International Journal of Computational and Experimental Science and ENgineering (IJCESEN)

Vol. 12-No.1 (2026) pp. 19-26
http://www.ijcesen.com

ISSN: 2149-9144

Research Article

Evaluating Social Housing Suitability in Oasis Cities Using GIS-Based Multi-Criteria Decision Analysis: A Case Study of Bou Saada, Algeria

Kaourane Mohamed[1,2]*, Redjem Ali[3,4], Nouibat Brahim[5,6]

[1]Mohamed boudiaf university, Urban Techniques Management Institute, 28000, M'sila-Algeria
[2]Laboratory of City Hydraulic Environment and Sustainable Development, University of Msila, Algeria
* **Corresponding Author Email:** mohamed.kaourane@univ-msila.dz - **ORCID:** 0000-0002-5997-3350

[3]Mohamed Boudiaf university, 28000, M'sila-Algeria
[4]Laboratory of City Hydraulic Environment and Sustainable Development, University of Msila, Algeria
Email: ali.redjem@univ-msila.dz - **ORCID:** 0000-0002-5997-0950

[5]Mohamed Boudiaf University, 28000, M'sila-Algeria
[6]Laboratory of City Hydraulic Environment and Sustainable Development, University of Msila, Algeria
Email: brahim.nouibat@univ-msila.dz - **ORCID:** 0000-0002-5997-1150

Article Info:

DOI: 10.22399/ijcesen.4593
Received : 18 September 2025
Revised : 25 December 2025
Accepted : 28 December 2025

Keywords

Oasis
Housing suitability
GIS-AHP
Climate-responsive design
Socio-cultural adaptation

Abstract:

This research presents a comprehensive assessment of habitat suitability in oasis environments by integrating advanced spatial analysis with multi-criteria decision-making methods. Oasis settings face specific climatic, cultural and spatial constraints that require analytical frameworks capable of capturing local complexity. To address this, the study uses a combined geographic information system (GIS) and analytic hierarchy process (AHP) approach to evaluate social housing suitability in three neighborhoods in Bou Saada, Algeria: the traditional old town (Kasser), the standardized 270 social housing development, and the newly planned AADL neighborhood.The analysis is structured around a multi-criteria framework that includes four key dimensions: environmental-climatic factors (34.7%), socio-cultural criteria (29.8%), functional and design aspects (20.3%) and economic-sustainability considerations (15.2%). Criterion weights were obtained using the AHP method, with consistency ratio verification (CR < 0.10) to ensure reliable pairwise comparisons. The results show significant variations in suitability between districts. The Old Town received the highest score (8.5/10), which reflects strong climate adaptability, cultural continuity and community cohesion. The AADL area was second (6.4/10), demonstrating moderate but better performance. In contrast, 270 social housing sector showed the lowest suitability (4.4/10), which indicates significant design limitations and weak contextual integration.These findings confirm that traditional urban forms provide inherent adaptive advantages in oasis environments. In addition to demonstrating the effectiveness of GIS-AHP integration at the neighborhood scale, the study provides practical insights for planners and policy makers engaged in developing climate-responsive, culture-based housing strategies for arid regions.

1. Introduction

The challenge of providing adequate housing in oasis cities represents one of the most complex intersections between environmental constraints, cultural characteristics and urban development pressures in modern North Africa.[1]. Oasis developments characterized by extreme climatic conditions, chronic water shortages and deeply rooted socio-spatial traditions require housing solutions that go beyond traditional urban planning approaches.[2] In Algeria, national social housing programs have built a large number of housing units in recent decades; However, these standardized architectural models often fail to respond to the environmental and cultural needs of oasis contexts.[3]. Therefore, assessing the suitability of habitat in such environments requires analytical frameworks capable of integrating multiple and sometimes conflicting criteria while ensuring transparency in the decision-making process.[4]. This research addresses an important gap in methods

for assessing livability for oasis cities by developing and using an integrated GIS-AHP framework at the neighborhood scale.The study tests the hypothesis that traditional urban forms – such as those found in historic oasis settlements – show better suitability characteristics than modern standardized housing developments when assessed using broader sustainability criteria. Bou Saada, located in the M'Sila province of central Algeria, provides an exemplary case study for this analysis. The city encompasses a wide range of urban typologies, from the traditional kesar (old town) with its compact, climate-responsive morphology, to newer social housing developments produced through standardized national programmes. This diversity enables comparative assessment of habitat performance across different development approaches in the same environmental and cultural context.The research objectives are: (1) to develop a comprehensive multi-criteria framework for assessing habitat suitability in oasis environments; (2) Use an integrated GIS-AHP methodology at the neighborhood scale[5]; (3) to make a comparative assessment of traditional and modern housing types; and (4) to develop evidence-based policy recommendations for sustainable housing development in similar arid contexts. [6].

2. Literature Review

2.1 Multi-Criteria Decision Analysis in Housing Assessment

The application of multi-criteria decision analysis (MCDA) methods in housing and urban planning has attracted considerable attention as planning experts seek systematic approaches to complex decision scenarios.[7] Malczewski's pioneering work established GIS-MCDA integration as a powerful tool for spatial decision support, enabling the simultaneous assessment of multiple evaluation criteria while maintaining geographic context.[5]. Recent studies have demonstrated the effectiveness of AHP in a variety of habitat-related applications, ranging from site selection to policy evaluation. [6]. Al-Shalabi et al. Was a pioneer in the use of GIS-based AHP for assessment of habitat suitability, and set methodological precedents for parameter identification, weight derivation and spatial integration.[6]

2.2 Social Housing in Algeria: Policies and Performance

Algeria's social housing sector has undergone significant transformation since independence, with major public investment providing hundreds of thousands of housing units. [8]. However, academic evaluation of these programs reveals persistent challenges related to architectural suitability, environmental performance and social integration. Studies conducted in various Algerian cities identify recurring patterns of poor performance in social housing projects. The emergence of various housing programs, including AADL (rent-for-sale housing), represents an attempt to overcome shortcomings of previous models.[9]. Nevertheless, systematic evaluation of these interventions is limited, especially through structured multi-criteria approaches. [6]. Improving the quality of existing urban construction requires a structured understanding of sustainability indicators and their direct impact on the urban built environment [10].

2.3 Oasis Cities and Environmental Adaptation

Traditional oasis settlements constitute exemplary models for environmental and socio-cultural adaptation to dry climates. Their urban fabric reflects a great understanding of climatic challenges through compact floor plans, narrow shaded streets and thick brick walls that reduce heat gain and create favorable microclimatic conditions.[11]. Passive cooling strategies are further enhanced by courtyards, optimized building orientation and natural ventilation systems, which collectively improve thermal comfort and reduce reliance on mechanical cooling. These strategies are complemented by sophisticated water management practices – including underground canals and mass irrigation systems – that ensure efficient resource use in water-scarce environments.[12]. Beyond environmental adaptation, oasis settlements constitute socio-spatial structures that reflect needs for privacy, communal interaction and cultural continuity, and create harmonious relationships between built form, social organization and the natural environment.[13].

2.4 GIS-AHP Integration in Urban Planning

The integration of GIS and AHP has become increasingly sophisticated, with applications ranging from regional spatial planning to detailed site-level analysis. However, most applications operate at a regional or city-wide scale, with limited attention to neighborhood-level assessments, where socio-spatial variables play a key role.[14]. Research gaps remain in several areas: (1) limited application of the GIS-AHP framework specifically to oasis contexts; (2) insufficient emphasis on cultural and social criteria in assessing habitat suitability; and (3) the lack of comparative assessment frameworks that

address traditional and modern housing types in arid environments.

3. Study Area

Bou Saada is located in Algeria's M'Sila Province (35°12'N, 4°11'E), it serves as an important urban center in the country's semi-arid central region. The city experiences a continental semi-arid climate, with hot, dry summers, temperatures often exceeding 40 °C, cool winters and an average annual rainfall of 200–300 mm.

The traditional core, known locally as saffron or the old town, reflects pre-colonial oasis settlement patterns adapted to both environmental and social conditions. [15]. The area is distinguished by its compact urban morphology, narrow shaded streets, traditional farmhouses with thick brick walls and integrated community spaces that improve climate resistance and social cohesion.

270 Housing social neighborhoods represent large public housing developments built in the 1980s and 1990s, characterized by standardized blocks of flats, large distances between buildings, limited vegetation and minimal adaptation to local climatic conditions.

The AADL neighborhood reflects recent rental housing initiatives, offering improved infrastructure and modern amenities, while relying on standardized architectural models with limited contextual feedback.

These three neighborhoods provide an ideal basis for comparative analysis, as they employ distinct development philosophies – traditional, standardized social housing and modern rent-to-sell programs – within the same environmental and cultural setting.

Figure 1. *Location Map of BOUSSADA city (Source: Prepared by the Author).*

4. Methodology

4.1 Multi-Criteria Framework Development

The research uses a comprehensive hierarchical criteria framework at four levels developed through literature review, expert consultation and field observation [16]. This framework integrates both quantitative spatial data and qualitative assessment factors that are relevant to the assessment of habitability in oasis cities, as depicted in Figure 2, which presents the integrated methodological framework for multi-criteria spatial analysis.

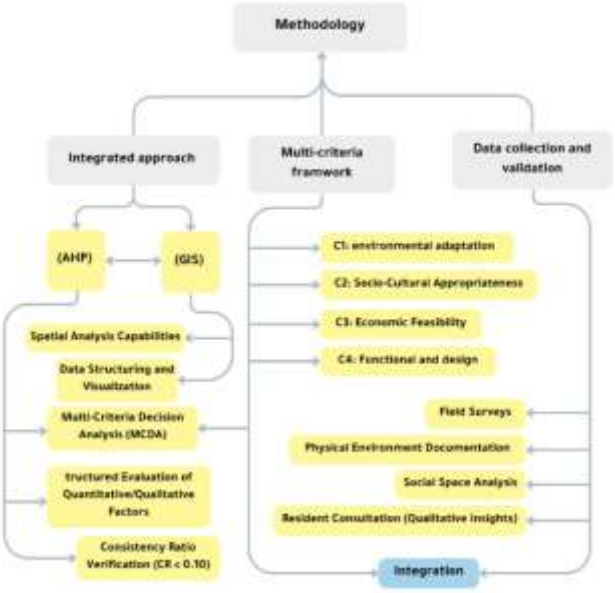

Figure 2. *Integrated Methodological Framework for Multi-Criteria Spatial Analysis (Source: Prepared by the Author).*

4.2 Analytical Hierarchy Process

Implementation

The Analytical Hierarchy Process (AHP) methodology follows Satie's established protocol (1980, 2008) with adaptations for housing assessment at the neighborhood level. The process includes:

1. **Construction of hierarchical structure:** A four-level hierarchy was established: (1) goal level – optimization of habitat suitability; (2) Criteria levels – four main criteria categories; (3) Sub-criteria level – specific evaluation factors; and (4) alternative level – three neighborhoods under evaluation.[16].
2. **Pairwise comparison matrix development:** Criterion weights were obtained through systematic pairwise comparisons using Satie's 1-9 scale (2008). Expert judgment, literature review and local context analysis informed the comparative ratios.

3. **Calculation and normalization of weights:** The parameter weights were calculated using the eigenvalue method. [16]. The eco-climatic criterion received the highest priority (0.347), indicating the critical importance of thermal comfort in desert environments, followed by socio-cultural factors (0.298), functional design (0.203) and economic sustainability (0.152).
4. **Consistency verification:** Matrix consistency was verified through calculation of consistency ratio (CR) [17]. All comparison matrices achieved CR values below 0.10, confirming acceptable levels of stability and validating the weighting results.

4.3 GIS Implementation and Spatial Analysis

Geographic information systems (GIS) played a central role in structuring, organizing and spatially representing the study's data. [5]. ArcGIS software was used to digitize neighborhood boundaries, georeference field observations, and integrate multiple spatial datasets. The GIS environment provided a platform to prepare and manage the spatial information required for AHP evaluation[17]. The final suitability scores for the three neighborhoods were mapped using graded color symbology, enabling a clear visual comparison of their relative performance across selected criteria.

4.4 Field Data Collection and Validation

Extensive field surveys were conducted to validate the spatial data and gather qualitative information necessary for multi-criteria assessment. Fieldwork included systematic photography, assessment of building condition, microclimate observations and evaluation of infrastructure functionality in all three districts with a particular focus on thermal comfort factors. Social space analysis included observation of community space use and adjustment of cultural practices. Informal discussions with long-term residents provided insights into housing satisfaction, environmental performance and community dynamics, and informed the qualitative aspects of the evaluation framework.

5. Results and Analysis

5.1 AHP Calculation Results

The comprehensive AHP analysis yielded separate suitability rankings across the three neighborhoods evaluated, the results of which were validated through rigorous consistency check procedures. [18]. The final weighted scores reveal significant performance variations attributable to different development approaches and design philosophies.

5.2 Final Suitability Rankings

The Old Town (Ksar) achieved the highest overall suitability score of 8.5/10, supporting the research hypothesis that traditional urban oasis forms have inherent adaptive benefits. [19]. The AADL area received a moderate score of 6.4/10, while the 270 social housing area recorded the lowest score of 4.4/10. These results highlight significant differences in environmental performance, cultural compatibility and overall viability between the three habitats.

Table 1. *Final Suitability Rankings table (Source: Prepared by the Author).*

Neighborhood	Suitability Score (Max 10)
Old City	**8.5**
AADL Neighborhood	**6.4**
270 Social Housing	**4.4**

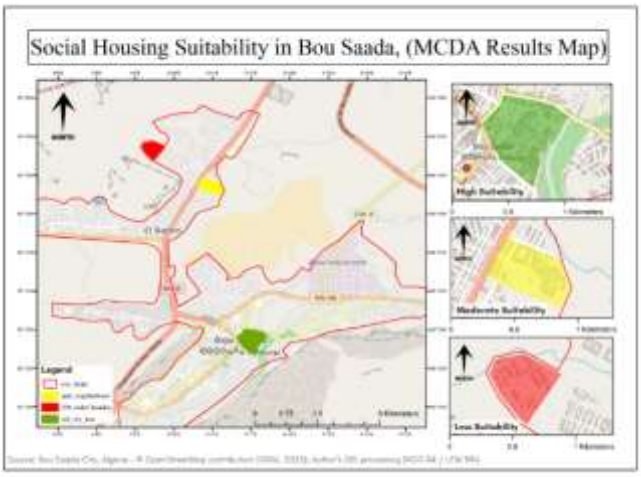

Figure 3. *Social Housing Suitability in Bou Saada Based on GIS–AHP Analysis (Source: Prepared by the Author).*

6. Detailed Criterion Performance Analysis

Analysis of weighted criteria scores provides insight into the underlying factors that shape the suitability variation between the three districts. The Old City shows the strongest overall performance, mainly driven by its exceptional socio-cultural integration (weighted score: 0.253) and its high level of environmental-climatic adaptability (weighted score: 0.278), which is in line with previous findings on oasis urbanism[13]. In contrast, the AADL area shows a more balanced performance profile, benefiting from the strengths of functional urban design (weighted score: 0.162). Nevertheless, its low

score in the environmental-climatic (0.208) and socio-cultural (0.164) highlights the obstacles to implementing standardized national habitat models in environmentally sensitive oases.[20]. The 270 social housing sector has the weakest performance across all criteria, reflecting the limitations of production-focused housing delivery strategies that insufficiently address local cultural patterns and climate needs. This is particularly evident in its low socio-cultural (0.089) and environmental-climatic (0.121) scores, which significantly reduce its overall suitability.

7. Spatial Pattern Analysis

GIS-based spatial analysis shows that the old city exhibits organic growth patterns that enhance pedestrian mobility, natural shade and social interaction, with street networks closely related to the local topography.[14]. In contrast, modern developments follow geometric grid layouts that prioritize vehicular circulation over pedestrian comfort and environmental response. 270 Social housing areas, characterized by wide streets and scattered buildings, generate harsh microclimatic conditions that reduce the general viability.

8. Validation and Sensitivity Analysis

The validation process confirms the reliability and robustness of the analysis results. Consistency ratios for all AHP pairwise comparison values were below the threshold of 0.10, indicating satisfactory decision consistency [18]. Sensitivity testing performed by varying criterion weights within reasonable limits yielded stable neighborhood rankings, confirming that the results reflect real performance differences rather than weighting bias. Additional field-based validation, including thermal comfort measurements and occupant interviews, confirms the analytical findings.

9. Discussion

9.1 Implications for Oasis City Housing Policy

The findings present strong evidence supporting the need to rethink standardized social housing approaches in oasis environments [19]. The Old Town's high suitability score (8.5/10), combined with its consistent performance on environmental, functional and socio-cultural criteria, shows that traditional oasis urbanism continues to provide relevant and effective solutions to modern housing challenges [21]. This highlights the potential of neo-spatial design strategies that combine traditional

Table 2. *Hierarchy of Criteria and Sub-Criteria with Global Weights for Housing Evaluation*

Main Criterion	Weight	Sub-Criterion	Weight within Criterion	Global Weight
C1: Environmental Adaptation	**0.347**	SC1.1: Thermal performance	**40.0%**	**0.1388**
		SC1.2: Water efficiency	**30.0%**	**0.1041**
		SC1.3: Site integration with natural features	**20.0%**	**0.0694**
		SC1.4: Use of appropriate materials	**10.0%**	**0.0347**
C2: Socio-Cultural Appropriateness	**0.298**	SC2.1: Spatial organization aligned with cultural practices	**35.0%**	**0.1043**
		SC2.2: Privacy considerations	**30.0%**	**0.0894**
		SC2.3: Community interaction spaces	**20.0%**	**0.0596**
		SC2.4: Adaptability to changing household needs	**15.0%**	**0.0447**
C3: Economic Feasibility	**0.203**	SC3.1: Construction cost efficiency	**25.0%**	**0.0508**
		SC3.2: Maintenance requirements	**20.0%**	**0.0406**
		SC3.3: Energy consumption costs	**30.0%**	**0.0609**
		SC3.4: Affordability relative to local income levels	**25.0%**	**0.0508**
C4: Functional and Design	**0.152**	SC4.1: Flexibility in space use	**35.0%**	**0.0532**
		SC4.2: Suitability of housing space for average family size	**25.0%**	**0.0380**
		SC4.3: Efficient internal spatial organization	**25.0%**	**0.0380**
		SC4.4: Quality of implementation and construction	**15.0%**	**0.0228**

environmental and social practices with modern construction methods and functions Building laws and regulatory systems work to preserve urbanism, and it plays a crucial role in ensuring that planning decisions remain in line with sustainable development principles [23].The results also indicate that housing quality in oasis cities should be assessed through a multidimensional framework that takes into account environmental performance, cultural appropriateness and long-term sustainability, rather than focusing solely on building volume or cost-effectiveness [6]. The AADL site's moderate score (6.4/10) suggests that modern programs could be significantly improved through better adaptation to local climate and culture. Recommended strategies include the integration of passive cooling systems, reinterpretation of the multi-family courtyard typology, and the design of shared spaces that support local social practices [24].

9.2 Environmental Adaptation Strategies

The Environmental Performance Assessment highlights several strategies capable of improving the climate response of Oasis City housing. Traditional methods – such as optimized building orientation, use of thermal mass, natural ventilation design and integrated shading systems – show proven effectiveness in mitigating extreme climate conditions [25]. In contrast, the poor environmental performance of standardized housing developments, exemplified by the low suitability score of 270 social housing estates (4.4/10), underlines the limitations of using universal design templates in arid environments.

9.3 Socio-Cultural Considerations

Sociocultural analysis emphasizes the fundamental importance of cultural compatibility in achieving residential satisfaction and supporting community well-being [26]. The spatial organization of the Old Town – adapted to privacy norms, gendered space use and traditional social practices – contributes significantly to its strong performance. The low sociocultural scores observed in contemporary housing developments indicate a gap between standardized design models and local social realities. Recommended improvements include providing adaptable courtyard space and spatial configurations that support extended family life and social interaction [26].

9.4 Methodological Contributions

This research contributes to the wider field of assessing habitat suitability in arid and desert areas in several ways. First, it demonstrates the effectiveness of integrating GIS with the analytic hierarchy process (AHP) to conduct multidimensional housing assessments at the neighborhood scale, which allows the combination of spatial, environmental, and sociocultural data [5]. Second, the study introduces a four-tier criteria structure that explicitly incorporates cultural and environmental dimensions, addressing limitations in many existing assessment frameworks [6]. Third, the application of the GIS-AHP approach at the medium (neighborhood) scale represents a methodological innovation, enabling detailed comparative insights that can inform housing policy, urban planning and neighborhood development strategies.

10. Conclusions and Recommendations

This research demonstrates the significant potential of traditional oasis urbanism to inform contemporary social housing development in arid environments Through an integrated GIS-AHP assessment, the old town of Bou Saada (8.5/10) was shown to outperform modern residential development across environmental, socio-cultural, functional and sustainable criteria. These findings challenge dominant assumptions about the superiority of standardized housing models and highlight the importance of locally adapted, context-sensitive approaches [20]. The study confirms that traditional design principles, when properly reinterpreted, provide viable solutions to improve modern housing performance in oasis cities.

11. Key Findings

Environmental Adaptation:

Traditional oasis settlements exhibit sophisticated passive design strategies including optimized orientation, thermal mass, and natural shading that enable comfortable living conditions with minimal reliance on mechanical cooling systems.[28].

Cultural Compatibility:

Cultural appropriateness is a decisive factor for housing satisfaction. The spatial configuration of the ancient city successfully accommodates privacy norms, extended family structures and traditional social practices, which stands in stark contrast to the cultural deficiencies observed in modern standardized development.

Hybrid Development Potential:

The moderate performance of the AADL site (6.4/10) demonstrates the feasibility of a hybrid

approach that combines traditional environmental knowledge with modern building technologies [29].

12. Policy Recommendations

Immediate Actions

Develop climate-responsive design guidelines tailored for oasis cities, which require optimized building orientation, natural ventilation strategies and integrated shading systems [30].ncorporate cultural compatibility standards into housing design frameworks, including flexible courtyards and community spaces adapted to traditional interaction patterns [26].Launches pilot demonstration projects demonstrating hybrid design models that integrate traditional spatial logic with modern features [31].

Medium-term Strategies

Establish professional training programs for architects, engineers and planners on oasis-appropriate design principles and environmental adaptation techniques [32].Revise building regulations and planning rules to encourage innovative, non-standard designs that better respond to local climate and cultural needs.Implement retrofit initiatives to improve the environmental and socio-cultural performance of existing social housing neighborhoods.

Long-term Planning Priorities

Align housing policy with broader environmental and cultural goals, integrating them into long-term urban development strategies [33].Invest in dedicated research and development programs to promote oasis-suitable construction methods, materials and technologies [34].

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

[1] N. Eddahar, “Major challenges facing North African oases.” ICDT-CIDC, 2025. [Online]. Available: https://icdt-cidc.org/wp-content/uploads/Major-Challenges-Facing-North-African-Oases-En.pdf

[2] M. Breviglieri, D. Goeury, and N. Gamal Said, “Oasis Rustles: Sound study of the sub-Saharan Urbanism,” *J. Urban Res.*, vol. 48, no. 4, pp. 47–64, 2024, doi: 10.21608/jur.2024.304358.1163.

[3] K. A. Tabet Aoul and F. Meliouh, “Vernacular versus social housing in the Algerian Sahara: Women’s quest for comfort,” in *The visibility of Zero Energy Housing*, F. Meliouh, Ed., ZEMCH Network, 2013, pp. 69–78. [Online]. Available: http://www.zemch.org/proceedings/2013/zemch2013.pdf

[4] X. L. Castillo and V. Yepes, “Multi-criteria decision methods in the evaluation of social housing projects,” *J. Civ. Eng. Manag.*, vol. 31, no. 6, pp. 608–630, 2025, doi: 10.3846/jcem.2025.24425.

[5] J. Malczewski, *GIS and multicriteria decision analysis*. John Wiley & Sons, 1999.

[6] S. Choudhury and S. Nayak, “Multi-criteria decision analysis for sustainable housing site selection: A GIS-based approach,” *Sustain. Cities Soc.*, vol. 52, p. 101861, 2020, doi: 10.1016/j.scs.2019.101861.

[7] L. Abdullah and C. W. R. Adawiyah, “Simple additive weighting methods of multi criteria decision making and applications: A decade review,” *Int. J. Inf. Process. Manag.*, vol. 5, no. 1, pp. 39–49, 2014.

[8] L. Makhloufi, “Affordable housing in Algeria: Policies, projects and expectations. The case of rental sale housing in Algiers,” *Cities*, vol. 159, p. 105735, 2025, doi: 10.1016/j.cities.2025.105735.

[9] H. Mezrag, H. Boutabba, and M. L. Benamra, “L’analyse de contenu comme méthode d’analyse de la conception et de la qualité du logement social. Cas de la ville de M’sila, Algérie,” *Ann. Univ. Buchar. – Geogr. Ser.*, vol. 71, no. 1, pp. 5–32, 2025, doi: 10.5719/aub-g/71.1/1.

[10] M. R. A. Ali and A. E.-S. E.-T. M. Abdel Halim, “Standards for improving the quality of existing urban construction in light of sustainable quality of life standards,” *Int. J. Comput. Exp. Sci. Eng.*, vol. 11, no. 3, 2025, doi: 10.22399/ijcesen.3676.

[11] M. E. Matallah and et al, “Assessment of the outdoor thermal comfort in oases settlements,” *Atmosphere*, vol. 11, no. 2, p. 185, 2020, doi: 10.3390/atmos11020185.

[12] W. Zhou and et al, “Potential of traditional domestic rainwater harvesting systems: current trends and future directions,” *J. Asian Archit. Build. Eng.*, vol. 23, no. 1, pp. 344–354, 2024, doi: 10.1080/13467581.2023.2214193.

[13] I. Fethi and D. Boussaa, “Vernacular architecture and urbanism in arid regions: Lessons from

Algerian oasis cities," *J. Arid Environ.*, vol. 144, pp. 170–179, 2017, doi: 10.1016/j.jaridenv.2017.04.006.

[14] G. D. Bathrellos, K. Gaki-Papanastassiou, H. D. Skilodimou, D. Papanastassiou, and K. G. Chousianitis, "Potential suitability for urban planning and industry development using natural hazard maps and geological–geomorphological parameters," *Environ. Earth Sci.*, vol. 66, no. 2, pp. 537–548, 2012, doi: 10.1007/s12665-011-1263-x.

[15] A. Diafat, "Preserving the Old 'Ksar' of Bou Saada – Algeria," in *Proceedings of World SB14 Barcelona Conference on Sustainable Building*, Barcelona: GBCe, 2014, pp. 324–330.

[16] T. L. Saaty, *The analytic hierarchy process: Planning, priority setting, resource allocation*. McGraw-Hill, 1980.

[17] R. Banai, "Fuzziness in geographical information systems: Contributions from the analytic hierarchy process," *Int. J. Geogr. Inf. Syst.*, vol. 7, no. 4, pp. 315–329, 1993.

[18] J. A. Alonso and M. T. Lamata, "Consistency in the analytic hierarchy process: A new approach," *Int. J. Uncertain. Fuzziness Knowl.-Based Syst.*, vol. 14, no. 4, pp. 445–459, 2006, doi: 10.1142/S0218488506004114.

[19] B. Nouibat, "Housing problems in Bou Saâda / Algeria: Study of 270 residences quarter," *Soc. Sci.*, vol. 4, no. 6, pp. 106–110, 2009, doi: 10.36478/sscience.2009.106.110.

[20] A. F. Mohamed, "Comparative study of traditional and modern building techniques in Siwa Oasis, Egypt: Case study: Affordable residential building using appropriate building technique," *Case Stud. Constr. Mater.*, vol. 12, p. e00311, 2020, doi: 10.1016/j.cscm.2019.e00311.

[21] L. Xie, H. Wang, and S. Liu, "Simulating the spatiotemporal variations of oasis rural settlements in the upper reaches of rivers of arid regions in Xinjiang, China," *PLoS ONE*, vol. 17, no. 9, p. e0275241, 2022, doi: 10.1371/journal.pone.0275241.

[22] F. Boubenia, S. V. Ilvitskaya, and T. V. Lobkova, "Vernacular architecture and modernity, between conservative and interpretive principles," *Int. Res. J.*, vol. 2, no. 128, 2023, doi: 10.23670/IRJ.2023.128.39.

[23] A. M. M. A. A. A. A. Safa and M. M. A. M. E. Shazly, "Building laws and regulations in the Arab Republic of Egypt as a means to preserve urbanization," *Int. J. Comput. Exp. Sci. Eng.*, vol. 11, no. 3, 2025, doi: 10.22399/ijcesen.3631.

[24] N. Matari, A. Mahi, N. Chabane, Z. R. Harrat, and M. Hadzima-Nyarko, "Design Methodology Development for High-Energy-Efficiency Buildings in Algerian Sahara Climatic Context," *Sustainability*, vol. 17, no. 6, p. 2660, 2025, doi: 10.3390/su17062660.

[25] D. Labdi, K. B. Boudjemaa, and H. Layeb, "Strategies for climate design to enhance energy efficiency in residential buildings: The case of Bou-Saada City, Algeria," *Bull. Serbian Geogr. Soc.*, vol. 105, no. 2, pp. 1–22, 2025.

[26] M. A. Abuhussain, N. Al-Tamimi, B. S. Alotaibi, M. K. Singh, S. Kumar, and R. Elnaklah, "Impact of Courtyard Concept on Energy Efficiency and Home Privacy in Saudi Arabia," *Energies*, vol. 15, no. 15, p. 5637, 2022, doi: 10.3390/en15155637.

[27] T. Mezerdi, A. Belakehal, and I. Sfaksi, "Impact of the socio-environmental quality of the courtyard house on occupant satisfaction: The case of M'chouneche Oasis, Algeria," *Int. Rev. Spat. Plan. Sustain. Dev.*, vol. 10, no. 1, 2022, doi: 10.14246/irspsd.10.1_74.

[28] K. Amraoui, L. Sriti, S. Di Turi, F. Ruggiero, and A. Kaihoul, "Exploring building's envelope thermal behavior of the neo-vernacular residential architecture in a hot and dry climate region of Algeria," *Build. Simul.*, vol. 14, no. 5, pp. 1567–1584, 2021, doi: 10.1007/s12273-021-0764-0.

[29] S. Thaibaoui and W. Arab, "Measuring the sustainability level of neighborhoods with the INDI standard: Case of the neighborhood 1600 AADL apartments in M'sila, Algeria," *Stud. Sci. Sci.*, vol. 42, no. 6, 2024, doi: https://sciencejournal.re/index.php/studies-in-science-of-science/article/view/678.

[30] M. Houkhi and N. Fezzioui, "Thermal comfort design of traditional houses in hot dry region of Algeria," *Int. J. Energy Environ. Eng.*, vol. 3, no. 5, 2012, doi: 10.1186/2251-6832-3-5.

[31] N. Abdel Gelil and K. Abo Eldardaa, "Life cycle assessment of hybrid vernacular modern technologies: a comparative study of the Ecofordable House and conventional RC structures," *Front. Built Environ.*, 2025, doi: 10.3389/fbuil.2025.1568067.

[32] I. Bahreldin, "Assessing the integration of sustainability and climate change in urban planning education: a Saudi Arabian perspective," *Int. J. Low Carbon Technol.*, vol. 19, pp. 2783–2796, 2024, doi: 10.1093/ijlct/ctae246.

[33] A. Moreno Monroy, J. Gars, T. Matsumoto, J. Crook, and A. Schumann, "Housing policies for sustainable and inclusive cities: How national governments can deliver affordable housing and compact urban development," OECD Publishing, 2020/03, 2020. doi: 10.1787/d63e9434-en.

[34] S. El din Ahmed Fouly and A. R. Abdin, "A methodology towards delivery of net zero carbon building in hot arid climate with reference to low residential buildings — the western desert in Egypt," *J. Eng. Appl. Sci.*, 2022, doi: 10.1186/s44147-022-00084-6.