Contents available at Iraqi Academic Scientific Journals

Iraqi Journal of Architecture and Planning

المجلة العراقية لهندسة العمارة والتخطيط

Journal homepage: https://iqjap.uotechnology.edu.iq

Study of The Durability of Mozabite Vernacular Architecture in Its Current State Through the Principle of Contextualisation: Case Study of The Beni-Isguen Ksar, Ghardaïa, Algeria

Samia Ouaali [a *], Karima Anouche [b]

[a] Faculty of Architecture and Civil Engineering, Laboratoire Métropole Architecture Urbanisme Societé (LAMAUS), University of Sciences and Technology of Oran Mohamed Boudiaf, Oran, Algeria.

[b] Faculty of Architecture and Civil Engineering, University of Sciences and Technology of Oran Mohamed Boudiaf, Oran, Algeria.

Submitted: 30/05/2025 Revised: 27/07/2025 Accepted: 08/10/2025 Published: 01/01/2026

K E Y W O R D S

Vernacular Architecture, Universal Heritage, Algeria, M'Zab Valley, Contextualization, Ecological Architecture, Sustainability.

A B S T R A C T

The study aims to assess how current Mozabite vernacular houses fit into their spatio-temporal context, focusing on the Beni-Isguen ksar in Ghardaïa, Algeria. Recognized as a UNESCO World Heritage Site, Mozabite architecture once embodied ecological and sustainable housing, perfectly adapted to its environment. However, transformations intended to ensure durability have raised questions about contextualization, a core principle in sustainable development. Using a multi-method approach—comprising fieldwork, interviews, photographs, and observations of architecture and lifestyle—the study examined contextualization through a multidimensional grid that encompassed physical, environmental, social, cultural, economic, and historical aspects. Results indicate that while these dwellings preserve strong physical, cultural, and historical roots, they no longer fully meet residents' social needs or respond to economic pressures. Unsupervised modifications have undermined compliance with heritage protection and weakened their environmental intelligence. The article concludes by offering perspectives for research, heritage rehabilitation, and the design of new housing that is ecological, sustainable, and better adapted to contemporary needs.

الكلمات المفتاحية

العمارة المحلية، التراث العالمي، الجزائر، وادي ميزاب، التكيّف السياقي، العمارة البيئية، الاستدامة.

الملخص

تهدف هذه الدراسة إلى تقييم مدى انسجام المساكن المحلية المزابية في حالها الحالي مع سياقها المكاني والزماني، بالاعتماد على دراسة حالة قصر بني يزقن في غرداية، الجزائر. هذه المساكن المدرجة على قائمة اليونسكو للتراث العالمي شكّلت نموذجاً ملهماً للسكن البيئي المستدام بفضل تناغمها التام مع محيطها. غير أن التحولات التي طرأت عليها، رغم مساهمتها في استمراريتها، أضعفت أصالتها وأثارت تساؤلات حول سياقها، وهو مفهوم أساسي في العمارة المرتبطة بمبادئ التنمية المستدامة. اعتمدت الدراسة منهجاً متعدد الأدوات يضم العمل الميداني والمقابلات والصور والملاحظات المعمارية والمعيشية، باستخدام شبكة تحليلية تغطي الجوانب المادية والبيئية والاجتماعية والثقافية والاقتصادية والتاريخية. أظهرت النتائج أن هذه المساكن ما تزال تحتفظ بجذورها المادية والثقافية والتاريخية، لكنها لم تعد تستجيب كلياً للاحتياجات الاجتماعية والاقتصادية للسكان. كما أن التحولات غير الخاضعة للإشراف أضعفت الامتثال لمتطلبات حماية التراث وأثرت في ذكائها البيئي. وتخلص الدراسة إلى آفاق لإعادة تأهيل التراث وتصميم مساكن جديدة أكثر استدامة وملاءمة للسياق الراهن.

* Correspondent Author contact: samia.ouaali@univ-usto.dz
DOI: https://doi.org/10.36041/iqjap.2025.160885.1169
Publishing rights belongs to University of Technology's Press, Baghdad, Iraq.
Licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

1. Introduction

The vernacular dwellings of the M'Zab valley in the ksour historically constituted a model of sustainable and ecological architecture (Kadri, 2021). They exhibited characteristics of anchoring in the local context, striking a harmonious balance between the built environment, the natural environment, and the lifestyles of the inhabitants, which largely contributed to their sustainable character (Gueliane, 2017). Designed according to the climatic, geographical, and cultural specificities of the territory, they met the needs of users while ensuring their daily well-being (Rezaei, 2021).

However, over the decades, these dwellings have undergone significant changes, undergoing profound transformations in response to the modernization of domestic space and new living needs (Bouali Messahel, 2019), particularly those of the ksar Beni-Isguen. Hammou and Drias (2024) report that 81.2% of the Mozabite vernacular houses have undergone major modifications. The rehabilitation works, often initiated by the inhabitants themselves to satisfy their aspirations, have led to a deterioration and modification of the original architecture. These changes have certainly ensured the survival of these dwellings, but this dynamic raises questions about the contextualization of this architecture — a key principle of ecological and sustainable architecture (Shahbazi, 2016).

Indeed, several works converge on this observation: the research of Chuapram et al. (2012), Widiastuti (2013), Thakkar (2019), and Mirkar & Sharma (2019) show that contemporary alterations of vernacular habitats often negatively affect their ecological and sustainable aspects. Ekaterina & Todorovska (2024) affirm and encourage a critical analysis of vernacular architecture in its current state because, although it often has sustainable and ecological qualities, it can obscure, through its evolution and transformations in response to contemporary needs, complex realities such as the challenges related to architectural sustainability and the impact of modernization on the environment.

Therefore, this study proposes to analyze the degree of contextualization of vernacular dwellings in the M'Zab Valley, through the case of the ksar of Beni-Isguen in its transformed state. The objective is to determine the extent to which these dwellings continue to fit into their local context and whether they still adhere to a logic of ecological and sustainable architecture.

It should be noted that a large number of previous works have explored the contextualization of the Mozabite vernacular habitat from various angles, particularly through thermal and bioclimatic performances, the materials used, and the interaction between the built forms and the natural environment, as well as the sociocultural and functional logics that underlie the design of dwellings. This research has also highlighted local construction practices and sustainable management methods, and the wealth of traditional know-how (Hamdani et al., 2012; Bellal, 2013; Rais & Cabellero, 2019; Rezaei, 2021; Kadri & Laafer, 2021; Kadri, 2021; Kadri & Bouchair, 2022; Messaitfa & Bencherif, 2023; Hammou & Drias, 2024; Dahmani et al., 2024).

However, they focused on the initial state of these architectures, often neglecting their contemporary evolution and the transformations that this habitat has undergone over time. Moreover, as revealed by Qasem Al-Hammadi and Grchev (2022), more than 84% of research on the contextualization of architecture is limited to the analysis of tangible aspects (forms, materials, morphology), often neglecting immaterial dimensions such as politics, culture, and social factors.

This double gap— (1) the lack of consideration for contemporary transformations and (2) the weakness in the dominant contextual approach — justifies the need for a new approach. To exceed this limit, this study adopts a global and updated approach to analyzing the contextualization of the vernacular habitat in the M'Zab Valley, focusing on the case of the ksar of Beni-Isguen in its current transformed state. To achieve this, the study develops a contextual analysis grid specifically tailored to the M'Zab valley, an approach currently absent in the scientific literature. This grid thus constitutes an original tool for assessing the degree of contextualization of the Mozabite vernacular architecture in its transformed state.

To achieve the research objective, the study combines theoretical contributions, field observations, and a multi-criteria analysis grid.

2. Theoretical Framework

2.1. The Sustainable Intelligence of Vernacular Architecture

The International Committee for Vernacular Architecture (CIAV) defines vernacular architecture as architecture that is popularly inspired and develops its own characteristics in a specific region, using local materials, building techniques, and traditional forms of that region (ICOMOS, 1999). According to Oliver (1997, 2003), it is designed by the inhabitants themselves or their community, in harmony with the environment, cultural values, lifestyles, and their economic resources. He defines it as "architecture of the people and by the people," emphasizing its ability to balance the comfort of the inhabitant while respecting the environment. Rapoport (1969) reinforces this idea by stating that this architecture reflects local social and cultural structures, is intelligently anchored to its natural and built physical context and its environmental context (climate, natural resources), and exhibits intrinsic sustainability. This description unequivocally establishes vernacular architecture as a sustainable practice (Ferrus et al. 2024). In this perspective, Hassan Fathy (1973) also recognized its sustainable potential through his achievements, such as New Gourna and New Baris in Egypt. He demonstrated that vernacular knowledge – integrating the use of local and natural resources, traditional construction techniques, bioclimatic devices, respect for cultural values, and the lifestyles of communities – offers sustainable solutions adapted to social, cultural, environmental, economic, and physical contexts.

This idea is also supported by numerous studies internationally. Several authors confirm that vernacular architecture is fundamentally sustainable, as it is born from a progressive adaptation to the local environmental, physical, cultural, social, economic, and regulatory context specific to each territory (Attia, 2019; Nguyen et al., 2019; Sayigh, 2019; Jagatramka et al., 2021; Gundogdu, 2021). As Al-Sakiny and Al-Kafaji (2022) also point out, built heritage has a close relationship with sustainable development, as it is based on environmental, social, and economic foundations. Therefore, vernacular architecture, as part of the built heritage, fully fits into this relationship. Vernacular architecture then emerges as a resource of inspiration for designing contemporary buildings that are ecological, sustainable, and well-anchored in their context (Martinovic and Herzegovin, 2023; Osou, 2024).

2.2. The Contextualization of Architecture

Context in architecture has given rise to what is known as 'contextualism', a theoretical approach that focuses on the relationship between architecture and its built environment (Al-Hammadi and Grchev, 2022). Having become a major paradigm of urban and architectural thought since the 1950s, it developed in reaction to the limits of the Modern Movement (Daglioglu, 2015). Contextualism seeks to understand the components of a place—its topography, climate, urban fabric, history, and sociocultural values—in order to design interventions that respect and extend its identity (Osou, 2024). From this perspective, contextualized architecture no longer views the building as an isolated object, but rather as a living component, integrated into its site, neighborhood, and community (Tan, 1992). It thus aims to establish a harmonious relationship between architecture and its context, taking into account the continuity of places and their singularity (Shahbazi, 2016).

Architectural context is not limited to the physical environment of a site; it encompasses a complex set of parameters that influence the design and use of a built space.

According to Unwin (2003), context is manifested in two fundamental categories:

- A spatial dimension, through the physical and environmental characteristics of the site;
- A temporal dimension, linked to the history and memory of the place, and sociocultural values that shape local identity.

In the same spirit, Hazbei and Cucuzzella (2023) distinguish two types of attributes in the architectural context:

- Tangible attributes, such as climate, materials, topography, adjoining buildings, built forms, and constructive details;
- Intangible attributes are related to the social structure, cultural values, religious values, and historical values of the territory.

2.3. Architectural Contextualism as A Foundation and Criterion of Sustainability

Contextualism is considered a central principle of sustainable architecture. Shahbazi (2016) states that considering the physical, historical, social, cultural, and climatic contexts is essential for achieving the goals of sustainable development in architecture. According to him, sustainable design does not oppose its context, but interacts with it, respecting its characteristics and enhancing the specificities of the place.

Along the same lines, Davey (2002) considers contextualism as the key to a sustainable future. He emphasizes that sustainable architecture cannot emerge without careful attention to the local context. This involves drawing on the unique characteristics of the site—whether physical, social, cultural, or environmental—to produce an integrated, resource-efficient architecture that respects local identities and cultures.

Pellaud (2011) further develops this idea with his principle of relativity, asserting that sustainability goals cannot be universal or standardized. They must adapt to each specific situation, directly aligning with the principles of contextualism. Morin (2000) adopts a more epistemological approach, emphasizing the need to consider complexity: any architectural creation must articulate both global and local dimensions, integrating diversity, interdependence, and rooting.

This concept is echoed in institutional definitions, such as that of the Organisation for Economic Co-operation and Development (OECD), which affirms that sustainable buildings must reduce their environmental impact while taking into account their context. Sustainability in architecture also implies a harmonious integration into its context, including the environment (Salman & Hameed, 2020).

In this regard, several recent studies highlight that contextualization is also a criterion for assessing sustainability. Tabarsa and Naseri (2017) argue that the integration of local contextual factors is an essential stepping-stone towards ecological and sustainable architecture. Numerous empirical studies (Farmer (2013), Shahbazi (2016), Bahrami (2016), Filep and Thompson-Fawcett (2020) point in the same direction: they demonstrate that design practices that value the local context are more likely to produce sustainable, adapted, and resilient responses. Thus, architectural contextualism appears not only as an essential principle of architectural sustainability but also as a crucial tool for assessing its local relevance.

2.3.1. Review Studies on The Evaluation and Analysis of Architectural Contextualization

To construct a solid, objective, and operational theoretical framework for analyzing architectural contextualization, this section is based on an in-depth review of previous scientific studies. It allows us to identify the dimensions, criteria, and indicators necessary for measuring the research variables selected in the context of developing the analysis and evaluation grid for the case studies.

Several authors have proposed methodological approaches to assess architectural contextualization, emphasizing the importance of the local environment in the design of built spaces. Akbari et al. (2017) emphasize the simultaneous consideration of physical (landscape, natural hazards, topography, soil character), climatic (sunshine, ventilation, temperature), social (lifestyle, domestic needs), and cultural (values, beliefs, identity practices) factors, to ensure the integration of the building into its site while meeting the requirements of sustainable development. Similarly, Abrar (2021) addresses the approach of contextual architecture, by coherently integrating the climatic (thermal conditions, sunshine, wind, precipitation), geographical (topography, nature of the soil, surrounding landscapes), cultural (values, beliefs, local traditions), economic (locally available resources, construction cost, maintenance cost) and political (regulations, institutional framework) dimensions of the local context. Alhamdani (2010) specifies that this approach is based on harmony with the natural environment (contour lines, natural elements, and landscape, climate, and natural resources), as well as the built environment (height, form, density, morphology, and typology). A systematic review on "Context Knowledge in Architecture" conducted by Yücel and Arabacıoğlu (2021) expands the understanding of architectural context. In addition to the geographical and material specificities of a site, the authors highlight the importance of sociocultural dimensions—such as adaptation to local lifestyles, user needs, and cultural values. They also emphasize legal aspects, including compliance with local regulations, as well as historical considerations, notably the respect for the memory and identity of the place.

Drawing on the work of Rapoport, Altman, Wohlwill, Venturi, Brown, and Izenour, Radoine (2017) argues that a project can be considered contextual if it responds to several essential environmental variables. He identifies five key dimensions. First, cultural values and symbolism are expressed through architectural

elements that convey meaning or identity. Second, the representation of cultural meaning refers to the project's ability to reflect beliefs, traditions, or collective memories. Third, spatio-cultural layout, meaning the organization of spaces in harmony with local lifestyles, social practices, or family structures. Fourth, environmental sustainability, achieved through the use and valorization of local resources. Finally, local construction expertise encompasses traditional building techniques, the utilization of local materials, and the involvement of local artisans. These variables enable the assessment of a project's degree of alignment with its environment and culture.

Hazbei (2023) proposes a structured categorization of the architectural context around seven complementary dimensions. The environmental context encompasses elements related to the site's climate, natural factors, and topography. The physical context refers to the formal characteristics of the built environment, such as proportionality, scale, construction materials, colors, architectural typology, urban morphology, and density. The social context encompasses the individual needs, lifestyle, and usage patterns of residents. The cultural context includes several key aspects. It encompasses local architectural properties and character, including tectonic forms, local materials, and typologies. It also involves the site's heritage, including historical or listed elements.

Additionally, it incorporates symbolic codes, such as religious values and social rituals. The sense of place is another important aspect, reflecting the collective perception and memory of the residents. Finally, it encompasses identity elements, which are recognizable features that express cultural anchoring—such as forms, colours, practices, or structures specific to a community. The historical context encompasses historic buildings and monuments, symbols, and the memory of past practices. The economic context considers the viability of building maintenance and operation, as well as the availability and accessibility of local materials, and the practices that contribute to local economic dynamics. Finally, the political and regulatory context encompasses legislation, local standards, and policies related to heritage management and preservation.

In his article "Criteria for Contextualism in Architecture" (2015), Nasr proposes a series of criteria and indicators to assess the contextualization of a building in its environment. These criteria are based on three fundamental references from vernacular architecture: people, site, and materials. People represent the center of non-physical dimensions, including social, political, economic, and cultural aspects. The site refers to the physical environment of the project, including views, trees, land topography, urban morphology, and climate. Finally, materials concern all the elements used for construction, in connection with local resources and traditional know-how. The proposed approach thus aims for a comprehensive assessment, based on both the tangible and intangible attributes of the architectural context. Guedria's (2016) study of the traditional housing of Nefta, in southwestern Tunisia, examines the contextualization of this housing through two main dimensions. First, the environmental context is analyzed through parameters such as the orientation of the houses and the choice of local building materials, which are adapted to the climate and available on-site. Second, the social context is assessed based on the living area, including the number of occupants and the layout of the rooms, which are designed to meet the needs and lifestyles of the inhabitants. The social dimension concerns the comfort of residents (Salim et al., 2025), which constitutes the central element of its evaluation.

The different approaches converge towards the idea that context in architecture is fundamentally multidimensional. From the cited works, seven contextual dimensions were identified – environmental, physical, social, cultural, economic, regulatory, and historical – each with its own analysis criteria and observable indicators. These theoretical contributions have enabled the establishment of a structured and operational analysis grid, designed to evaluate the degree of architectural contextualization in the buildings studied in this research (see Section 2.5).

2.4. The Contextualization of The Mozabite Vernacular Habitat

To enrich and adapt the analysis grid indicators to the local context, a combined approach of documentary analysis and field research was employed. The research was based on scientific documentation, as well as archival and historical sources. These were provided by specialized institutions in the region, including the Office for the Protection and Promotion of the M'Zab Valley, heritage archive libraries, and the Saharan Cultural and Documentation Center. In addition, interviews were conducted in the ksour—both individually and in groups—with residents who serve as custodians of local memory, as

well as with historians, heritage experts, and presidents of heritage protection associations. The group interview, in particular, allowed for a diverse range of points of view to emerge by encouraging expression through interaction between participants. This approach enabled the identification of the architectural specificities of the Mozabite habitat, which ensured its contextual anchoring.

These specificities manifest themselves notably through:

2.4.1. Adaptation To the Physical Context

Mozabite vernacular housing was distinguished by a strong capacity to adapt to its physical context, both natural and built. Located far from fertile land and in perfect harmony with the terrain, the dwellings followed the contour lines without altering the landscape, contributing to a harmonious integration into the environment (Roche, 2003; Benyoucef, 2010; Gouaich et al., 2018). This layout considered the textures and natural tones of the soil, along with the preservation of panoramic views, thereby reinforcing the visual and symbolic link with the environment while contributing to visual comfort. The buildings also demonstrated resilience to natural hazards, particularly seasonal flooding in wadi bottoms and earthquakes, thanks to their location at heights and on rocky peaks (Benyoucef, 2010). In terms of construction, the houses fit coherently into the existing urban fabric: their proportions (size, height, density) respected the rules of balance between dwellings, without dominating or being dominated (Bouali Messahel, 2019). The typology of the houses, their compact and terraced morphology, and the coherence of the exterior façades demonstrate a collective desire to preserve the harmony of the built environment (Donnadieu and Didillon, 1986; Benyoucef, 2019).

2.4.2. Adaptation To the Environmental Context

Mozabite vernacular housing was distinguished by its adaptation to the local environmental context, utilizing local, natural resources, and responding to the climate and seasons. Indeed, the spatial design of the dwellings took into account the optimal orientation of interior spaces, favoring natural light, cross-ventilation, and passive thermal control (Ravéreau & Roche, 1990). Most dwellings were oriented towards the southeast, allowing for optimal control of sunlight and contributing to good thermal comfort throughout the year (Razaei, 2021), while also protecting from sandstorms.

The building materials used primarily came from the immediate environment: locally extracted stone, plaster, earth, and palm ensured both good thermal inertia and a reduced ecological footprint (Kadri and Laafer, 2021). These natural resources were used according to traditional know-how that maximized their thermal efficiency.

Mozabite architecture also incorporated ingenious bioclimatic solutions: in addition to orientation, thick stonewalls and rare façade openings limited unwanted heat exchanges, while the Chebek (opening on the floor) and the Skiffa (entrance vestibule) played a key role in seasonal thermal regulation through the draft effect, in both summer and winter (OPVM, 2019). Climate adaptation was reinforced by an interior organization marked by the principle of nomadism—a lifestyle based on seasonal movement—that influenced domestic architecture by establishing the flexibility of spaces. Residents occupied different rooms according to the seasons and times of day, moving to cooler areas in summer or sunnier areas in winter, thus promoting natural thermal comfort without resorting to mechanical systems (Bouali-Messahel, 2019).

2.4.3. Adaptation To the Local Cultural and Regulatory Context

Mozabite vernacular housing was distinguished by its deep roots in the cultural norms of the Mozabite community. The architecture also expressed a strong identity through symbolic elements, including simple geometric patterns, sober façade colors, the house's orientation towards the qibla, the integration of worship spaces into the interior layout, and the utilization of ancestral knowledge passed down from generation to generation (Rezaei, 2021). The construction of dwellings was also based on Touiza, a system of community mutual aid, where everyone participated in the construction site according to their means (physical or financial), strengthening social ties and consolidating a culture of active solidarity (Parmentier, 1946). This collective knowledge was reflected in the use of local materials, simple construction techniques, and the visual unity of the built ensemble (Ravéreau, 1981).

This architecture, shaped according to endogenous principles, reflected a spatial organization in accordance with the ethnic, cultural, and regulatory norms specific to the Mozabite community. The houses

were designed according to a framework governed by the Orf (customary law), which established strict rules regarding privacy and community harmony. These included the separation of interior spaces by gender and the division of the house into two distinct zones: one reserved for private family use, and the other for receiving male guests. The roof terrace had to be enclosed by walls at least 1.70 meters high, allowing women to circulate freely without being seen. The house threshold symbolized the boundary between the public world of men and the private, protected life of the family and women. Respect for the shared wall was also crucial. No entrance faced that of a neighbor. Openings could not look directly into adjoining homes and had to stay within the height limit prescribed by law, to preserve privacy while still allowing sunlight and natural ventilation into both houses (Bellal, 2013; Gueliane, 2020).

These characteristics ensured that the habitat had a profound resonance with its site and culture, thereby reinforcing its contextual anchoring.

2.4.4. Adaptation To the Social Context

From a social perspective, the Mozabite vernacular house demonstrated a great capacity to adapt to the social needs of the inhabitants. It provided a space and a spatial arrangement that facilitated intergenerational cohabitation, while ensuring the privacy and functional separation of spaces (Bouali-Messahal, 2019). The interior spaces were flexible, scalable, and adapted to a logic of seasonal use (Bouali-Messahal, 2019). Furthermore, the introverted nature of the house, combined with the thickness of the walls, contributed to good acoustic insulation, limiting external nuisances. The spatial organization, as well as traditional construction techniques, ensured significant thermal and sound comfort, without recourse to modern technologies. External aesthetics also played a significant social role, characterized by sobriety and the absence of ornamentation or ostentation, reflecting a desire to express social equality in line with the demands and values of Mozabite society (Ravéreau, 1981).

2.4.5. Adaptation To the Economic Context

Mozabite housing was distinguished by an economical construction logic, with a surface area generally less than 100 m² and a sober architecture, reduced to the essentials, both in the spatial organization and in the treatment of the façades (Ravéreau, 1981). The forms were not the result of an aesthetic choice, but rather a logical adaptation: the rooms were adjusted to the span of the palm beams (approximately two meters), the ceilings were low, and the staircases had a single flight due to the low height of the floors. Each space was used optimally (Donnadieu & Didillon, 1986). Ravéreau speaks of an "economy of gesture" to describe this constructive rationality.

The principle of economy was also reflected in the materials used, which were collected on-site, thus reducing supply and transportation costs. The implementation of simple techniques, transmitted orally, enabled the inhabitants to build their own houses without relying on a specialized workforce. The bioclimatic principles and passive strategies integrated into architecture — such as controlled orientation, thick walls, and the absence of overheating — avoided the use of mechanical or costly devices to ensure comfort. The Mozabite dwelling of the ksar had masonry furniture, which also reduced furnishing costs.

2.4.6. Adaptation To the Historical Context and Respect for The Memory of The Place

For several centuries, until the 1950s and 1960s, Mozabite architecture successfully preserved the identity and spirit of the place (Bousquet, 1983). The construction of the habitat was part of a logic of transmission, where each generation perpetuated inherited knowledge and practices, without breaking with the Mozabite architectural identity. This fidelity to the past was reflected, on the one hand, by the compatibility of textures, materials, and architectural details with those of old buildings, notably the mosque, the architectural emblem of the ksar (Ravéreau, 1981). New interventions, when they existed, tended to preserve this material coherence to maintain the visual integrity of the ksourian landscape. On the other hand, the use of architectural forms inherited from local history – such as arcades, flat roofs, or discreet openings – reinforced the building's typological and symbolic continuity. Architecture thus becomes a vector of collective memory, where each detail tells its own story (Constant, 1979).

Finally, this adaptation was also based on the preservation of traditional knowledge, notably through community-building practices, the role of local artisans, and the intergenerational transmission of knowledge. This process not only reinforced the heritage identity but also contributed to the sustainability of the habitat by building on solutions already proven by history.

This process of highlighting the contextualization of Mozabite housing made it possible to validate and adapt the indicators of the analysis grid according to the specificities of the local context (see Section 2.5).

2.5. Elaboration Of the Contextualization Analysis Grid

Based on the research analysis and fieldwork conducted in the previous sections (2.1 to 2.5), an evaluation grid was developed to measure the degree of contextualization of the Mozabite vernacular habitat after transformation, as shown in Table (1).

Table 1. Analysis grid for studying the principle of contextualisation in architecture. Source: (Authors).

Dimensions	Analysis criteria	Interpretation of aspects into Indicators
Physics	1. Harmony with the natural environment	1.1. Integrating into the landscape (siting along contours, use of colours and textures in the natural nuances of the terrain, preserving views and panoramas). 1.2. Responses to natural hazards (flood protection, earthquake resilience, etc.). 1.3. Adaptation to topography and natural soil.
	2. Consistency with the built environment	2.1. Matching the proportions of the buildings (shape, size, density, and height) to the existing urban fabric. 2.2. Adapt to the local typology and morphology. 2.3. Consistency of external façades.
Environmental	3. Use of local and natural resources	3.1. Orientation of spaces (light, ventilation, thermal control). 3.2. Materials used (type, origin).
	4. Adaptability to climate and seasons	4.1. Building orientation (considering factors such as sunshine, shade, sandstorms, etc.). 4.2. Natural ventilation, solar protection, thermal insulation techniques, bioclimatic techniques, façade openings. 4.3. Use of interior spaces for thermal comfort.
Cultural	5. Meeting cultural and local values	5.1. Spatial organisation is structured according to ethnic and local norms. 5.2. Local architectural properties. 5.3. Use of local architectural character. 5.4. Presence of symbolic, identity, or heritage elements. 5.5. Use of traditional construction know-how. 5.6. Resonance with the identity of the site.
Social	6. Adapting to the lifestyles and needs of today's users	6.1. Living space and its relationship to the number of inhabitants are important considerations. 6.2. Layout of interior spaces and number of rooms. 6.3. Interior comfort (visual, olfactory, thermal, acoustic). 6.4. Aesthetic requirements. 6.5. Service efficiency (access to water, waste management). 6.6. Ability of buildings to meet functional requirements.
Economical	7. Access to resources	7.1. Local availability of traditional materials. 7.2. Local presence of traditional building skills.
	8. Economic viability of building maintenance and operation	8.1. Cost of traditional materials. 8.2. Cost of local artisans skilled in traditional materials. 8.3. Optimisation of natural resources. 8.4. Maintenance, renovation, and rehabilitation costs.
	9. Impact on the local economy	9.1. Use of local building materials. 9.2. Involvement of local artisans and workers in maintenance and modification work.
Policy and regulations	10. Compliance with local regulations	10.1. Respect for local and cultural principles and rules. 10.2. Compliance with heritage protection requirements or protected areas (architectural style, materials, height, etc.).
History	11. Respecting the memory of the place	11.1. Compatibility of textures or details with iconic buildings. 11.2. Use of forms and practices inherited from local history. 11.3. The continuity of knowledge and the preservation of old features.

3. Methodology

The methodology of this research is based on a mixed approach, combining theoretical sources (literature review, historical and archival documentation) and empirical sources (field observations, semi-structured interviews, architectural surveys and photographs), in order to analyze to what extent, the vernacular architecture of the transformed dwellings of the ksar of Beni-Isguen remains contextualized, that is to say, in adequacy with its local environment. This methodological choice is justified by the desire to strengthen the validity and depth of the analysis by combining theoretical contributions with direct field observations (Dawson, 2002; Johnston, 2014; Sugiyono, 2014). The analysis was structured around four complementary steps, Figure (1):

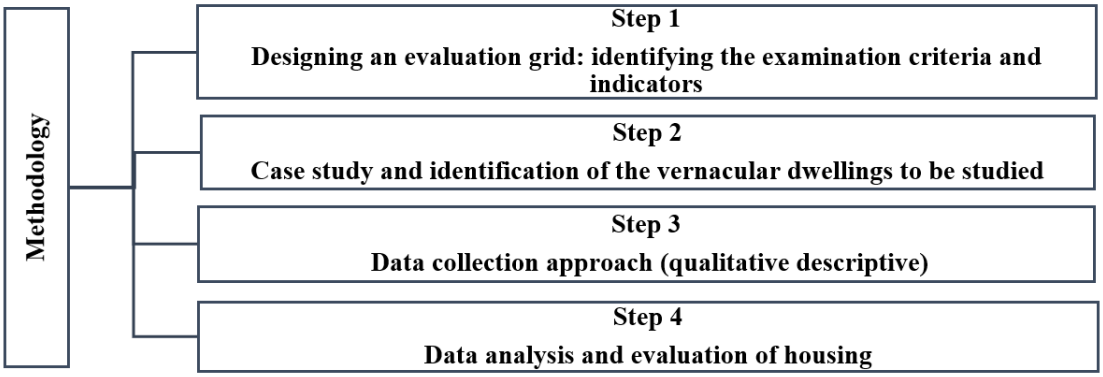


Figure 1. The methodological framework of the research. Source: (Authors).

First, a design for an evaluation grid is developed to measure the degree of contextualization after transformation, based on the literature review and the theoretical framework established previously. This made it possible to identify the main contextual dimensions — physical, social, cultural, historical, environmental, economic, political, and regulatory — as well as the relevant criteria for the analysis. Thus, the theoretical basis was enriched by consulting historical and archival documentation from specialized institutions operating in the M'Zab Valley and by conducting interviews in the ksour, either individually or in groups, to gain a deeper understanding of the original elements of Mozabite architecture that ensured its contextual anchoring. This cross-referencing made it possible to validate and adapt the indicators in the local context. In the second step, a targeted selection of transformed dwellings was made based on field observations and exchanges with the inhabitants, associations, and local authorities, focusing on vernacular houses that are still inhabited and representative of current dynamics. The selected case studies have been subject to qualitative documentation (surveys, observations, interviews), making it possible to gather the information necessary for the rigorous application of the analysis grid. This approach aims to establish a solid empirical basis for evaluating how these dwellings react to their context after transformation. Finally, the case studies are analyzed, and to facilitate reading the analysis and interpreting the results, ratings were assigned to each indicator. Each indicator was assessed on a scale of 1 to 5, as follows: 1 (very low/poor), 2 (low/poor), 3 (average/acceptable), 4 (good/satisfactory), and 5 (very good/excellent). The grades were then weighted fairly, with each dimension representing 14.29 points in the final overall grade, according to the following formula:

$$\text{Score dimension} = \left(\frac{\text{Average score}}{5}\right) \times 14{,}29 \qquad (1)$$

The graphical representation, in the form of a radar, allows for the visualization of the contextualization profile of each dwelling. The objective is to obtain a profile as close as possible to the value 14.29.

Although this methodology offers an exhaustive exploration, it presents certain limitations. On the one hand, the selection of transformed vernacular dwellings has been hampered by the scarcity of available cases (vernacular dwellings built since the foundation of the ksar and still inhabited today). The ancestral vernacular dwellings were either destroyed and rebuilt or abandoned. This may have limited the diversity of the sample. To overcome this constraint, research was conducted on the entire vernacular urban fabric with the help of residents, associations of ksour neighbourhoods, heritage protection associations, tourist

guides, and local officials exercising authority in the Mozabite society, as well as through field observations.

On the other hand, the incomplete access to certain technical and historical archives limited the understanding of the original elements of Mozabite architecture that ensured its contextual anchoring. In-depth interviews with the guardians of local memory and field agents with empirical knowledge of the built environment partly compensated for this difficulty. Moreover, even if this method is based on a rigorous evaluation grid based on objective criteria—such as the physical characteristics of the dwellings, their landscape integration, or compliance with local ethnic regulations—it is not limited to a strictly technical reading. Thanks to a methodological triangulation combining architectural surveys, field observations, and interviews with the inhabitants, the analysis also takes into account more subjective dimensions such as the perceptions of the inhabitants of their thermal comfort, the adaptation of spatial dimensions, and satisfaction with spatial organization, thus offering a more complete understanding of the contextualization of transformed architecture. Furthermore, the site's World Heritage status, combined with the conservative nature of Mozabite society, posed specific challenges: in particular, access to the highly intimate domestic space is strictly limited, especially for foreign men, due to the presence of women in the home. Thus, visits, photography, and architectural surveys proved difficult. However, being a woman and accompanied systematically by a tourist guide from the community somewhat alleviated these constraints, allowing the surveys to be conducted under more favorable conditions. Finally, although designed for a specific context, the analysis grid can be used in other similar contexts; however, it must always be subject to prior verification and possible adaptations to ensure its relevance.

4. Case Study

The M'Zab Valley, with its palm groves, lies to the north of the Algerian Sahara Desert, 600km from the capital, Algiers, Figure (2). It is composed of five ksour (ksar, in the singular): Al Atteuf, Bounoura, Ghardaïa, Beni-Isguen, and Melika Figure (3). The ksar, as a fortified city, is an original type of dwelling unique to the Maghreb (North Africa), whose origins date back to the first urban forms characteristic of the Arab-Muslim cultural area—like many medieval The Beni-Isguen ksar was founded in 1320-1321, following the initial settlement of Tafilalt, considered the first human settlement in the city (Cherifi, 2015).

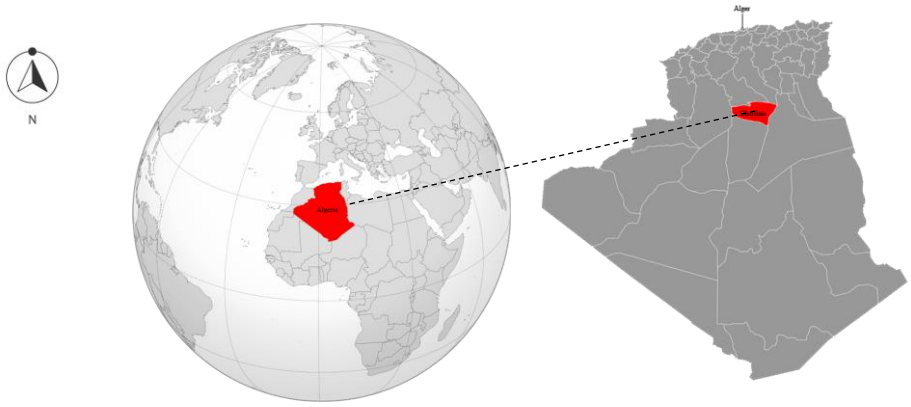


Figure 2. Geographic location: Algeria, Ghardaïa. Source: (Google, adapted by the Authors).

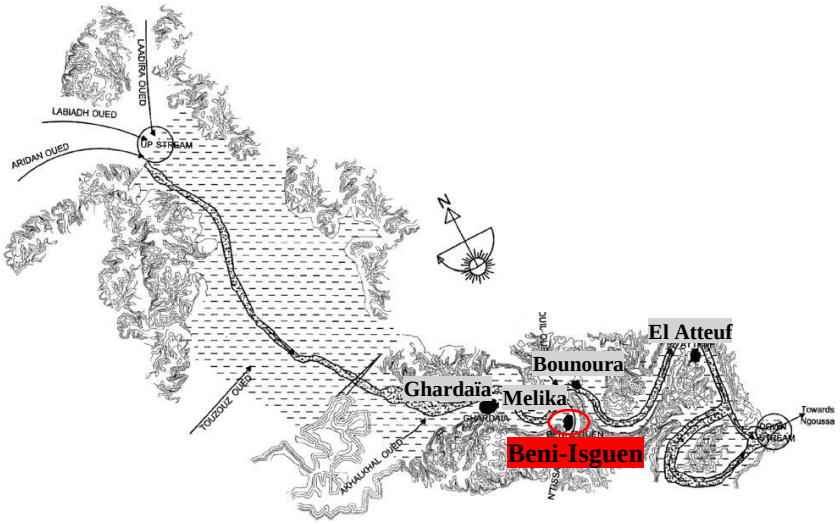


Figure 3. The M'Zab Valley and its five Ksour. Source: (Bouchair & Dupagne, 2003, adapted by the Authors).

Figure 4. View of the ksar Beni-Isguen, dominated by the quadrangular minaret of its mosque. Source: (Photos by Authors).

The Mozabite Ksourian vernacular house is organized around a central space dedicated to women's domestic tasks. Access is via a chicane entrance (vestibule), ensuring interior privacy. It houses the kitchen (Innayene), often at an angle, with wall niches and a fireplace, as well as the Tahdja, a weaving space. The ground floor also includes a family living room, a reception room for guests (Tizefri), a storage space (Tazeka Nel'Aoulet), a dry toilet (Ajmir), and a traditional bathroom (El-Maghsel), generally located in the narrow peripheral spaces. These may also house a small prayer room or a bedroom for an older person, as well as the men's reception room (Douiriyat), which is accessible via a secondary chicane entrance. A secondary staircase sometimes leads to a men's lounge upstairs (Laâli), while the main staircase, discreet and narrow, is integrated into a corner.

The upper floor is organized around a courtyard terrace, the Tighrghart, overlooking the Ammas N'tedart. Next to it is a covered gallery (Ikomar), used for daily activities on summer days and for internal circulation between the different rooms (Tazeka). The upper terrace (Annej Amekrane), accessible by a new staircase, serves as both a multifunctional space for women's gatherings and an outdoor sleeping area on hot nights.

The case objects selected represent some of the rare Mozabite vernacular houses still in existence, among the oldest (over 500 years old). They are located in the Tafilalt area, the historic cradle of the Beni-Isguen ksar, and fully meet the selection criteria defined for this study, see Figure (5). The houses are identified by numbering them with the letter 'T' and the codes: T1, T2, T3, T4, T5, as shown in Table (2).

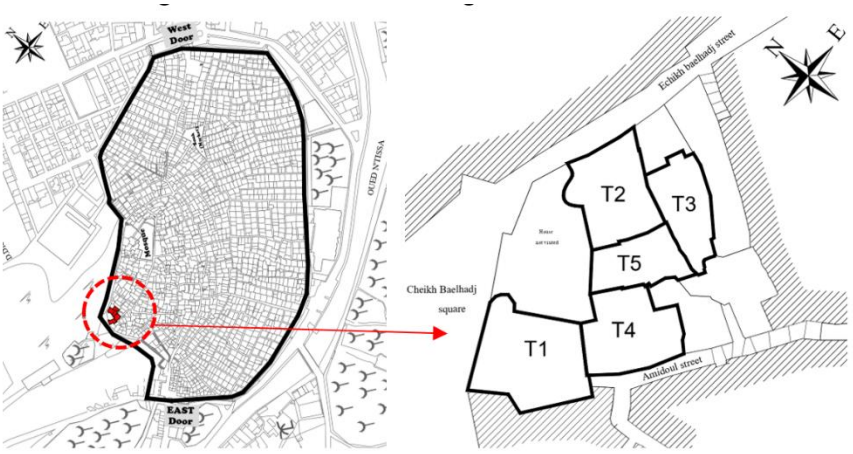
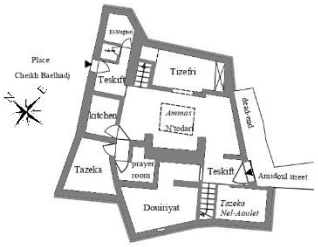
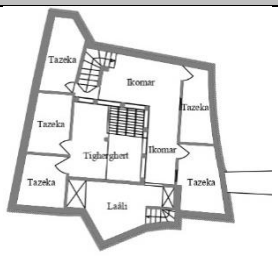
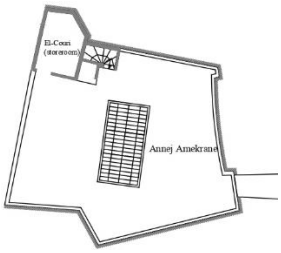
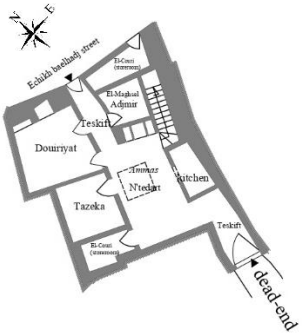
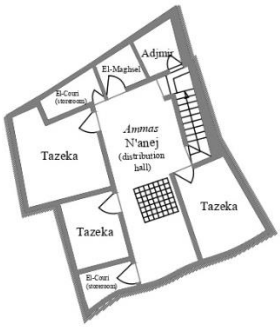
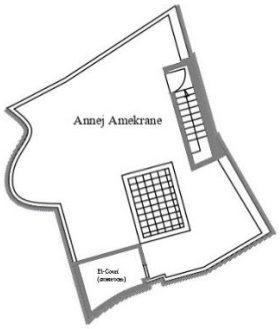
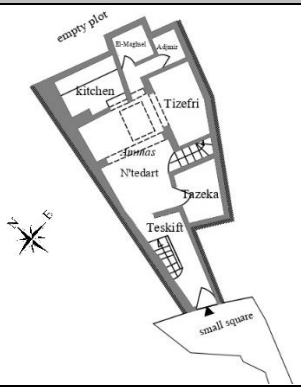
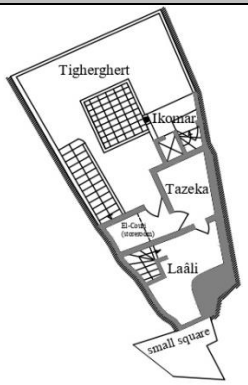
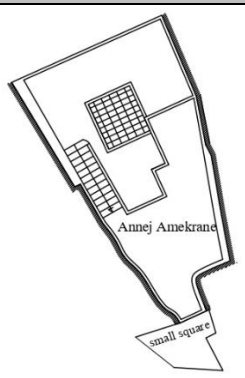
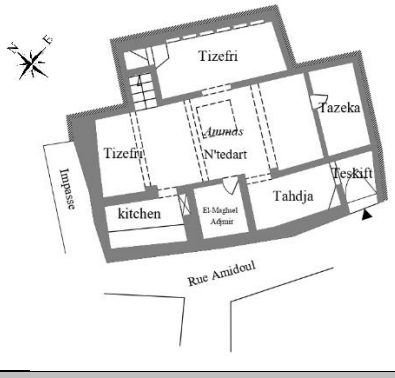
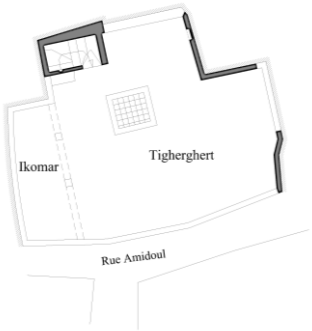
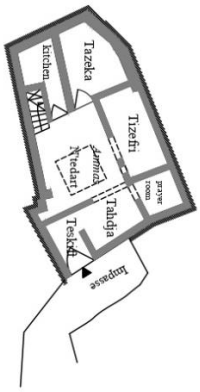
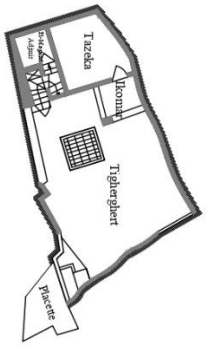
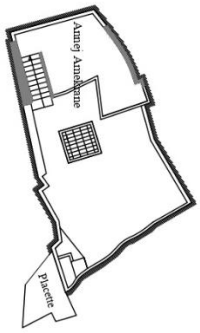


Figure 5. Location of the dwellings studied at Ksar Beni-Isguen. Source: (Centre for Urban Planning Studies and Implementation - URBAT agency of Ghardaïa, 2018, adapted by the Authors).

Table 2. Description of the houses studied. Source: (Images and Plans prepared by the Authors).

Appearance	**Plan surveys**		
			
Dwelling T1:	**Ground floor plan**	**First floor plan**	**Terrace plan**
Location: Place Echikh Baelhadj. State of conservation: Good (restored). Floor area (m²): 88,86m²			
			
Dwelling T2:	**Ground floor plan**	**First floor plan**	**Terrace plan**
Location: Echikh Baelhadj Street. State of conservation: Good. Floor area (m²) :78,28m².			
			

Appearance	Plan surveys		
Dwelling T3:	**Ground floor plan**	**First floor plan**	**Terrace plan**
Location: Amidoul Street. State of conservation: Good. Floor area (m²): 45,75m².			
			
Dwelling T4:	**Ground floor plan**	**Terrace plan**	
Location: Amidoul Street. State of conservation: Good. Floor area (m²): 67,80m²			
			
Dwelling T5:	**Ground floor plan**	**First floor plan**	**Terrace plan**
Location: Amidoul Street. State of conservation: Good. Floor area (m²): 37,52m².			

5. Results And Discussion

The study of the principle of contextualisation in the architecture of the five dwellings enables the analysis of both the architectural aspects visible directly on site (form, spatial organisation, orientation, etc.). In contrast, others have emerged through interactions with local stakeholders, revealing social, cultural, or economic dynamics that are often otherwise invisible. The results are as follows, Table (3):

Table 3. Results of the evaluation of the homes according to the analysis grid. Source: (Authors).

Physical dimension						
Criteria	**Indicators**	**Housing assessment**				
		T1	**T2**	**T3**	**T4**	**T5**
1	**1.1**	**4**	**4**	**5**	**5**	**5**
	1.2	**4**	**4**	**4**	**4**	**4**
	1.3	**5**	**5**	**5**	**5**	**5**
2	**2.1**	**4**	**4**	**4**	**5**	**5**
	2.2	**4**	**3**	**4**	**4**	**4**
	2.3	**5**	**5**	**5**	**5**	**5**
Average physical dimension for each dwelling		**4,3**	**4,16**	**4,5**	**4,6**	**4,6**
Environmental dimension						
Criteria	**Indicators**	**Housing assessment**				
		T1	**T2**	**T3**	**T4**	**T5**

3	3.1	4	2	3	5	5
	3.2	3	2	4	5	4
4	4.1	4	2	3	5	5
	4.2	2	2	4	4	4
	4.3	1	1	2	2	2
Average environmental dimension for each dwelling		2,8	1,8	3,2	4,2	4
Cultural dimension						
Criteria	Indicators	Housing assessment				
		T1	T2	T3	T4	T5
5	5.1	5	2	5	3	4
	5.2	4	2	4	4	4
	5.3	4	3	4	4	4
	5.4	4	4	4	4	4
	5.5	4	3	4	4	4
	5.6	5	5	5	5	5
Average cultural dimension for each dwelling		4,3	3,16	4,3	4	4,16
Social dimension						
Criteria	Indicators	Housing assessment				
		T1	T2	T3	T4	T5
6	6.1	2	1	2	1	1
	6.2	3	3	2	2	2
	6.3	2	2	3	3	2
	6.4	3	2	2	2	3
	6.5	4	4	4	4	4
	6.6	2	1	1	1	1
Average social dimension for each dwelling		2,66	2,16	2,33	2,16	2,16
Economic dimension						
Criteria	Indicators	Housing assessment				
		T1	T2	T3	T4	T5
7	7.1	1	2	3	3	1
	7.2	4	4	4	4	4
8	8.1	1	1	1	1	1
	8.2	1	1	1	1	1
	8.3	2	1	3	3	3
	8.4	3	3	1	2	1
9	9.1	4	4	4	4	4
	9.2	4	4	3	3	3
Average economic dimension for each dwelling		2,5	2,5	2,5	2,62	2,25
Political and Regulatory Dimension						
Criteria	Indicators	Housing assessment				
		T1	T2	T3	T4	T5
10	10.1	5	5	5	5	5
	10.2	2	1	3	3	2
Average political and regulatory dimension for each dwelling		3,5	3	4	4	3,5
Historical dimension						
Criteria	Indicators	Housing assessment				
		T1	T2	T3	T4	T5
11	11.1	4	4	4	4	4

	11.2	4	4	4	4	4
	11.3	4	1	5	5	5
Average historical dimension for each dwelling		4	3	4,33	4,33	4,33

A cross-analysis of the scores obtained by the five houses reveals a significant finding, see Table (4) and Figure (6):

Table 4. Result of a cross-analysis of the scores obtained by the five dwellings. Source: (Authors).

Dwelling	Physical dimension	Environmental dimension	Cultural dimension	Social dimension	Economic dimension	Political and Regulatory Dimension	Historical dimension
T1	12,29	8,00	12,28	7,60	7,15	10,00	11,43
T2	11,89	5,14	9,03	6,17	7,15	8,57	8,57
T3	12,86	9,15	12,28	6,66	7,15	11,43	12,38
T4	13,15	12,00	11,43	6,17	7,49	11,43	12,37
T5	13,15	11,43	11,89	6,17	6,43	10,00	12,38

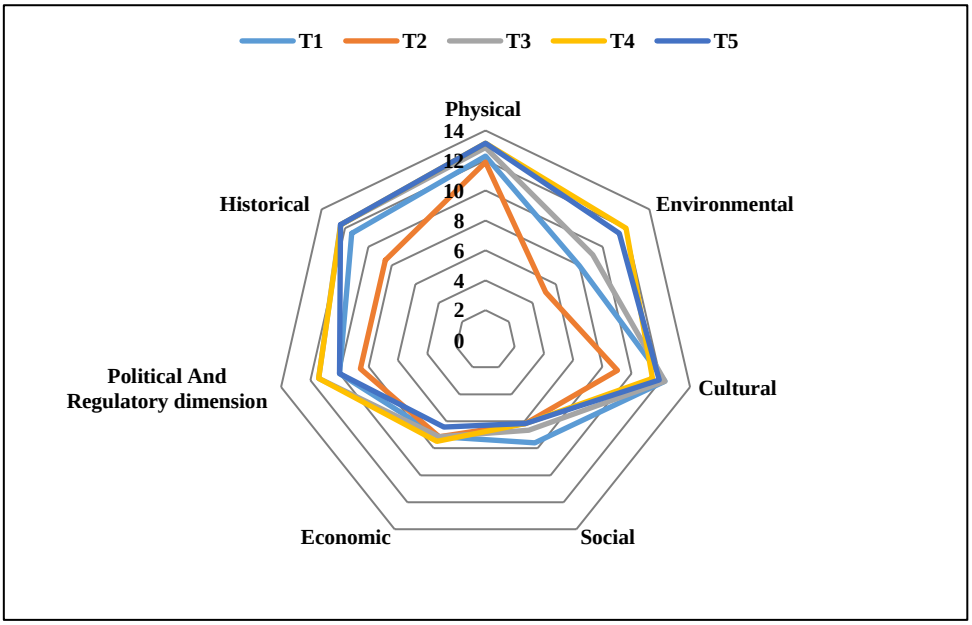


Figure 6. Profile of the evaluation of the principle of contextualisation in architecture for each dwelling. Source: (Authors).

5.1. The Physical Dimension

The physical dimension of the assessed houses reveals a good overall performance (scores between 4.16 and 4.6), reflecting fidelity to vernacular principles in terms of siting that harmonizes with both the natural and built environments. This coherence with the physical context is based first of all on a fine adaptation to the topography, see Figure (7), an intelligent management of natural hazards through strategic siting choices, and on the insertion into the urban morphology, in particular, the maintenance of the compactness of the houses. Elements that were respected from the initial construction phase have remained unchanged since, with no transformation having been carried out. This approach not only preserves the visual and geomorphological coherence of the landscape (see Figure (8), but also limits thermal impacts by reducing direct exposure to solar radiation and sandstorms or runoff in the event of Oued flooding.

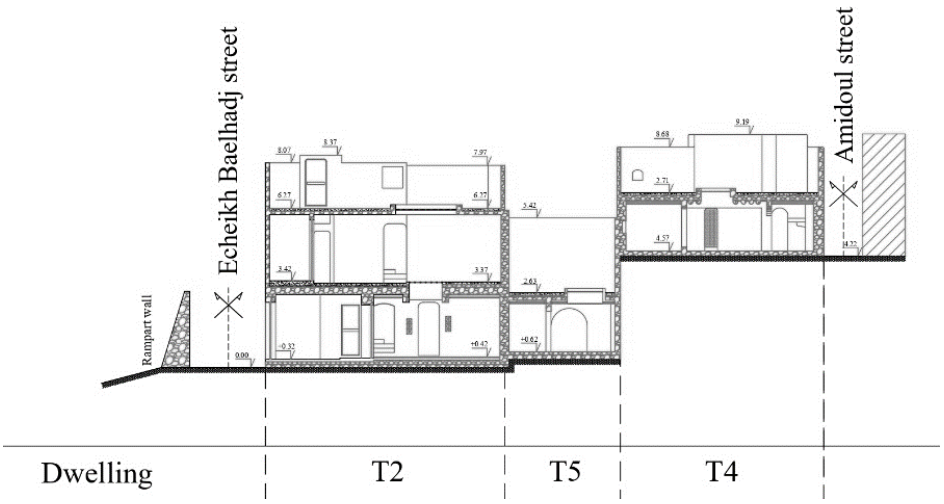


Figure 7. Schematic section showing the adaptation to the topography of the site of the case studies T5, T4, and T2. Source: (Drawing: URBAT agency of Ghardaïa, 2018, adapted by the Authors).

Figure 8. Harmonisation of the landscape between the built form of the houses analysed and the natural terrain. Source: (Photos by Authors).

However, integration into the local typology and morphology sometimes remains compromised due to the transformations made, as evidenced by the score given to house T2 for indicator (2.2), see plans in Table (2). This divergence reflects an attempt to adapt to contemporary needs, resulting in a partial alteration of the original typological logic. This concerns the interior reorganization that enabled the introduction of several bathrooms, which were not present in the initial configuration. This modification addresses the cohabitation of several families, each requiring private hygiene spaces, whereas previously these uses were shared. At the same time, certain traditional spaces – such as the supply room or the weaving space – have been removed, as they have become obsolete in the face of changing practices (industrialized food products, disappearance of domestic artisanal activities). The addition of a floor, particularly for bedrooms, also reflects a growing individualization of living styles. Finally, the use of industrialized materials, which are inexpensive but not well-suited to local morphological standards, accentuates the gap with vernacular construction principles. The houses studied feature simple, uniform façades, faithful to Mozabite vernacular aesthetic principles (simple geometry, lack of ornamentation, colors consistent with the surrounding landscape), see Figure (9).

Figure 9. A homogeneous façade that respects vernacular codes, despite the use of industrialized materials. From left to right: T1, T2, T3 houses. Source: (Photos by Authors).

These results highlight the growing tensions between the concern to preserve vernacular principles and the desire to integrate new functions, often incompatible with the initial configuration.

5.2. The Environmental Dimension

The environmental dimension assessment highlights notable heterogeneity among the houses studied, reflecting varying levels of local resource use and adaptation to climate conditions. This diversity reflects contrasting approaches in response to contemporary changes in the built environment.

The houses T4 and T5 achieved high average scores (4.2 and 4), reflecting good climate and environmental integration. They maintain the initial optimized orientation of the interior spaces. The Chebek (zenithal opening) remains functional for thermal regulation. The traditional plastering technique for exterior walls is also preserved, providing shade and ventilation. The continued use of natural materials helps to reinforce thermal inertia and improve ambient comfort.

Conversely, the T1 and T2 houses, particularly the latter (1.8), demonstrate a partial break with vernacular logic. These low scores are attributed to the abandonment of natural materials, replaced by industrialized solutions—such as cement, concrete blocks, and concrete—which are poorly suited to the local climate due to their low thermal inertia (Figure 10). The interior layout comprises cross-ventilation and natural lighting. Thermal comfort is impaired, requiring the use of mechanical equipment. This break with vernacular logic highlights an uncontextualized modernization, where current needs (visual comfort, speed of execution, immediate savings) take precedence over environmental sustainability.

House T3, with an average score of 3.2, occupies an intermediate position. It retains certain passive features, such as orientation and the use of mixed materials. Still, it shows limitations in bioclimatic continuity, with unsuitable opening dimensions that do not allow for the introduction of lighter, low-inertia materials during renovations.

Figure 10. Comparison of materials used after renovation or modification: on the left, T1 and T2 with industrialized materials (concrete block, brick, cement, steel beam); on the right, T4 and T5 preserving traditional materials (stone wall, lime, palm beam). Source: (Photos by Authors).

These results reveal the challenges of modern adaptation. First, practical constraints: the growing scarcity of traditional materials, due to the depletion of local resources, makes them expensive and difficult to access. Second, specialized artisanal labor is also becoming scarcer and more expensive. Finally, economic difficulties are prompting residents to turn to industrialized solutions, which are often considered more accessible but are frequently less environmentally friendly.

A few initiatives are beginning to emerge, notably through a government-funded vernacular housing rehabilitation project.

5.3. The Cultural Dimension

The analysis of the cultural dimension reveals a relatively satisfactory consideration of identity and vernacular aspects in the houses studied, although notable variations are observed between the cases. The T1 and T3 houses display the best performance, reflecting a strong fidelity to traditional spatial organization (see the plans in Table 2). This is particularly evident in the preservation of religious spaces (such as the prayer room) and the respect for the principles of privacy based on the separation of genders. Furthermore, these houses utilize traditional skills in their renovation work, thereby strengthening their identity.

Conversely, the T2 house records the lowest average (3.16), due to poor performance on several indicators (5.1, 5.2, 5.3, 5.5). This decrease is due to major transformations: the first floor was entirely rebuilt using industrialized materials and modern techniques (concrete structure), aiming to create new bedrooms for each individual and meet increased needs for surface comfort. Indeed, the original bedrooms, often limited to 4–6 m², did not allow for the integration of contemporary furniture and equipment.

The T4 house, for its part, occupies an intermediate position. Although it retains a strong resonance of identity, it receives a more modest score for spatial organization. This situation results from discreet but significant adaptations, such as transforming the women's lounge (Tizefri) into a bedroom due to a lack of space.

These results highlight the structural tensions inherent in the evolution of vernacular housing. On the one hand, there is a clear desire to preserve symbolic landmarks and inherited construction practices; on the other, there is a need to adapt space to contemporary requirements (thermal comfort, individualized private spaces, modern equipment, enlarged surfaces). The transformations observed, therefore, do not reflect a rejection of the vernacular model, but rather a series of compromises and reinterpretations, often conditioned by economic constraints, the scarcity of traditional know-how, or the evolution of lifestyles.

5.4. The Social Dimension

The results show a poor overall performance in the social dimension across all the houses studied. This reflects a persistent mismatch between inherited housing and the current needs of users. The indicator relating to sufficient living space (6.1) is particularly low, indicating high occupancy density and spaces that are often unsuitable for the number of inhabitants. Similarly, the building's capacity to respond to contemporary functional practices (6.6) receives the lowest scores, reflecting the inability of the original spatial configurations—designed for extended families and collective use—to integrate current, more individualized uses. Technology has emerged, and its invasion of homes has changed everything: satellite channels, the internet, video games, and mobile phones. Each member of the household has gradually withdrawn into their own interests, dependent on their personal device and demanding an individual space. However, the occasional improvements in services (water, electricity, waste) are well noted in all the houses, but do not compensate for the structural limitations linked to changing lifestyles. Interviews reveal the frustration of younger generations, who struggle to adapt to homes often stuck in outdated spatial patterns and poorly adapted to meet the needs for privacy, comfort, and flexibility. To address this, some residents resort to adaptation solutions—such as internal divisions and the addition of floors and annexes—which, without technical support, alter the architectural quality and harm the coherence of the building.

This observation highlights major adaptation challenges: the difficulty of modifying housing without compromising its distinctive qualities and the lack of flexible regulations to oversee these transformations. At the same time, changing social practices—such as individualized living and fragmented family life—exacerbate the gap between traditional buildings and contemporary uses.

5.5. The economic dimension

The results highlight a modest average (between 2.25 and 2.62), reflecting the growing economic fragility of the vernacular model. While traditional know-how persists (7.2 = 4), passed down by local associations, the depletion of natural resources (7.1) and soaring costs make their implementation difficult. Specialized labor has become scarce and expensive, while vernacular materials are often more expensive than those produced by industry (indicators 8.1 and 8.2 = 1). This pushes residents toward more accessible solutions that are less suited to the local climate, such as concrete or cinder blocks. Furthermore, spatial

configuration transformations for domestic comfort, such as the addition of a kitchen, the removal of the Ikomar and Tigherghert on the upper floor, and the introduction of industrial furniture, replace traditional integrated features (niches, wall storage), thus breaking with the functional and thermal logic of the home. However, local economic benefits remain positive (scores of 3 to 4) thanks to the employment of regional artisans, even though the materials used are often industrialized.

5.6. The Political and Regulatory Dimension

The analysis shows strong compliance with the "Orf" (10.1 = 5), a community construction standard that guarantees urban coherence and neighborhood relations. However, indicator 10.2 reveals partial compliance with heritage conservation rules (scores of 1 to 3). The modifications made—openings on the façade, visible extensions—reflect a circumvention of conservation regulations, often due to the lack of a flexible support framework. This highlights a major challenge of modern adaptation: how to integrate current needs without breaking with heritage logic or imposing rigid standards.

5.7. The historical dimension

Overall, well rated (≈4), the historical dimension is largely preserved. The harmony with the emblematic buildings and the continuation of inherited forms and textures (11.1, 11.2) reflect a strong attachment to the memory of the place. However, House T2 shows a marked break (11.3 = 1): the removal of the Tizefri (women's lounge) and major alterations to the identity spaces. This illustrates one of the contemporary dilemmas: certain functional adjustments, motivated by comfort needs, can lead to an irreversible loss of spatial and symbolic reference points if there is no suitable supervision or sufficient awareness.

6. Conclusions

This study assessed the relevance of contextualizing Mozabite vernacular architecture after transformation, using the dwellings of the ksar of Beni-Isguen as a case study. By using a multi-criteria analysis grid, it highlighted a set of contrasting dynamics, revealing both the resilience of Mozabite vernacular housing in the face of time and change, as well as its limits in a context of accelerated socio-economic and environmental transformation.

The fundamental contribution of this research lies in adopting a comprehensive and updated approach to architectural contextualization, which is broadened to include dimensions often neglected by previous work, such as social practices, cultural dynamics, and collective memory. By focusing on transformed vernacular dwellings, the study provides a critical examination of the contemporary challenges of sustainability within a living heritage context. It highlights the tensions between preservation and adaptation, while offering an original tool: a multi-criteria analysis grid that allows for the precise assessment of the levels of continuity or rupture in the evolution of Mozabite housing.

The most positive results pertain to the physical, cultural, and historical dimensions, demonstrating a strong coherence between vernacular architecture and its geographical and cultural context. The capacity for integration into the relief, adaptation to the topography, and chromatic harmony with the natural environment reflect a constructive intelligence that is still perceptible, the fruit of generations of empirical experimentation. Similarly, the compatibility with the emblematic historical forms of the ksar attests to an attachment to the memory and the Mozabite architectural identity. This underlines the heritage value of this habitat, which continues to play a structuring role in the cultural representation of domestic space.

On the other hand, the weaknesses of the social and environmental dimensions are particularly prominent. Once perfectly adapted to the local context—both environmentally, culturally, and socially—this housing now struggles to meet contemporary domestic needs. The poor performance in terms of living space and adaptability to contemporary uses illustrates the growing gap between the current needs of residents (space, comfort, modern amenities) and the inherited structure of the houses. This observation is all the more worrying since the transformations made by residents—often carried out without technical or regulatory support—sometimes alter the original architectural qualities without fully meeting the needs. As a result, the environmental dimension, which has long been considered one of the strengths of vernacular housing, now appears to be in transition. These architectures exhibit a clear deterioration in this dimension, resulting from the abandonment of vernacular practices in favor of contemporary construction choices

unsuited to the desert context. This shift reflects the gradual erosion of the integrated environmental logic that characterized traditional Mozabite buildings.

From an economic perspective, the scarcity of traditional materials, rising costs, and the gradual disappearance of skilled labor make it difficult to sustain the vernacular construction model. This observation highlights a structural tension: maintaining old techniques is culturally valued but economically unviable, prompting residents to resort to industrialized solutions, which are often less suited to the climate and bioclimatic principles.

Finally, the political and regulatory dimension highlights an interesting paradox. On the one hand, residents continue to respect strong customary norms such as the Orf, which, although oral and customary, guarantees a certain urban coherence and implicit social regulation. On the other hand, the partial non-compliance with heritage protection rules reflects a complex reality: residents adapt their homes on a daily basis, often outside of formal conservation frameworks, to meet immediate functional, economic, or social needs.

The results obtained open up concrete perspectives on both a scientific and a professional level. On an academic level, they enrich our understanding of the interactions between vernacular architecture, local roots, and transformation dynamics, contributing to reflections on future models of sustainable and ecological housing in the Saharan regions of Algeria. On an operational level, they provide a basis for reflection to rethink the modalities of preserving and adapting the built heritage, reconciling sustainability requirements with local social and economic realities. They also offer avenues for designing new buildings that are anchored in vernacular logics while meeting contemporary needs.

Finally, several recommendations are formulated in order to strengthen the sustainability and contextual coherence of interventions on transformed vernacular housing:

- Promote an evolving approach to preservation, based on adaptation rather than fixed conservation, to better meet current needs while respecting local traditions and cultural heritage.
- Encourage the use of local and natural materials (earth, lime, palm), better suited to the Saharan climate, and rehabilitate traditional construction techniques to improve the thermal performance of buildings.
- Integrate passive design principles and bioclimatic orientation into transformation or new construction projects to minimize the reliance on mechanical devices.
- Support local artisanal know-how through training, professional development, and mentoring programs for young artisans.
- Involve residents and local associations in transformation processes to ensure greater ownership of the interventions and maintain the social memory of the sites. 6. Adapt public policies and urban regulations to regulate transformations better while promoting contextual innovation within the living heritage framework.
- Develop contextualization assessment tools, such as the grid proposed in this study, to guide diagnostics, rehabilitation, or construction projects in ksour.

References

Abrar, N. (2021). “Contextuality and Design Approaches in Architecture: Methods to Design in a Significant Context”. International Journal of Education & Social Science, 2(11), 294-305.

Akbari, A., Bazrafkan, K., Tehrani, F., Soltanzadeh, H. (2017). “Conceptualism and Regionalism Planning Methods in the Iranian Architecture (Case Study: Distinctive Works of Different Eras in Tehran Architecture)”. International Journal of Urban and Rural Management, 16(48), 327-342.

Alhamdani, M.R. (2010). “ Strategy and application of contextual approach in the architectural design of Renzo Piano’s works” (Strategi dan aplikasi pendekatan kontekstual dalam perancangan karya arsitektural Renzo Piano) [Indonesian],, Doctoral thesis, Universitas Gadjah Mada, Indonesia.

Al-Hammadi, N.A.Q., Grchev, K. (2022). “Aspects of contextual architecture regarding traditional/contemporary architecture, physical/cultural and place identity: a systematic literature review”. Open House International, 48(1), 119-140. https://doi.org/10.1108/OHI-01-2022-0007

Al-Sakiny, U.F., Al-Kafaji, M.K. (2022), “Treatments of Sustainable Preservation in Heritage Buildings:

Reviews the Treatments that can Improve the Preservation of Heritage Buildings", Iraqi Journal of Architecture and Planning, 21 (2), 59-75. https://doi.org/10.36041/iqjap.2022.132935.1028

Attia, A.S. (2019). "Traditional sustainable architecture techniques and their applications in contemporary architecture: Case studies of the Islamic house in Fatimid Cairo and Sana'a, cities in Egypt and Yemen", International Journal of Civil and Environmental Engineering, 13 (5), 266–271.

Awoussi, M.Y., Domtse, E.K.A., Gake, D.K., Genovese P.V., & Dziwonou Y. (2025). "Analysis of the Sustainability Elements of Vernacular Architecture in Northern Togo: The Case of the Kara Region". Sustainability, 17(6), 2450. https://doi.org/10.3390/su17062450

Bahrami, A. (2016). "Indigenous architecture as a context- oriented architecture, a look at indigenous architecture of Shushtar". Journal of Fundamental and Applied Sciences, 8(2), 380–297. https://doi.org/10.4314/jfas.8vi2s.52

Bellal, T. (2013). "Gender and zones of users in traditional Berber M'Zab houses". International Journal of Humanities and Social Science, 13(19), 60-73.

Benyoucef, B. (2010). "The M'Zab. A thousand-year-old journey" (Le M'Zab. Parcours millénaire) [French] (1st ed.). Alger: Éditions Alpha.

Benyoucef, B. (2019). "The M'zab: Perspectives in urbanism and sociology" (Le M'zab : Regards d'urbanisme et de sociologie) [French] (1st ed). Alger: L'Observatoire Espace & Société.

Bouali Messahel, M. (2019). "Types of habitat and forms of seasonal alternance of the Mozabite oasien: the example of Beni Isguen" (Types d'habitat et formes d'alternances saisonnières de l'habiter mozabite oasien: l'exemple de Béni Isguen) [French]. Paris Nanterre University, Paris, France.

Bouchair, A., Dupagne, A. (2003). "Building traditions of Mzab facing the challenges of re-shaping of its built form and society". Building and Environment, 38(11), 1345–1364. https://doi.org/10.1016/S0360-1323(03)00065-9

Centre for Urban Planning Studies and Implementation – URBAT. (2018). Revision of the M'Zab Valley PDAU: plan for the municipality of Bounoura (Revision du PDAU de la Vallee du M'Zab: plan d'aménagement de la commune de Bounoura) [Unpublished document, French]. Ghardaïa : Technical Department.

Cherifi, B. (2015). "The M'zab studies of historical and cultural anthropology" (Le M'zab études d'anthropologie historique et culturelle) [French]. Sédia, Algiers.

Chuapram, S., King, R., Panin, O. (2012). "Transformation of local living: Buddhist Thai communities and vernacular houses around Songkhla Lake Basin", Procedia - Social and Behavioral Sciences, 50, 42–54. https://doi.org/10.1016/j.sbspro.2012.08.016

Constant, Y. (1979). "The Abadite city in the M'Zab Valley (Algeria)" (La cité abadite de la vallée du M'Zab (Algérie)) [French], Doctoral thesis, Unité pédagogique d'architecture de Nancy, France.

Daglioglu, K.E. (2015). "Reinterpreting the Contemporary Architectural Practice in Turkey in the light of Context Debate". Middle East Technical University, Ankara, Turkey.

Dahmani, K., Aouissi, K.B., Chettah, S.E. (2024)." Implementing Sustainability in Urban Desert Regions Through Solar Orientation, The Islamic Vernacular Architecture of the M'zab Ksour in Particular". Journal of Islamic Architecture 8(2), 408-422. https://doi.org/10.18860/jia.v8i2.25531

Davey, P. (2002). "In context", Architectural Review, special issue on context and scale.

Dawson, C. (2002). "Practical research methods: A user-friendly guide to mastering research techniques and projects" (3rd ed.). How To Books, Oxford, UK.

Donnadieu, C., Didillon, H., Didillon, J M. (1986). "Living in the desert: The Mozabite houses" (Habiter le désert. Les maisons mozabites) [French] (1st ed). Bruxelles: Pierre Mardaga.

Farmer, G. (2013). "Re-contextualising design: three ways of practising sustainable architecture".

Architectural Research Quarterly, 17(2), 106–119. https://doi.org/10.1017/S1359135513000468

Fathy, H. (1973). "Architecture for the poor: An experiment in rural Egypt" (1st ed.). Chicago: University of Chicago Press.

Ferruses, I. J., Artola Dols, S., Cantó Gago, C., (2024). "Sustainable approaches employed in settlements designed by Hassan Fathy: Lessons from New Gourna and New Baris in Egypt", ISVS e-journal, 11 (4), 192–206. https://doi.org/10.61275/ISVSej-2024-11-04-12

Figueira, J., Greco, S., & Ehrgott, M. (2005). "Multiple Criteria Decision Analysis: State of the Art Surveys" (1st ed.). Springer, Boston, MA.

Filep, C. & Thompson-Fawcett, M. (2020). "New urbanism and contextual relativity: Insights from Sweden". Urban Planning, 5(4), 404–416. https://doi.org/10.17645/up.v5i4.3514

Gouaich, Y., Mebrouki, A., Ghariri, R., Mebarki, A., Belabbas, A., Manav, B., Serra, J., Torres, A., (2018). "A novel method for assessing the chromatic integration of architecture in the Ksourian landscape of M'zab Valley, Algeria", Color Research & Application, 1-19. https://doi.org/10.1002/col.22225

Guedria, A. (2016). "Local architecture and sustainable development: comparative study of housing in Nefta for new sustainable designs" (Architecture locale et développement durable : étude comparée de l'habitat à Nefta pour de nouvelles conceptions soutenables) [French]. National School of Architecture and Urbanism, Tunis, Tunisia.

Gueliane, N. (2020). "The 'Construction Orf in Aɣlan: Definition and sources" (Le 'orf de la construction à Aɣlan : Définition et sources) [French]. Revue d'histoire méditerranéenne, 2.

Gueliane, N. (2020). "The 'Orf of construction in Aɣlan: Definition and sources" (Le 'orf de la construction à Aɣlan : Définition et sources) [French], Revue d'histoire méditerranéenne, (2).

Gueliane, N., (2017). "The vernacular architectural heritage, lever of the development of a sustainable architecture", International Journal of Human Settlements, 1 (3), 25-35.

Gundogdu, E., Birer, E. (2021). "Evaluation of ecological design principles in traditional houses in Mersin", ICONARP International Journal of Architecture and Planning, 9 (1), 25–52. https://doi.org/10.15320/ICONARP.2021.149

Hamdani, M., Bekkouche, S.M.A., Benouaz, T., & Cherier, M.K. (2012). "Study and effect of orientation of two rooms of buildings located in Ghardaia, Algeria". Energy Procedia, 18, 632-639. https://doi.org/10.1016/j.egypro.2012.05.076

Hammou, M., Drias, A. (2024). "A socio-environmental analysis of contemporary modifications to Algerian Mzab traditional houses". African Geographical Review, 43(7), 914–932. https://doi.org/10.1080/19376812.2024.2318747

Hazbei, M. (2023). "Parametric Architecture: From Context and Livability Challenges to Optimization Complexity". Concordia University, Montréal, Canada.

Hazbei, M., Cucuzzella, C., (2023). "Revealing a gap in parametric architecture's address of "context", Buildings, 13, 3136. https://doi.org/10.3390/buildings13123136

International Council on Monuments and Sites (ICOMOS), (1999). "Charter on the Built Vernacular Heritage", https://www.icomos.org/en/participate/179-articles-en-francais/ressources/charters-and-standards/178-charte-du-patrimoine-bati-vernaculaire

Jagatramka, R., Kumar, A., Pipralia, S., (2021). "Transformations of vernacular architecture of India: Problems and prospects", ISVS e-journal, 8 (1), 23–32.

Johnston, M. (2014). "Secondary Data Analysis: A Method of Which the Time has Come". Qualitative and Quantitative Methods in Libraries 3(3), 619-626.

Kadri, M. (2021). "The M'Zab Valley Ksur, a living legacy and a school of inspiration, towards a sustainable development approach". International Journal of Human Settlements, 5(5), 370- 381.

Kadri, M., Bouchair, A., Laafer, A. (2022). "The contribution of double skin roof coupled with thermo reflective paint to improve thermal and energy performance for the 'Mozabit' houses: Case of Beni Isguen's ksar in southern Algeria". Energy & Buildings, 256. https://doi.org/10.1016/j.enbuild.2021.111746

Kadri, M., Laafer, A. (2021). "Energy design", a promising approach towards ecological construction. Case of the dwellings of M'Zab Ksur". Algerian Journal of Engineering Architecture and Urbanism, 5(6), 347-354.

Kuru Yücel, R., Arabacioğlu, F.P. (2023). "Context" knowledge in architecture: A systematic literature review". Megaron, 18(3), 366–386. https://doi.org/10.14744/megaron.2023.81594

Martinovic, S., Herzegovina, A., (2023). "Vernacular residential architecture in the context of sustainability – Case study of Svrzo's House Complex", Journal of Sustainable Architecture and Civil Engineering, 1 (32), pp. 19–40. https://doi.org/10.5755/j01.sace.32.1.32753

Messaitfa A., & Bencherif, M. (2023). "A strategy to improve comfort level and optimize the thermal behavior of the building; learning from M'zab Architecture". Prostor : znanstveni časopis za arhitekturu i urbanizam, 31(2(66)), 210-223. https://doi.org/10.31522/p.31.2(66).6

Mirkar, V., Sharma, S. (2019). "Awareness of the past and the need of the future for a relevant vernacular expression", in Proceedings of the National Conference on Revitalizing Indigenous Architecture, Bhopal: SPA Press, pp. 145–162.

Morin, E. (2000), "The seven necessary knowledges for the education of the future" (Les sept savoirs nécessaires à l'éducation du futur) [French], (1st ed). Paris: Seuil.

Namicev, P., Namicheva Todorovska, E. (2024), "Transformations of the vernacular houses of Macedonia in the 19th century", Journal of Vernacular Architecture Studies, 12 (1), pp. 65–82.

Nasr, T. [@TracyNasr]. (2015, October 13). "Criteria for Contextualism in Architecture" (Critères du contextualisme en architecture) [French]. [LinkedIn]. Available at: [https://www.linkedin.com/pulse/criteria-contextualism-architecture-tracy-nasr/] (Accessed: [11 March 2025])

Nguyen, A.T, Truong, N.S.H, Rockwood, D., Le, A.D.T., (2019). " Studies on sustainable features of vernacular architecture in different regions across the world: A comprehensive synthesis and evaluation", Frontiers of Architectural Research, 8 (4), 535-548. https://doi.org/10.1016/j.foar.2019.07.006

Oliver, P. (1997), "Encyclopedia of Vernacular Architecture of the World" (1st ed.). Cambridge: Cambridge University Press.

Oliver, P. (2003). "Dwellings: The Vernacular House Worldwide" (1st ed.). London & New York: Phaidon.

OPVM, (2019), "(Traditional housing, architecture and Orf in the protected area of the M'Zab valley) [French], [Online brochure]. Available at: http://www.opvm.dz/19_Brochures/163_L_habitation_traditionnelle_%28Arabe%29/d (Accessed: [25 July 2025])

Osou, R. (2024). "Inspiring heritage in contemporary architecture", Doctoral thesis, Brandenburg University of Technology Cottbus–Senftenberg, Germany.

Parmentier, H. (1946). "Mutual aid among the Ibadi Berbers of the M'Zab" (L'entraide chez les berbères ibadites du M'Zab) [French], IBLA, Revue de l'Institut des belles lettres arabes.

Pellaud, F. (2011). "For an education in sustainable development" (Pour une éducation au développement durable) [French], (1st ed). Paris: Quae.

Radoine, H. (2017). "Architecture in Context: Designing in the Middle East". John Wiley & Sons, Hoboken, New Jersey (NJ), USA.

Rais, M.E.A., & Caballero, R.T. (2019). " Vernacular architecture en algeria "M'zab" = Arquitectura

vernacula en argelia “M’zab”. BUILDING& MANAGEMENT, 3(1), 49-58. https://doi.org/10.20868/bma.2019.1.3876

Rapoport, A. (1969). “House form and culture” (1st ed). Englewood Cliffs, NJ: Prentice-Hall.

Ravéreau, A. (1981). “The M'zab, an architectural lesson” (Le M’zab, une leçon d’architecture) [French], (1st ed). Paris: Sindbad.

Ravéreau, A., Roche, M., (1990). “The lessons of tradition” (Les enseignements de la tradition) [French], Architecture méditerranéenne, (35), 54–59.

Rezaei, N. (2021). “Lessons from tradition in the building of contemporary settlements: the case of Tafilalt in the M'Zab Valley, Algeria”. Architecture and Culture, 9(2), 310-334. https://doi.org/10.1080/20507828.2021.1883377

Roche, M. (2003). “The M’Zab: Ancient Cities of the Sahara” (Le M’Zab : Cités millénaires du Sahara) [French] (1st ed.). Bez-et-Esparon: Études & Communication.

Roy, B. (1996). “Multi-criteria Methodology for Decision Aiding” (1st ed.). Springer, Boston, MA.

Salim, B.H., Abdulhussain, L.A., Salman, A.S. (2025). “Ethical Considerations of Technical Sustainability in Architectural Production”, Iraqi Journal of Architecture and Planning, 24 (2), 18-35. https://doi.org/10.36041/iqjap.2025.153129.1110

Salman, A.S, Hameed, T.M. (2020). “Sustainability Systems in Architecture”, Iraqi Journal of Architecture and Planning, 19 (1), 13-24. https://doi.org/10.36041/iqjap.v19i1.489

Sayigh, A. (2019). “Sustainable vernacular architecture: How the past can enrich the future”, 1st edition, Brighton: Springer Nature.

Shahbazi, S. (2016). “Contextualism: A strategy for achieving sustainable architecture”, European Online Journal of Natural and Social Sciences, 5(3), 306-314.

Sugiyono, S. (2014). “Quantitative research methods, qualitative and R & D” (1st ed.). Alfabeta, Bandung, Indonesia.

Tabarsa, M., Naseri, Y. (2017). “The role of contextualism in architectural design of museums”, Journal of History, Culture and Art Research, 6 (1), 354–365. https://doi.org/10.7596/taksad.v6i1.747

Tan, Y.L.L. (1992). “Contextualism and fragmentation: A dualistic guideline to the design of urban architecture Complexity”. Massachusetts Institute of Technology, Cambridge, USA.

Thakkar, J. (2019). “Re-engaging vernacular building practices: Facilitating the revitalization through a systematic approach”, (1st ed).Bhopal: SPA Press.

Thinnakorn, W., Kaewtawee, R., Srimuang, K., & Ahmad, A.G. (2025). “Sustainability assessment of vernacular architectural heritage: the case of Shino-European shophouse in Tha Wang historical neighbourhood, Thailand”. Cogent Arts & Humanities, 12(1). https://doi.org/10.1080/23311983.2025.2482385

Unwin S. (2003). “Analysing Architecture” (2nd ed.). Routledge, London.

Widiastuti, I. (2013). “Critical study of vernacular settlement-architecture of Kerala in India and Minangkabau in West Sumatra, Indonesia (Of societies practicing matrilineal kinship)”, Doctoral thesis, Universitas Gadjah Mada, Indonesia.