhances insulation, reduces heat absorption, and creates additional green spaces. Furthermore, sustainable urban drainage systems are utilized for managing stormwater and reducing urban flooding.

8.4 Sustainable transportation

Promoting sustainable transportation is integral to the city’s planning. This includes expanding and improving the quality of public buses, trams, or metro services, along with establishing dedicated and safe cycling lanes and walking paths (Fig. 7). Policies and infrastructure that encourage carpooling, electric vehicle use, and other sustainable transport methods aim to reduce car dependency.

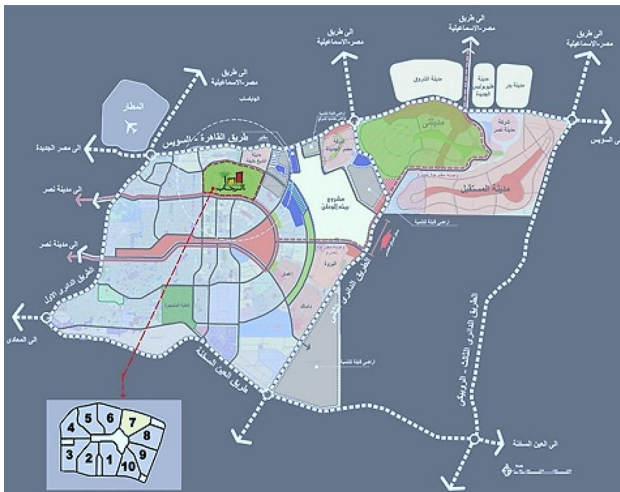


Fig. 4 Al Rehab City’s development with the surrounding natural environment

Fig. 5 Al Rehab neighborhood pattern and design

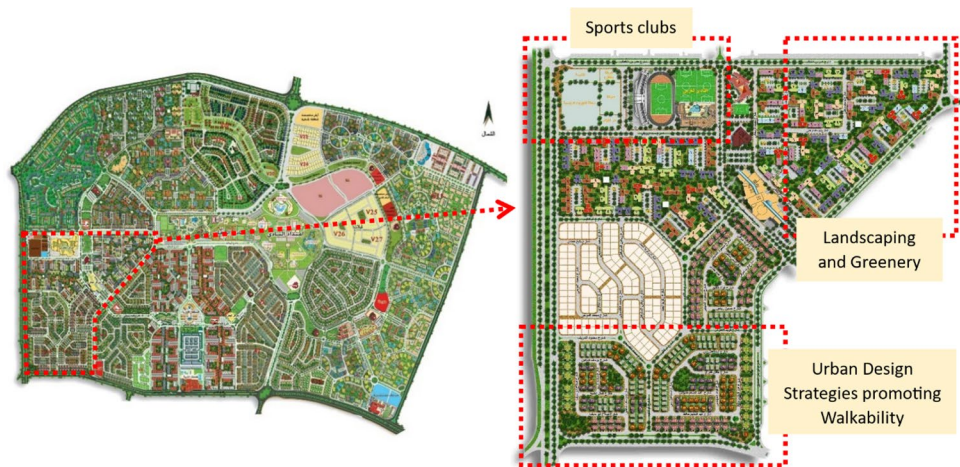




Fig. 6 Urban green spaces and shaded walkway



Fig. 7 Public transit accessibility, and encouraging cycling

8.5 Energy efficiency and renewable energy

Energy efficiency and the use of renewable energy are prioritized, with the construction of buildings designed to minimize energy consumption and the leveraging of Cairo's sunny climate to install solar panels on rooftops for electricity and hot water. Smart energy management integrates technology for efficient energy use and monitoring in residential and commercial buildings.

8.6 Water conservation and management

Water conservation and management are critical, considering Cairo's water scarcity. Strategies include installing low-flow fixtures and appliances in buildings, collecting and storing rainwater for landscaping and non-potable uses, and treating and reusing greywater for irrigation and other non-drinking purposes (Fig. 8).

8.7 Waste management and recycling

Effective waste management in Al Rehab City involves establishing comprehensive recycling facilities for various types of waste, encouraging practices that minimize waste generation,

such as composting and the use of reusable products, and exploring waste-to-energy technologies as a sustainable disposal method.

8.8 Community engagement and social sustainability

Fostering community engagement is essential. This is achieved through participatory decision-making processes, community awareness programs educating residents about sustainability practices, and ensuring cultural and social inclusivity in development and community activities. This approach reflects the diverse cultural fabric of Cairo and promotes social cohesion and environmental stewardship.

By focusing on these areas, Al Rehab City can develop into a model of urban sustainability, harmoniously blending modern urban living with environmental consciousness and social cohesion (Figs. 9 and 10).



Fig. 8 Water management system in Al Rehab city



Fig. 9 Facilities strip containing business and jobs opportunities

9 Challenges in implementing sustainable assessment systems in Cairo

In the realm of sustainable development, particularly in urban settings, several key barriers impede progress across various domains. These challenges range from financial and economic constraints to socio-cultural factors, each playing a significant role in shaping the trajectory of sustainable urban development.

9.1 Financial and economic barriers

The implementation of sustainable technologies and green building practices often incurs higher upfront costs. This is particularly problematic in developing economies where cost-effectiveness is a major factor in decision-making. Additionally, there is a notable lack of financial incentives. The need for more government-led initiatives, like

grants, subsidies, or tax reductions, is evident to motivate both developers and homeowners to embrace sustainable practices.

9.2 Policy and regulatory hurdles

On the policy front, existing frameworks may not be adequately supportive of sustainable development. The absence of comprehensive guidelines and standards is a significant hurdle in the adoption of green building practices. Moreover, the bureaucratic processes involved in securing approvals for sustainable projects can be daunting and time-consuming, often deterring stakeholders from pursuing these initiatives.

9.3 Socio-cultural factors

Public awareness and perception present another challenge. A general lack of understanding or misinformation about the benefits of sustainable living prevails. Overcoming established habits and traditional practices requires substantial efforts in awareness-raising and education. Engaging the local community in sustainable practices is also crucial but challenging. Demonstrating the tangible benefits of these practices is necessary to gain community buy-in and support.

9.4 Technical and expertise challenges

Technologically, limited access to cutting-edge sustainable technologies can be a barrier to implementation. Coupled with this is the issue of skill gaps. There's a pressing need for more local expertise in areas like green building and sustainable urban planning. Training and capacity-building initiatives are essential to bridge this gap and equip local professionals with the necessary skills.



Fig. 10 Communal courtyards and local market areas

9.5 Infrastructure and urban planning limitations

The existing urban infrastructure poses its own set of challenges when it comes to integrating sustainable solutions. Adapting this infrastructure can be complex and costly. Furthermore, urban sprawl, especially when it's unplanned or poorly planned, complicates the implementation of cohesive sustainable strategies. This sprawl can impede the establishment of effective and sustainable urban development plans.

Overall, addressing these barriers requires a multifaceted approach, involving policy reforms, financial incentives, educational programs, and infrastructural adjustments, all geared towards facilitating a smoother transition to sustainable urban living.

10 Opportunities for improvement in Al Rehab City

In the pursuit of sustainable urban development, a comprehensive and multi-tiered approach is key, encompassing everything from innovative financing to community engagement and technical innovation. This approach is crucial for the

successful implementation of sustainable practices in urban settings like Al Rehab City.

10.1 Innovative financing and investment

Encouraging private sector investment in sustainable projects is crucial. This can be achieved through incentives and forming partnerships, which can significantly advance sustainability initiatives. Additionally, exploring green financing options such as green bonds or sustainability-linked loans is essential. These financial tools can provide the necessary capital for implementing large-scale sustainable projects, thereby facilitating significant progress in sustainable urban development.

10.2 Policy and governance enhancements

The enactment of policies specifically promoting and mandating sustainable practices in urban development is vital. Such policy reforms can create an environment more conducive to the adoption of sustainable initiatives. Furthermore, streamlining the administrative processes involved in approvals and incentivizing green projects can significantly accelerate the pace of sustainable development.

10.3 Community and cultural integration

Developing comprehensive education and outreach programs is essential to change public perceptions and behaviors towards sustainability. These programs can greatly increase awareness of the importance and benefits of sustainable living. Moreover, designing sustainability initiatives that align with and respect local cultural values can enhance community acceptance and participation. Such integration ensures that sustainability is not just a concept imposed from the top down but is woven into the cultural fabric of the community.

10.4 Fostering technical expertise and innovation

Investing in local research and development to create sustainable technologies tailored to Egypt's specific context can be transformative. This local focus ensures the development of relevant and effective solutions. In addition, providing training and development programs in green building and sustainability is key to building a local workforce that is knowledgeable and skilled in these critical areas.

10.5 Modeling sustainable urban development

Implementing pilot projects within Al Rehab City can act as a valuable demonstration of the effectiveness of sustainable practices. These projects can serve as practical examples, showcasing the benefits and feasibility of sustainable urban development. Additionally, Al Rehab City can be used as a learning ground, where successful strategies and solutions can be adapted and applied to other parts of Cairo and beyond. This approach not only tests the viability of sustainable practices but also allows for adaptation and improvement, creating a model for broader implementation.

In summary, the advancement of sustainable urban development in Al Rehab City requires an integrated approach that includes innovative financing, policy enhancement, community engagement, fostering technical expertise, and the implementation of pilot projects. This comprehensive strategy is key to creating a sustainable, livable urban environment that can serve as an example for other cities to follow.

11 Conclusion

Al Rehab City, located in Cairo, stands as a model for modern urban development, thanks to its strategic planning and smart location. This development offers a less polluted environment and a higher quality of life compared to many other parts of Cairo. However, one of the main challenges it faces is ensuring efficient connectivity with the rest of the city.

The city's urban design is noteworthy, featuring well-planned streets, residential areas, and commercial zones. A key aspect of this design is the emphasis on green infrastructure. This includes the presence of parks and landscaped areas, which not only enhance the city's aesthetic but also its environmental sustainability. There is potential for further improvements, such as the introduction of green roofs and sustainable stormwater management systems, which would further cement Al Rehab City's commitment to eco-friendly urban living.

In terms of transportation and energy, Al Rehab City's development plan is forward-thinking. It includes initiatives for sustainable transportation, advocating for the use of public transit, cycling, and electric vehicles. Additionally, the city recognizes the importance of energy efficiency and the utilization of renewable energy sources, particularly solar energy, as key areas for ongoing development.

Given Cairo's arid environment, water conservation and efficient water management are critical. Al Rehab City shows significant potential in implementing water-saving technologies, which is essential for the sustainability of any urban area in such a climate. Alongside this, effective waste management and recycling are recognized as vital components for sustainable urban living, ensuring that environmental impact is minimized.

Lastly, the role of community engagement in Al Rehab City is highlighted as a crucial element for the success of sustainability initiatives. Encouraging resident participation in local governance and sustainability projects not only fosters a stronger community bond but also enhances the social sustainability of the city. This participative approach ensures that the residents are actively involved in shaping the sustainable future of their city.

The future of green urban planning in Cairo, and specifically in developments like Al Rehab City, is promising yet demands concerted efforts. The potential impact of embracing comprehensive assessment systems like LEED-ND and BREEAM-Communities is substantial. These frameworks can guide the city towards more sustainable, efficient, and livable urban spaces. However, this transition requires addressing economic, policy, technological, and cultural challenges.

The integration of sustainable practices in urban planning is not just an environmental necessity but also an opportunity for economic and social development. Investments in green infrastructure, renewable energy, and sustainable transportation can stimulate local economies and create new job opportunities. Furthermore, enhanced urban living conditions contribute to the overall well-being of residents.

In the longer term, if Cairo successfully adopts and implements these green urban planning principles, it could become a model for sustainable urban development in the region. This transformation could inspire other cities in

Egypt and the Middle East, showing that sustainable urban living is not only feasible but also beneficial in improving the quality of life in rapidly urbanizing cities.

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Declarations

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