

Evaluation of Sustainability Using LEED Rating Scales: The Bismayah New City in Baghdad, Iraq

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Received	Reviewed	Revised	Published
26.09.2023	15.11.2023	15.12.2023	31.12.2023

<https://doi.org/10.61275/ISVSej-2023-10-12-12>

Abstract

Sustainability is crucial in the design and management of residential complexes, as assessing the sustainability of them can contribute to improving the quality of life for residents while minimizing the environmental impact. Despite its importance, numerous challenges affect the sustainability of residential complexes, such as unsustainable urban planning, the cost of environmental technology, consumer culture, social and cultural challenges, as well as waste management and pollution.

This research evaluates the extent to which residential complexes can achieve long-term sustainability, in terms of environmental sustainability. This requires a comprehensive analysis of various aspects and indicators such as the availability of sustainable design, appropriate infrastructure, energy and water efficiency in buildings, in addition to the availability of green spaces, and access to sustainable transportation modes. They all aim to improve the quality of life for residents and minimize the negative environmental impact of buildings.

In evaluating the current situation of residential complexes, the application of the LEED scale with its five indicators (energy, water, materials and resources, indoor environmental quality, site selection) is immensely useful. In this research, this scale is applied to a selected residential complex in the Bismayah City in Baghdad, Iraq. It utilizes a descriptive analytical approach for the selected complex. It also ascertains residents' opinions, to assess the reality of sustainability in the Bismayah residential city.

The paper thus highlights the gaps, and proposes planning and design treatments to achieve integrated environmental sustainability. The findings indicate a widespread consensus regarding the significance of elements associated with intelligent location and connectivity, neighborhood design, green infrastructure and architectural aspects, and innovative practices in neighborhood development. They manifest at differing degrees of neutrality and reservations, thereby reflecting a nuanced perspective on these facets of urban planning.

Keywords: Environmental sustainability, LEED scale, Residential complexes, Bismayah City, Iraq.

Introduction

The world today is witnessing a notable increase in interest towards environmental sustainability across various sectors, including the construction and urban development sector. Sustainable residential complexes have become vital in achieving a balance between our needs as human beings and protecting the environment we inhabit.

Indeed, sustainable residential complexes pose significant challenges to contemporary cities in the 21st century. With escalating population growth, climate changes, and resource depletion, in light of these challenges, it has become more imperative than ever to begin adopting sustainable lifestyles and developmental plans aimed at preserving natural resources while enhancing the quality of life.

Residential complexes represent one of the principal sectors needing a transition towards environmental sustainability, since many individuals reside within them. Sustainable residential complexes are characterized by their reduction in reliance on natural resources, and mitigation of energy and water consumption. They provide healthy indoor environments, and foster social interaction and community spirit. They are designed in ways that encourage interaction and communication among the residents, such as providing shared green spaces, recreational areas, and accessible public transportation. Residents are encouraged to engage in community activities, and share experiences and resources, which enhances social ties and cultivates a sustainable community life.

To ensure environmental sustainability of cities, scales and assessment tools have been developed aiming to identify and measure sustainable environmental standards and achieve environmentally friendly practices. They can be applied to ascertain the sustainability of these residential complexes. In this context, this research aims to increase awareness and understanding about the significance of environmental sustainability in residential complexes and to promote the shift towards the implementation of sustainable practices in Iraq.

Its objectives are as follows.

1. To ascertain the level of sustainability in a selected residential complex in the city of Basmayah in Iraq.
2. To help achieve sustainable residential communities in Iraq with the collaboration and commitment of all stakeholders involved.

Theoretical Framework

Environmental Sustainability Metrics

Environmental sustainability metrics are pivotal tools for identifying and measuring the standards aimed at preserving the environment and ensuring its sustainability over the long term. The significance of these metrics revolves around several aspects:

1. **Environmental Impact Assessment:** Environmental sustainability metrics assist in evaluating the environmental impact of activities and projects on the surrounding environment (Galli et al., 2020).
2. **Promoting Sustainability:** Environmental sustainability metrics contribute to enhancing sustainable environmental practices and behaviors. This is achieved by setting stringent and standardized criteria (Malik et al., 2021).
3. **Improving Environmental Performance:** Environmental sustainability metrics provide standards and guidelines to improve environmental performance across a variety of sectors and industries. These standards encompass efficient use of natural resources, reducing harmful emissions, effective waste management, and preserving biodiversity (Nguyen et al., 2021).
4. **Achieving Sustainable Development:** Environmental sustainability metrics contribute to achieving sustainable development on economic, environmental, and social levels. By focusing on environmental standards, a balance is created between present needs and future requirements, while preserving the environment and providing a quality of life for the coming generations (Hysa et al., 2020).

5. Environmental sustainability metrics play a crucial role in achieving a balance between economic growth and environmental preservation, promoting sustainable practices, and improving environmental performance (Zhang, Geng and Wei, 2022).

Types of Environmental Sustainability Metrics

In recent decades, residential complexes have witnessed a significant shift towards eco-friendly design and sustainability. Developers, designers, and residents have realized that the built environment significantly impacts the inhabitants' health and quality of life (Khaleefah Alrikabi and Alumery, 2021). In this context, the environmental aspect has become crucial in planning and designing residential complexes, leading to the emergence of various metrics and tools for evaluating environmental performance and encouraging residential complexes and urban development towards more sustainable steps, improving life quality and reducing environmental impact (Abaas, 2016). These can be utilized in designing new projects or developing existing ones to achieve environmental and sustainability goals. This research will delve into some key metrics:

- **Envision Rating System:** This specifically focuses on infrastructure and urban development. It aims to assess and enhance the sustainability of infrastructure projects and urban development, such as roads, bridges, buildings, water and sewage systems, energy, transport, etc. (Pedersen, 2012).
- **Green Globes:** It is an environmental assessment system used for evaluating buildings, residential complexes, and commercial premises. Green Globes focuses on several environmental, economic, and social aspects such as energy, water, materials, indoor air quality, waste management, and environmental facilities. Projects are evaluated based on specific points, and Green Globes certifications are granted based on performance (Pedersen, 2012).
- **SITES** is a metric for assessing environmental sustainability of natural sites, green spaces, and other architectural projects. SITES acronym refers to "Sustainable Sites Initiative", a joint venture between several prestigious environmental and professional organizations. It aims to promote sustainable design, operation, and maintenance of green spaces and natural sites. Projects are evaluated according to a set of criteria and guidelines covering several environmental, social, and economic aspects (Ismaeel and Elsayed, 2022).
- **Living Building Challenge (LBC):** Considered one of the most demanding rating systems in the sustainability arena. It aims to create buildings that interact positively with the environment and surrounding areas, encompassing seven main categories addressing materials, energy, water, site, beauty, health, and happiness.
- **BREEAM (Building Research Establishment Environmental Assessment Method):** It's one of the most internationally recognized rating systems, evaluating the performance of buildings and communities in several aspects including energy, water, transport, materials, health, and environmental quality. Various ratings are granted reflecting the environmental performance level of the project (Ferreira et al., 2023).
- **LEED (Leadership in Energy and Environmental Design):** It's the most renowned and globally recognized metric in the sustainable construction industry. It covers various aspects like energy, water, materials, indoor air quality, innovation, and site design, providing a comprehensive system for evaluating and improving the environmental performance of buildings (Ferreira et al., 2023).

Despite the similarities among some of these measures in terms of objectives, they exhibit different characteristics and standards for evaluating and enhancing sustainability in construction projects, each with its unique features. For instance, 'Envision' measure focuses on evaluating and designing sustainable infrastructure, whereas the 'Green Globes' measure aims to improve building performance in areas such as energy, water, materials, air quality, health, and comfort. The 'SITES' measure emphasizes sustainable site design, conservation of biodiversity, and enhancing the relationship between buildings and the natural surroundings.

On the other hand, the Living Building Challenge measure aims to create buildings that interact positively with the environment and achieve full sustainability without reliance on external energy sources. Moreover, the 'BREEAM' measure explores multiple aspects like energy, water, materials, transportation, health, and environmental quality (U.S. Green Building Council., no date; Alkinani, Al-Hussaini and Alzaidi, 2022).

According to the objective and vision of the research which requires choosing a measure that considers the overlap between design standards represented by buildings and planning standards represented by the site, this research will rely on the LEED measure for its evaluation, given that it's a common and reliable measure in the field of sustainability. It is a comprehensive system covering a wide range of standards and specifications to enhance the environmental performance of buildings. It considers design factors and site factors when evaluating the sustainability of projects (Reeder, 2010).

The LEED Measures

The LEED (Leadership in Energy and Environmental Design) measure is a sustainability certification system aimed to encourage and honor buildings and projects with outstanding environmental performance. It was developed by the U.S. Green Building Council (USGBC) and is widely used worldwide as a recognized standard for evaluating sustainability of buildings (U.S. Green Building Council., no date).

The LEED measure aims to achieve comprehensive sustainability in various fields such as site design, energy efficiency, water management, indoor air quality, sustainable material usage, and environmental innovation. The measure comprises a set of standards and technical criteria that need to be met to obtain certification.

Projects are categorized into different segments such as new buildings, schools, offices, hospitals, commercial centers, and residential communities, with certifications granted based on the scores achieved. LEED measure is considered one of the leading tools in enhancing sustainability in the construction industry, as it contributes to reducing the consumption of natural resources and the negative environmental impact of construction projects. It also promotes awareness about the importance of sustainability and encourages the adoption of more eco-friendly construction practices, achieving higher levels of environmental, economic, and social performance in buildings, thereby contributing to a healthier and more sustainable future environment (Benson and Bereitschaft, 2020).

In the LEED measure, various categories are used to classify projects, and the indicators and standards applied vary based on the project type and category. Here are some common categories in the LEED measure:

- **New Construction:** This category includes new projects that involve entirely new construction.
- **Existing Building:** This category includes projects undergoing renovation and improvement processes of existing structures such as structural updates and energy efficiency enhancements.
- **Retail:** This category targets small commercial buildings like stores, restaurants, and small commercial centers.
- **Office Buildings:** This category targets commercial buildings used as business offices and corporate premises.
- **Schools:** This category targets educational buildings like schools, universities, and other educational facilities.
- **Healthcare:** This category targets buildings associated with healthcare like hospitals, health centers, and clinics.
- **Neighborhood Development:** This category targets the development of sustainable residential communities encompassing multiple buildings and infrastructure.

Indicators for Residential Complex Development According to LEED Measures

In the LEED measure, there is a specific category for sustainable residential complex development called "Neighborhood Development" (ND). This category aims to promote sustainability in residential complexes through an integrated design encompassing numerous buildings, infrastructure, and facilities (de Siqueira *et al.*, 2020).

There are several key areas focused on within this category, including:

- **Environmental Diversity and Location:** This area encompasses the preservation of biological diversity and natural resources and ensuring access to essential facilities and services.
- **Smart Design and Location:** This area requires intelligent and efficient residential complex design concerning land use, facilities, mobility, and providing easy access to public amenities.
- **Transportation Provision:** This area focuses on providing and enhancing public transportation, pedestrian access, bicycling, and reducing reliance on private cars.
- **Environmental Quality and Health:** This area aims to provide a healthy environment and quality of air and water, and building design to improve comfort and health for residents.
- **Innovation and Design Process:** This area encourages taking innovative initiatives in residential complex development and applying new and effective practices in the design and construction processes (Table 1).

Table 1: Indicators for residential complex development according to LEED measure
Source: Author

Categories	Criteria
Site Design and Environmental Location	Wise choice of location, preferring sites near facilities and public transportation.
	Preservation of biological diversity and existing natural landscapes.
	Providing pedestrian access, cycling, and community design to enhance social communication and interaction.
Land and Resource Management	Redevelopment and use of existing land instead of building on new land.
	Use of renewable and local resources in construction processes, water recycling, and efficiency enhancement.
	Efficient water management through the design and implementation of a rainwater collection system.
Mobility and Accessibility	Providing and enhancing public transportation and safe spaces for pedestrians and cycling.
	Enhancing connections between surrounding communities and providing efficient transportation for residents.
Environmental Quality and Health	Designing buildings to improve indoor air quality, natural lighting, and waste management.
	Providing green spaces, recreational areas, and enhancing public health and well-being for residents.
Innovation and Performance	Achieving superior performance in different sustainability areas through applying new and innovative techniques and practices.
	Applying strategies and tools to measure and evaluate the environmental, social, and economic impact of the residential community.

Literature Review

Empirical Evaluation of Bismayah New City's Sustainability Using LEED-ND Indicators: Recent literature in urban sustainability and planning presents a multifaceted analysis of assessment tools and methodologies, each contributing uniquely to the field. Bahale & Schuetze (2023) set the stage by critically examining three neighborhood sustainability assessment systems, emphasizing their integration of social, economic, and environmental aspects. This foundational work is critical for understanding the nuances of sustainable and resilient neighborhood planning.

Building on this groundwork, Aguiar Borges et al. (2020) take a bibliometric approach to scrutinize Neighborhood Sustainability Assessment Tools (NSATs), reviewing an extensive array of articles. Their findings reveal a significant reliance on qualitative methods and highlight a gap in quantitative research, pointing to emerging themes such as big data and climate change, and a notable underrepresentation of developing regions, particularly Africa. This comprehensive analysis paves the way for future research directions, underscoring the necessity for a more diverse and quantitative approach in NSAT assessments.

Simultaneously, Salles et al. (2023) explore the potential of incorporating sustainability indicators into CIM for urban sustainability assessment. By conducting a comparative analysis of established systems like BREEAM-C, LEED-ND, SNTool, and SBToolPT Urban, they identify key sustainability priorities and propose advanced methodologies for enhancing urban planning through information modeling techniques. This work signifies the growing importance of integrating sustainable development goals with innovative digital tools.

In a similar vein, Zhang (2022) investigates the integration of parametric Form-Based Code (FBC) with LEED-ND sustainability criteria, focusing on urban community development. Their research provides valuable insights into enhancing urban sustainability through parametric FBC, contributing a methodological framework that aligns with LEED-ND's principles.

Complementing these studies, Salati et al. (2022) present a comprehensive literature review of urban sustainability assessment tools. They aim to establish a consistent list of sustainability indicators, critically examining various methods and proposing a refined set suitable for diverse urban environments. This work is pivotal in standardizing sustainability indicators across different tools.

Meanwhile, Gao et al. (2022) delve into the role of government support in ecovillage development in China, comparing it with international examples. Their assessment of financial and policy support reveals strengths and weaknesses in China's approach, offering valuable insights for rural development policies and suggesting improvements for ecovillage assessments.

Adding another dimension, Sonet et al. (2021) provide an in-depth analysis of public participation in the design of public parks in Malaysia. Their work underscores the significance of public involvement in achieving sustainable urban development and reviews various methodologies and indicators used in the public participation process.

In the context of rapidly urbanizing cities, Kresse & Krabben (2021) examine the impact of land readjustment policies on urban ecological performance, particularly in Taipei and Seoul. Their research highlights the importance of considering ecological costs in land development policies, proposing strategies to enhance ecological sustainability.

De Siqueira et al. (2020) offer a critical examination of LEED-ND sustainability indicators in the development of slum areas in Rio de Janeiro. Their analysis of the Morro do Encontro project identifies gaps in meeting LEED-ND criteria, pointing out areas for improvement in sustainable urban solutions for slum areas.

Further, Aguiar Borges et al. (2020) evaluate BREEAM Communities and LEED Neighborhood Design from a critical heritage studies perspective. They emphasize the need for a more inclusive approach to heritage in sustainable urban development, highlighting the tendency to prioritize material over immaterial heritage aspects.

Wu et al. (2018) explore the transition from green building principles to broader green community concepts, identifying imbalances in the allocation of credits across different sustainability dimensions in the LEED ND rating system.

Finally, Zuniga-Teran et al. (2016) examine the integration of walkability in urban design through the LEED-ND certification system. Their study suggests enhancements for a more comprehensive approach to walkability, contributing to the practical application of multidisciplinary findings in urban planning for healthier communities.

Together, these studies form a comprehensive tapestry of research in urban sustainability, each contributing critical insights into various assessment tools, methodologies, and the overarching goal of integrating sustainability principles into urban planning and design.

Title of Study/Article (Authors, Year)	Summary of the Study
Bahale & Schuetze, 2023	Examines three neighborhood sustainability assessment systems, focusing on their sustainability and resilience in urban planning. Compares these systems across various themes, integrating social, economic, and environmental aspects in urban development.
Aguiar Borges et al., 2020	Utilizes a bibliometric approach to review 117 articles on Neighborhood Sustainability Assessment Tools (NSATs). Finds a dominance of qualitative methods and highlights trends like big data and climate change, noting a lack of contribution from developing regions.
Salles et al., 2023	Investigates incorporating sustainability indicators into CIM for urban sustainability assessment. Analyzes systems like BREEAM-C, LEED-ND, SNTTool, and SBToolPT Urban for sustainability priorities, proposing a methodology to enhance urban planning through information modeling.
Zhang, 2022	Explores integrating parametric Form-Based Code (FBC) with LEED-ND sustainability criteria. Assesses alignment with LEED-ND's principles in urban community development using methodological frameworks, statistical analysis, and scoring.
Salati et al., 2022	Presents a literature review of urban sustainability assessment tools, focusing on establishing a consistent list of indicators for sustainable urban design. Critically examines indicators across different methods, proposing a refined set of sustainability indicators.
Gao et al., 2022	Investigates the impact of government support on ecovillage development in China. Assesses the effectiveness of support in fostering ecovillages, comparing with BREEAM Community and LEED-ND. Highlights strengths and weaknesses in China's approach.
Sonet et al., 2021	Analyzes public participation in the design of public parks in Malaysia. Examines the integration of public involvement in park planning, emphasizing its importance for sustainable urban development and reviewing methodologies and indicators used.
Kresse & Krabben, 2021	Examines the impact of land readjustment policies on urban ecological performance in Taipei and Seoul. Assesses governmental and real estate market responses, using LEED ND for evaluation, and proposes strategies for ecological sustainability.
de Siqueira et al., 2020	Critically examines the application of LEED-ND indicators in slum areas in Rio de Janeiro. Analyzes the Morro do Encontro project, comparing it with LEED-ND criteria and identifying gaps in sustainability.
Aguiar Borges et al., 2020	Evaluates BREEAM Communities and LEED Neighborhood Design from a critical heritage studies perspective. Highlights the prioritization of material over immaterial heritage aspects, suggesting a more inclusive approach to heritage in sustainable urban development.
Wu et al., 2018	Explores the transition from green building to green community concepts. Analyzes LEED ND 2009 certified projects, identifying imbalances in sustainability credits and proposing redesigns in the LEED ND framework.
Zuniga-Teran et al., 2016	Examines LEED-ND's incorporation of walkability in urban design. Uses a Walkability Framework to evaluate LEED-ND, identifying strengths and gaps and proposing enhancements for a more comprehensive walkability approach.

Research Methodology

This study evaluates the sustainability of Bismayah New City in Baghdad using the Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) rating system as a benchmark. The LEED-ND system provides a comprehensive set of indicators and metrics that focus on areas such as:

- Smart location and linkage
- Neighborhood pattern and design
- Green infrastructure and buildings
- Innovation

In this research, a selected residential complex is analyzed and evaluated using the indicators associated with LEED assessment. It examines the standards and indicators that must be achieved to obtain a LEED certification in the Neighborhood Development category. The indicators (Site Design and Environmental Location, Land and Resource Management, Mobility and Accessibility, Environmental Quality and Health, along with Innovation and Performance) are applied, to analyze these indicators and explore how they are implemented in the context of a selected residential complex. The challenges and benefits associated with this sustainable approach will be discussed (Pedro, Silva and Pinheiro, 2018).

Data Acquisition

The methodology for data acquisition was expanded to encompass three distinct phases:

1. Direct fieldwork: This included site visits to the city to observe the urban structure, transportation systems, and communal amenities.
2. Desktop research: This involved extracting data from various authoritative sources, such as governmental publications, scholarly articles, and relevant online repositories.
3. Resident Survey Implementation: In addition to these methods, a structured survey was conducted, targeting the residents of the area. This survey, comprising 100 questionnaires, aimed to gather firsthand insights from the inhabitants, offering valuable data on their experiences, perceptions, and interactions with the local urban environment and services. This approach provides a more nuanced understanding of the area's socio-economic dynamics and complements the empirical data collected through fieldwork and desktop research.

Data Analysis

The accumulated data was then thoroughly examined using the aforementioned LEED-ND indicators. This analytical stage pinpointed the city's sustainability strengths and areas requiring improvement by comparing Bismayah New City's performance against the standard LEED-ND benchmarks.

Environmental Evaluation Models

The environmental evaluation models employed in this study were rooted in the LEED-ND metrics, offering a structured approach for appraising Bismayah New City's sustainability attributes across different dimensions. These models were instrumental not only in gauging the current sustainability stance but also in highlighting potential avenues for enhancement.

Bismayah New City Overview

The Bismayah New City Project (BNCP) is Iraq's largest urban development initiative. Located 10 kilometers southeast of Baghdad (Fig. 1), the city will cover 1,830 hectares and eventually house approximately 600,000 residents in 100,000 residential units (Fig. 2). The project includes not only essential infrastructure such as electricity, water, and roads, but also comprehensive public facilities from educational to commercial spaces.



Fig. 1: The location of Basmayah City in relation to Baghdad

Source: Google Maps, 2023



Fig. 2: Basmaiyah City master plan
Source: Municipality of Basmaiyah

Findings

Our investigation into the perceptions surrounding the LEED-ND (Leadership in Energy and Environmental Design for Neighborhood Development) indicators has brought forth several illuminating findings, as elaborated below (Table 2, Fig. 3):

Smart Location and Linkage

Proximity to Transit: The feedback on this sub-indicator reveals a somewhat divided perception. While a combined 43% of respondents expressed a positive stance (Strongly Agree or Agree), 27% remained neutral, and 30% had reservations (Disagree or Strongly Disagree). The average score of 20.16% suggests that proximity to transit remains a moderately important aspect for most.

- **Bicycle Network Connectivity:** A noteworthy 77.5% of respondents acknowledged the significance of bicycle network connectivity, while only a combined 10% exhibited any form of disagreement. This emphasizes the rising importance of sustainable and healthy modes of transportation in urban planning.
- **Pedestrian Network Connectivity:** More than half (52.5%) of participants favored pedestrian connectivity. The limited opposition (23.66% combined for Disagree and Strongly Disagree) underscores the need for pedestrian-friendly neighborhoods.

Neighborhood Pattern and Design

Mixed-use Neighborhood Center: With 64% leaning towards agreement on the importance of mixed-use neighborhood centers, it highlights an inclination towards diverse, versatile spaces. However, the average score of 22.25% suggests a nuanced view on this topic.

- **Walkable Streets:** Reflecting modern urban planning ideals, a substantial 66.66% emphasized the significance of walkable streets, while only a minority expressed concerns.

- **Access to Civic and Public Spaces:** The data revealed a strong inclination (65%) towards the importance of access to public spaces, showcasing the preference for inclusive urban environments.

Green Infrastructure and Buildings

Reduced Automobile Dependence: Responses were quite mixed. The close distribution across all categories, with a total average of 21.57%, indicates a complex interplay of factors when it comes to car dependence.

- **Green Buildings and Infrastructure:** While a total of 44.29% expressed a positive sentiment, it's crucial to note that a combined 38.57% were neutral or had reservations. This may point to emerging challenges or concerns in the realm of green infrastructure.
- **Water and Energy Conservation:** The emphasis on water and energy conservation was clear, with 52% showcasing agreement. This highlights the contemporary importance of sustainability in neighborhood development.

Innovation

Innovation in Neighborhood Design: Responses were dispersed, with a combined 47.83% agreeing on the importance of innovative design, and a significant 28% remaining neutral. The total average of 19.01% implies a cautious optimism.

- **Innovation in Technology and Operations:** A combined 48.77% leaned towards the positive, with an almost equal 44.66% remaining neutral or expressing concerns. This suggests that while innovations are welcome, there's a need for clarity and reliability in technological advancements.
- In summary, the findings provide a vivid panorama of the shifting paradigms in neighborhood development. While sustainability and inclusivity remain at the forefront, there's a palpable need for reliable innovation and a holistic approach to urban planning.

Table 2: LEED-ND Indicators in Bismayah New City

Source: Author

LEED-ND Indicators	Sub-Indicators	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Total average
		%	%	%	%	%	
Smart Location and Linkage	Proximity to transit	0.17	0.26	0.27	0.2	0.1	0.2
	Bicycle network connectivity	0.375	0.4	0.13	0.05	0.05	
	Pedestrian network connectivity	0.21	0.31	0.23	0.13	0.11	
Neighborhood Pattern and Design	Mixed-use neighborhood center	0.26	0.38	0.18	0.08	0.1	0.22
	Walkable streets	0.28	0.38	0.18	0.07	0.08	
	Access to civic and public spaces	0.28	0.37	0.18	0.08	0.1	
Green Infrastructure and Buildings	Reduced automobile dependence	0.18	0.25	0.23	0.23	0.13	0.22
	Green buildings and infrastructure	0.18	0.26	0.26	0.17	0.12	
	Water and energy conservation	0.27	0.25	0.21	0.16	0.11	
Innovation	Innovation in neighborhood design	0.23	0.245	0.28	0.17	0.07	0.19
	Innovation in technology and operations	0.23	0.25	0.29	0.15	0.07	

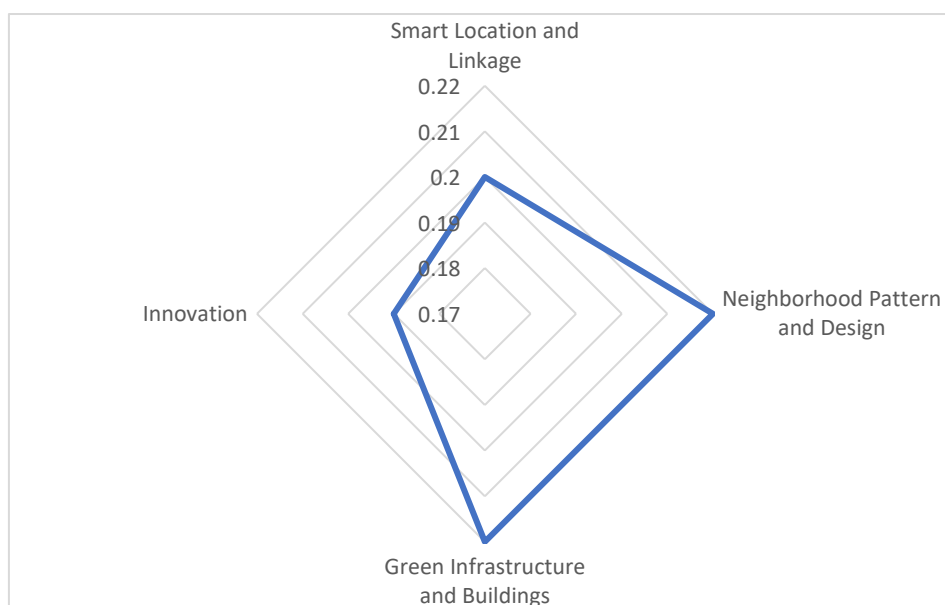


Fig. 3: LEED-ND Indicators in Bismayah New City
Source: Author

Conclusions

1. Green Infrastructure and Buildings

This research demonstrates that Bismayah New City has achieved moderate success in integrating green infrastructure and sustainable building practices. However, the city's performance in this category is influenced by challenges such as the prevalence of informal settlements and non-standardized residential layouts, indicating a gap between planned sustainability goals and their on-ground execution.

2. Neighborhood Pattern and Design

The city's approach to neighborhood pattern and design shows promising, albeit uneven, advancements. While there is evidence of efforts to create mixed-use spaces and walkable streets, the overall impact of these initiatives is diluted by irregular urban planning and the lack of cohesive design strategies.

3. Smart Location and Linkage

Assessment in the Smart Location and Linkage category reveals average performance. Despite some progress in enhancing connectivity and transit accessibility, these efforts are yet to reach a level of maturity and effectiveness that significantly shifts urban mobility paradigm.

4. Innovation in Sustainable Urban Development

Innovation within the realm of sustainable urban development emerges as a significant challenge for Bismayah New City. The research indicates a need for more robust integration of innovative sustainable solutions to enhance the city's overall sustainability footprint.

5. Holistic and Integrated Urban Planning

The findings underline the necessity for a comprehensive, systematic, and integrated urban planning approach. Such a methodology should not only encompass environmental sustainability but also consider the socio-economic dimensions to ensure a balanced and sustainable urban development.

6. Implications for Policy and Future Research

This study enriches the academic discourse on sustainable urban development, particularly in the context of emerging cities like Baghdad. The insights gained from the LEED-ND assessment of Bismayah New City pave the way for future research in sustainable urbanization. From a policy standpoint, the findings emphasize the critical need to prioritize sustainability in urban development strategies to achieve long-term ecological, social, and economic stability.

Recommendations

Drawing from the research conclusions on the Bismayah New City and its assessment using the LEED-ND sustainability tool, the following recommendations are proposed to enhance its sustainable urban development:

1. **Strengthening Innovation:** The city should bolster the application of LEED-ND metrics, especially within the innovation sector. To realize this, incentives, such as fiscal reductions or grants, should be considered for developers integrating cutting-edge sustainable technologies and methods in their initiatives.
2. **Formalizing Urban Development:** Tackling the challenge of informal settlements and unchecked urban sprawl is vital. To improve alignment with LEED-ND's neighborhood pattern and design indicators, it's recommended to devise urban planning policies that facilitate the formalization of these settlements. Introducing zoning laws mandating adherence to specific design standards for new projects can also be instrumental.
3. **Enhancing Green Infrastructure:** Augmenting investments in sustainable infrastructure and building practices is of paramount importance. Initiatives might encompass the promotion of green roofing, rainwater collection systems, sustainable building designs, and the creation of communal parks and green areas. These steps will not only enhance air quality but also counteract the urban heat island phenomenon.
4. **Promoting Alternative Transit:** To better the Smart Location and Linkage metric, there's a need to diminish the dependency on private transport. This can be achieved by endorsing alternatives like cycling and walking, constructing bike paths, pedestrian routes, and rolling out public transport systems that are both reachable and cost-effective.
5. **Boosting Sustainability Awareness:** Elevating community consciousness about sustainable lifestyles is essential. Organizing educational campaigns, workshops on energy conservation, waste management, and sustainable commuting, alongside initiatives like community gardens, will drive local food production and diminish food wastage.

It is concluded that by adhering to these strategies, Bismayah New City can evolve into a sustainable urban space, offering an enhanced living experience for its inhabitants while also benefiting the environment.

Limitations of the study

It is acknowledged that the study was conducted in a single city, and the results may not be generalizable to other cities. The study used the LEED-ND rating system as a benchmark, but other rating systems may be more appropriate for assessing sustainability in different contexts. The study did not consider the social and economic dimensions of sustainability.

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