

Reinterpreting Vernacular Cooling Methods for Contemporary Architecture: Mashrabiya Screens and Courtyard Strategies in Bahrain

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Abstract

In most vernacular buildings, there have been very effective strategies that responded to the harsh climatic conditions whereby buildings have been shaded from excessive exposure to sun. These ensured that the interiors of such buildings were cooler and more livable. Indeed, they also provided character and identity to those buildings. In contemporary architecture however, such methods are often not employed. Instead, they use air-conditioning to cool the interiors while using large glass windows which even bring in direct sunlight as well as heat. Nevertheless, there is an emerging trend in incorporating vernacular traditional shading methods in contemporary architecture too. In this context, this research investigates how contemporary buildings in Bahrain reinterpret two vernacular shading strategies: the ‘mashrabiya screens’ and ‘courtyards’ and how effective these reinterpretations are for environmental comfort by controlling daylight and glare as well as a reduction in heat-gain, while providing privacy and cultural continuity. The study addresses the gap between using vernacular elements as visual motifs versus using them as climate-performing systems.

The study adopted a mixed-method comparative case study approach. Three case studies were reviewed: two in Bahrain and one in the Gulf as a benchmark. Data were collected through architectural documentation and photo-based content analysis to extract design variables such as screen porosity, depth, coverage, and courtyard enclosure. Performance evidence was recorded through documentation-based observations and a simplified comparative simulation logic applied consistently across the cases. User perceptions were captured through a short Likert-scale questionnaire and three semi-structured interviews.

Findings indicate that effective reinterpretations combine measurable shading performance with privacy regulation and usable shaded space. The courtyard-based heritage case shows strong privacy and microclimate advantages through enclosure and self-shading, while the contemporary mesh “veil” demonstrates strong glare diffusion and privacy screening at the street edge. Overall, the research concludes that contemporary mashrabiya/courtyard reinterpretations perform best when design variables are aligned with climate exposure and user needs, supporting recommendations for performance-informed shading rather than decorative application.

Keywords: Mashrabiya screens and courtyard, Vernacular shading, Daylight and glare control, Privacy, Bahrain.

Introduction

The hot climate, strong sunlight, and high privacy expectations of Bahrain continue to shape how the buildings are designed and experienced. In the past, vernacular architecture historically relied on passive strategies particularly the ‘mashrabiya’ screens and courtyards to filter daylight, reduce glare and solar gain, regulate visibility, and create shaded microclimates that support comfort and social life (Olgyay, 1963; Fathy, 1986; Givoni, 1998). However, many contemporary buildings increasingly depend on mechanical cooling and extensive glazing, which can intensify heat gain and glare if not carefully moderated.

At the same time, there is a renewed interest in expressing regional identity through patterned screens and shaded spaces. Yet a key issue remains there. Vernacular elements may be reintroduced as symbolic features without matching the performance logic that originally made them effective. This creates a gap between appearance and performance, where factors such as porosity, depth, coverage, orientation response, enclosure, and usability are not always designed to meet user comforts and the privacy needs.

In this context, this research examines how contemporary buildings in Bahrain reinterpret ‘mashrabiya’ screens and courtyard strategies, and evaluates their effectiveness for environmental comfort, privacy, and cultural continuity. Its aim is to investigate how these strategies are reinterpreted in current practice and assess whether they operate as high-performing passive systems. The objectives are:

- To develop evaluation criteria for shade provision, daylight/glare control, privacy, and usability;
- To analyze three selected case studies (B & C supported by site observations; A based on published sources) using drawings and photographic documentation to identify what performs well and what underperforms;
- To compare the patterns across the cases and
- To propose design recommendations that support performance-based reinterpretation rather than decorative use.

Theoretical Framework

This inquiry examines how contemporary architecture in Bahrain reinterprets two vernacular shading strategies, mashrabiya screens and courtyards. Moreover, it evaluates their effectiveness for environmental comfort, privacy, and cultural continuity. The key concepts framing the inquiry are climate-responsive comfort, privacy, and culturally grounded reinterpretation.

From a climate-responsive perspective, Olgyay (1963) points out that architecture should follow bioclimatic principles, especially orientation, shading, and airflow to improve comfort while reducing dependence on mechanical cooling. Givoni (1998) similarly explains that passive strategies can modify thermal conditions through solar control and ventilation potential, meaning that forms and envelope decisions can measurably influence comfort conditions. Within this lens, mashrabiya and courtyards are understood as environmental mediators: screen characteristics such as porosity and depth regulate daylight and glare, while courtyard enclosures and shading influence microclimate moderation and usability (Olgyay, 1963; Givoni, 1998). They are both strategies employed in vernacular architecture.

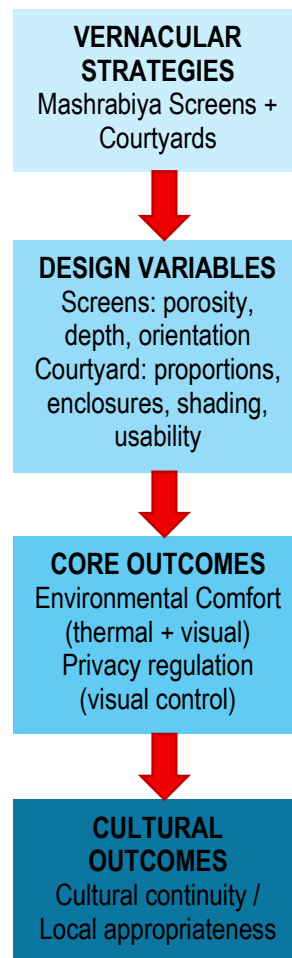
Fathy (1986) describes vernacular architecture as a practical response to hot climates and lived social patterns, where shading elements and courtyards remain embedded because they serve both environmental and human needs. This supports a key evaluative principle in the present inquiry. Contemporary “reinterpretations” should thus be judged by whether they preserve the working principles that generate comfort and usability, rather than reproduce traditional forms only as visual motifs (Fathy, 1986). In other words, issues such as privacy matter.

Westin (1967) explains privacy through what he calls privacy regulation theory. In fact, he conceptualizes privacy as control over access and exposure. Adding to this, Altman (1975) frames privacy as a dynamic process regulated through behavioral and environmental

mechanisms such as boundaries and visual control. In contexts where privacy is a strong spatial driver, these theories clarify why shading screens and inward-oriented courtyards are relevant. Indeed, they provide architectural tools that regulate visibility and interactions while enabling daylight and ventilation. In this way, privacy and comfort operate as interconnected outcomes rather than separate design aims (Westin, 1967; Altman, 1975). Undeniably, they are an essential aspect of culture.

Cultural continuity is explained through theories linking built form to culture and place. Rapoport (1969) argues that house forms reflect cultural values and patterns of living, not just climate alone. Frampton (1983), through critical regionalism, suggests that contemporary architecture can remain modern while rooted in place by translating local meanings and climatic responses into present-day designs rather than copying historical images. These perspectives support evaluating mashrabiya and courtyard reinterpretations in Bahrain by whether they sustain local appropriateness, comfort, privacy, and lived usability rather than functioning only as symbolic references (Rapoport, 1969; Frampton, 1983).

Collectively, these theoretical perspectives establish a framework in which design variables including screens, porosity, depth, orientation responses, courtyard proportions, enclosures, and usability influence comfort outcomes such as thermal and visual comfort as well as privacy, which together shape perceptions of cultural continuity in contemporary practices. However, many discussions of these themes remain separated across environmental, social, and identity lenses. Therefore, this inquiry uses the above theoretical perspectives to connect these dimensions and guide the evaluation of contemporary applications through consistent criteria. This framework can be graphically illustrated as follows.



Lenses: Olgyay & Givoni (comfort) | Westin & Altman (privacy) | Rapoport & Frampton (culture) | Fathy (vernacular)

Fig. 01: The Theoretical Framework

Source: Author

Review of Literature

There is plenty of literature that examine how the hot and humid climate, intense solar exposure, and high privacy expectations of Bahrain continue to shape the ways in which the buildings are designed and experienced. Most often, it is identified that within this context, ‘mashrabiya’ screens and courtyards are two key vernacular shading strategies historically linked to daylight filtering, glare reduction, heat-gain moderation, and privacy. This review synthesizes what prior research has examined how these strategies are being reinterpreted in contemporary practices. It identifies gaps of knowledge, particularly for Bahrain-focused evaluations.

Despite the abundance however, overall, literature is fragmented and uneven. Some studies focus on measurable environmental performances, while others emphasize socio-cultural drivers such as privacy norms, heritage perceptions, and identity acceptance. In fact, relatively few studies integrate these dimensions in a single evaluative approach for Bahrain. As a result, evidence about ‘success’ is often discussed either through performance outcomes such as daylight, glare and thermal comfort or through meanings and acceptance, rather than through both together.

Among them, the studies focused on Bahrain highlight a persistent tension between daylight access and privacy. For example, Aljawder and El-Wakeel (2019) evaluate daylight performance of a traditional Bahraini mashrabiya, and report improved daylight distribution and reduced glare compared to unshaded openings, supporting the argument that mashrabiya historically operates as an environmental device rather than only a decorative motif. Complementing this, Aljawder and El-Wakeel (2020) also examine contemporary residential houses in Bahrain and report that façade openness and shading acceptance are strongly shaped by privacy expectations, implying that shading effectiveness must be culturally responsive rather than treated as a purely aesthetic façade layer.

Beyond Bahrain, research emphasizes that mashrabiya integration benefits from being assessed within the logic of environmental performance. Bagasi et al. (2021) frame mashrabiya as part of a ventilation and solar-control strategy, indicating that it can influence indoor thermal conditions through shading and ventilation-related effects. However, Altomman (2013) cautions that contemporary mashrabiya applications can drift towards symbolic or stylistic use if not grounded in context-driven variables such as porosity, depth, orientation response, and privacy needs. Taken together, this strand of literature suggests that successful reinterpretations depend on balancing socio-cultural privacy demands with measurable comfort outcomes such as daylight quality, glare control, and reduced solar load (Aljawder and El-Wakeel, 2020; Bagasi et al., 2021; Altomman, 2013).

Parallel literature frames the courtyard as an indigenous spatial device that addresses both environmental and socio-cultural needs. In this regard, Lafi and Al-Khalifa (2024) discuss courtyards in contemporary Bahraini houses and argue that inward-living patterns aligned with privacy expectations keep the courtyard relevant while also offering sustainability potential. They stress that successful reinterpretations depend on careful courtyard proportions, enclosure, and spatial organizations so that the courtyard remains usable and socially appropriate in the present housing conditions (Lafi and Al-Khalifa, 2024). AbdulKareem (2016) also reviews the Middle Eastern courtyard house as a climatic response and reports that courtyard microclimates can support comfort through shading and controlled exposure, while also noting that performance varies with geometry, enclosure ratio, and environmental context. Adding to this performance evidence, Al-Qa’ed and Patterson (2024) report that greenery and courtyard-related spatial conditions can contribute to measurable thermal improvements in hot-arid heritage housing contexts, reinforcing the importance of microclimate strategies for comfort.

A third strand addresses cultural continuity and public acceptance, which can shape whether vernacular strategies are embraced in contemporary projects. In this connection, Allaith (2025) examines public perceptions of reviving traditional Bahraini architecture and reports strong support for incorporating traditional elements into contemporary projects, linking heritage integration with identity and perceived environmental responsiveness. However, perception-based support does not automatically confirm environmental performance. When

read alongside performance-focused studies and critiques of symbolic mashrabiya use, literature indicates a recurring issue: vernacular elements may be adopted for identity, but their success depends on whether they are designed and assessed as functional environmental systems rather than symbolic references (Altomman, 2013; Allaith, 2025).

Overall, prior research broadly agrees that mashrabiya screens and courtyards remain relevant in hot climates because they connect comfort, privacy, and cultural meanings. At the same time, research focused on Bahrain remains fragmented across performance studies, courtyard microclimate discussions, and heritage perception work, with limited integrations between measurable comfort outcomes and lived socio-cultural experience.

This reveals a clear gap for Bahrain-based research to document contemporary applications and apply consistent evaluation criteria such as screen porosity/depth/orientation response and courtyard proportions/enclosure/usability so that symbolic revival can be distinguished from performance-informed reinterpretations.

Research Methodology

A mixed-methods comparative case study methodology was adopted to evaluate how contemporary buildings reinterpret mashrabiya screens and courtyard strategies, and how effective these reinterpretations are for comfort, privacy, and cultural continuity. The approach combines qualitative evidence such as design intent, privacy practices, cultural meanings and user experiences with structured, comparable ‘quantitative indicators’ for which evidence is extracted from documentations. These indicators include screen porosity/opening ratio estimates, coverage, depth/offset, courtyard enclosure and shading logic. Credibility is strengthened through triangulation by cross-checking the findings across case documentation, performance notes, and user feedback.

Methods and Techniques - Data Sources

Three case studies were used to represent the different reinterpretation approaches:

- Case Study A (Gulf benchmark): Al Bahr Towers involving a dynamic mashrabiya façade. This is a desk-based study using published sources only. There is no site visit.
- Case Study B (Bahrain heritage): Siyadi House / Siyadi Pearl Museum. This involves site observations and a photographic survey supported by published sources.
- Case Study C (contemporary Bahrain): Dar Al-Muharraq. This involves site observations and a photographic survey supported by published sources.

Data collection tools included

Data was collected by means of the following tools.

- A standardized case sheet and design-variables checklist for screens and courtyards,
- A photo/plan-based documentation notes and a simplified comparative simulation plan (concept-level),
- A short Likert-scale questionnaire for user perceptions, and
- Semi-structured interviews.

Step-by-step implementation

1. Case selection and coding: Three case studies were confirmed (A, B & C) to cover dynamic mashrabiya, courtyard-based shading, and contemporary screen/veil shading.
2. Documentation capture: For each case, representative photographs were gathered. These involved site photos for the Case study B and C, while published images were surveyed for the Case study A). Plans were used where available, especially for the Case Study B to confirm courtyard position and enclosure.

3. Design-variable extraction (checklist): A single checklist format was applied across the three case studies to record: screen type, façade coverage, porosity/openness (visual estimate), depth/stand-off, operability, shading layers, daylight filtering character, and privacy control. For the Case study B, courtyard presence and enclosure were recorded as the key variables supporting microclimate and privacy.
4. Performance evidence (documentation-based): Raw observation notes were recorded consistently across the case studies focusing on glare/direct sun, daylight character, privacy/visibility, and expected heat-gain tendencies. Case study A was treated as AI-assisted interpretation from the published descriptions/images; Case studies B and C were supported by site observations and photographs.
5. Simplified simulation plan (concept-level comparison): A consistent comparison logic was set across the case studies (screen “more open vs more closed”, screened vs unscreened opening, veil present vs no veil) to produce relative outputs (high/medium/low exposure and glare risk) rather than instrumented lux readings.
6. Questionnaire (user feedback): A short 5-item Likert questionnaire was used for Case studies B and C (n = 15 responses per case). Items measured perceived thermal comfort acceptability, daylight/glare comfort, privacy acceptability, shading effect on usability/length of stay, and overall cultural appropriateness. Response frequencies were tabulated and visualized using stacked percentage charts.
7. Interviews (semi-structured): Three short interviews were conducted using the same 6 core questions: one staff member for the Case study B, one guide/staff member for the case study C, and one visitor familiar with both the sites. Interviews were recorded as written notes (coded as INT-B1, INT-C1, INT-BC1) to protect anonymity.

Outputs Produced

The methodology produced a set of comparable raw data: case profiles (A & C), completed design-variable checklists, documentation-based performance logs and a simplified simulation plan, questionnaire frequency tables and charts (Case studies B & C), interview transcripts/excerpts, and brief ethics/reliability notes supporting consistency and transparency.

Research Ethics and Reliability

Ethical issues were taken into consideration throughout the research process. Participation in the questionnaire and interviews was voluntary, and participants were informed of the purpose of the study and could stop at any time. No real names were recorded; instead, participant codes were used (e.g., INT-B1, INT-C1, INT-BC1). Questions avoided sensitive personal information, focusing only on comfort, daylight/glare, privacy perception, and usability.

To improve reliability, the same questionnaire items and the response scale were used for the case study B and the case study C, and the same variable checklist format was applied across the cases (A & C). The simplified simulation assumptions were kept consistent across the case studies for fair comparison. Case study observations were supported by multiple sources such as site observations and photographs for the case studies B & C, and published sources for the case study A, enabling triangulation across documentation, questionnaire results, and interview insights to strengthen credibility.

Findings

The findings present the research data collected to examine how contemporary architecture reinterprets vernacular shading strategies in Bahrain; especially mashrabiya-like screens and courtyards and how effective these reinterpretations are for environmental comfort, privacy, and cultural continuity. As mentioned, the study uses a mixed-methods comparative case study approach across the three case studies: Al Bahr Towers (Abu Dhabi, UAE) as a Gulf benchmark dynamic “mashrabiya” façade, and two Bahrain case studies: Siyadi House / Siyadi Pearl Museum (courtyard + traditional shaded openings) and Dar Al Muharraq (mesh “mashrabiya” veil).

Data were gathered through case documentation (photos, plans, and extracted design variables), a simplified comparative simulation plan with consistent assumptions across cases, user questionnaire responses ($n = 15$ for the case study B and $n = 15$ for the case study C), and three short semi-structured interviews (Case study B staff, Case study C guide, and a visitor familiar with the both). The findings are presented systematically by data type to show the patterns in shading performance, user perceptions, and observed spatial usability.

Case Study A (Gulf): Al Bahr Towers, Abu Dhabi, UAE

Dynamic ‘mashrabiya’ facade

A contemporary high-rise that reinterprets mashrabiya as a performance-based shading system (responsive facade), directly linked to comfort + daylight/glare control.



Fig. 1: Al Bahr Towers, Abu Dhabi, UAE

Source: <https://www.ahr.co.uk/projects/al-bahr-towers>



Fig. 2: A detail of the Mashrabiya - Al Bahr Towers, Abu Dhabi, UAE

<https://www.ahr.co.uk/projects/al-bahr-towers>

Basic Information

- Project: Al Bahr Towers (twin office towers)
- Location: Abu Dhabi, UAE
- Key vernacular strategy: Mashrabiya-inspired external shading screen, responsive/dynamic facade.

Raw Design Variables (mashrabiya screen)

- Screen type: Triangular PTFE/fiberglass “umbrella” modules on a kinetic frame (operates as responsive façade).
- Coverage: High approx. 60–80% of the main glazed elevation is behind the operable screen system (varies by façade orientation/zone).
- Porosity / openness: Variable (kinetic)
- Closed mode: approx. 10–25% open (mostly shaded)
- Open mode: approx. 40–60% open (more daylight/views)
- Depth / stand-off from glazing (screen offset): approx. 0.6–1.2 m (estimated from façade module scale)
- Orientation response: Yes (screen adjusts by façade exposure / sun position; shading intensity changes across elevations).
- Material/finish (visual): bronze/gold-toned external screen; glazed curtain wall behind.
- Raw performance evidence (documentation-based)
- Claimed performance purpose: reduce solar gain + glare; allow daylight while maintaining comfort.
- Evidence type: published project description / façade system notes + published images showing open/closed states. (Desk-based, secondary sources + photo evidence)
- Planned simulation input (simplified): compare screen ON vs OFF (or “more open vs more closed”) using a basic daylight/solar exposure tool with consistent assumptions.



Fig. 3: Detail Views of the Mashrabiya - Al Bahr Towers, Abu Dhabi, UAE
<https://www.ahr.co.uk/projects/al-bahr-towers>

It is clear from the foregoing information that the re-interpretation of the mashrabiya at Al Bahr Towers, Abu Dhabi, UAE, effectively acts as a cooling technique while also inscribing a modern appearance to the building. Its application is different from the traditional vernacular ones although it does achieve equally effective colling effect for the building.

Case Study B: Siyadi Pearl Museum/Siyadi House, Muharraq, Bahrain Courtyard + Traditional Shading

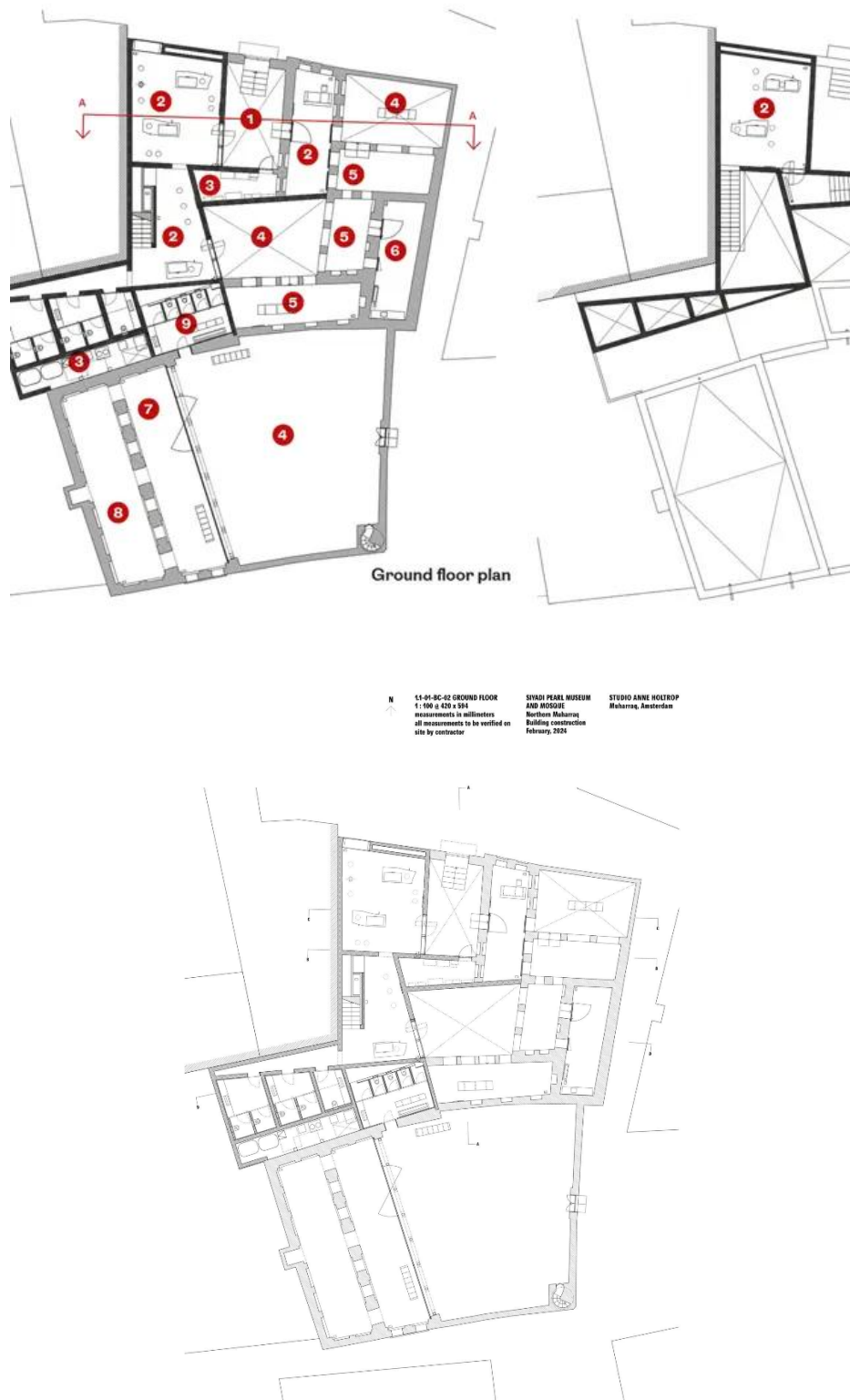


Fig. 4: Siyadi Pearl Museum, Bahrain

Source: <https://divisare.com/projects/517621-studio-anne-holtrop-siyadi-pearl-museum>

The case study B is a heritage building where the courtyard enclosure and the shaded openings - traditional screens/shutters support privacy, glare reduction, and microclimate comfort. This house has been renovated and conserved by the specialists: Studio Anne Holtrop.

The Siyadis were one of Bahrain's most prominent pearl-trading dynasties between the 19th and 20th centuries, owning their own pearling fleet. Built in 1921, this four-level building is the only one of its kind from the pearling era. It remains the last preserved example where a grand pearl merchant hosted international buyers from as far away as India and Europe.

Basic Information

- Project: Siyadi Pearl Museum / Siyadi House (Pearling heritage site)
- Location: Muharraq, Bahrain
- Key vernacular strategy: Courtyard as thermal/social core + shaded openings (traditional timber screens/shutters) for privacy + glare control.

Raw Design Variables (Mashrabiya and a Courtyard)

- Screen type: Traditional timber mashrabiya/wooden lattice shutters to upper windows (fixed + operable panels).
- Coverage: Medium (mainly upper openings; approx. 20–40% of façade openings).
- Porosity / Openness: Moderate–high (approx. 35–55% open area depending on panel density).
- Depth / Screen Stand-off: Shallow–moderate (approx. 0.06m–0.12 m as a timber lattice/shutter build-up).
- Orientation Response and Shading Layers: Passive (same screen logic repeated; performance depends on façade orientation + courtyard shading). Arcades + recessed openings + courtyard enclosure + timber screens.
- Courtyard Presence and Enclosure: Central open-to-sky courtyard; high enclosure provides privacy and strong self-shading.

Raw Performance Evidence Based on Documentation

- Purpose: Reduce glare/sun; improve privacy; cool courtyard via shade/enclosure.
- Evidence: Photos/plan: shaded courtyard, deep recesses, screened openings, high enclosure.
- Simulation: Compare shaded ratio + screened vs unscreened openings (daylight/solar), same assumptions.



Fig. 5: A View of Siyadi Pearl Museum, Bahrain

Source: <https://divisare.com/projects/517621-studio-anne-holtrop-siyadi-pearl-museum>

Case Study C: Dar Al-Muharraq, Muharraq
 Mesh 'Mashrabiya' Veil / Curtain Facade)
 Bahrain



Fig. 6: Views of Dar Al-Muharraq, Muharraq, Bahrain

Source: <https://culture.gov.bh/en/visitingbahrain/CulturalTourism/Destinations/Name,15022,en.php>

A contemporary cultural venue where a draped metal mesh veil acts as a mashrabiya-like shading layer for privacy + filtered daylight and a softer street presence. Situated in the old city of Muharraq along the Pearling, testimony of an Island Economy pathway, it is a training and research centre for traditional folk music and has a space for cultural and musical events. According to the Bahrain Authority for Culture and Antiquities, it is an extension to Dal Jinaa, the three-storey building enveloped with a steel mesh, which also acts as a cooling device shading the building from direct sunlight. The mesh can be lifted on the ground floor, opening it up directly to the street and reinforcing its role as an open majlis to the city (<https://culture.gov.bh/en/visitingbahrain/CulturalTourism/Destinations/Name,15022,en.php>).

Basic Information

- Project: Dar Al Muharraq (performance venue / cultural space – Pearling Path)
- Location: Muharraq, Bahrain
- Key Vernacular Strategy: Full-height mesh veil (contemporary mashrabiya reinterpretation) providing shading + privacy + daylight filtering.

Raw Design Variables (screen)

- Screen Type: Metallic mesh veil (chainmail-like), draped as a curtain.
- Coverage: Very high approx. 80–95% of exposed façades are behind the mesh veil (continuous wrap).
- Porosity / Openness: High (breathable screen) —approx. 50–70% open area (visual estimate from mesh density).
- Depth / Stand-off from Glazing (offset): Approx. 0.30–0.80 m (varies due to drape + fixing line; deeper at the “curtain” fold).
- Operability / Adjustability: Semi-variable veil can be lifted/opened (curtain logic), changing openness and airflow.

- Orientation Response: Passive (same system on all sides; performance depends on sun angle + street width/adjacent walls).
- Material/finish (visual): Silvery metallic mesh veil; glazed openings behind.
- Raw performance evidence (documentation-based)
- Claimed/expected purpose: Filter daylight, reduce glare and heat gain, improve privacy, and allow ventilation while keeping the façade visually light.
- Evidence type: Day + night photos showing veil continuity, filtered visibility, and softened glare (screen present at full height; “curtain” fold at lower edge).
- Planned simulation input (simplified): Compare screen ON vs screen OFF (same window-to-wall ratio) for daylight/solar exposure using consistent assumptions across cases.

Raw Design Variables Checklist (Mashrabiya / screen + courtyard)

Case study A: Al Bahr Towers, UAE|

Case Study B: Siyadi House, Bahrain.

Case Study C: Dar Al Muharraq, Bahrain.

Table 01: Raw Design Variables in the Case Studies

Source: Research

Variable	Case A	Case B	Case C
Screen type	Kinetic umbrella modules	Timber lattice / shutters	Draped metal mesh veil
Coverage (façade)	High	Medium (windows)	Very high
Porosity / openness	Variable	Medium – high	High
Depth	Deep	Shallow	Medium (drape)
Operable	Yes (dynamic)	Partly	Semi (lift/adjust)
Orientation response	Yes	Passive	Passive
Shading layers	1 main layer	Multi (recess + arcade)	1 veil layer
Daylight filtering	High control	Moderate	High diffusion
Privacy control	Moderate	High	High
Note: Values are visual estimates derived from site visit and published photos/plans, used for cross-case comparison			

Table 02: Raw Design Variables in the Case Studies

Source: Research

VARIABLE	CASE Study A	CASE Study B	CASE Study C
Courtyard present	No	Yes (central)	No
Enclosure level	N/A	High	N/A
Shading sources	N/A	Walls + arcades + recesses	N/A
Usability (social)	N/A	High	N/A
Microclimate role	N/A	Strong	N/A
Note: Values are visual estimates derived from site visit and published photos/plans, used for cross-case comparison			

Raw Performance Evidence (documentation + simplified simulation)

evidence basis:

- Case Study A: Al Bahr Towers, UAE: ai interpretation based on published images and project descriptions (no site visit).
- Case Study B and C (Bahrain): evidence based on personal visit observations and photographs, supported by published documentation

Table 03: Documentation-Based Performance Notes: Raw Observations

Source: Research

item	Case Study A: Al Bahr Towers (dynamic screen)	Case Study B: Siyadi House (courtyard + timber)	Case Study C: Dar Al Muharraq (Mesh veil)
			
Glare / Direct Sun	Strong reduction when screen is “closed”; daylight increases when more open	Reduced by recesses + shutters; courtyard self-shading limits harsh sun	Reduced by veil diffusion; glare softened on street-facing opening
Daylight Quality	Variable: changes with screen openness	Moderate: controlled openings + courtyard bounce light	Diffused: softer daylight, lower contrast near façade
Privacy / Visibility	Moderate to high (screen blocks direct views when closed)	High (screened windows + inward courtyard)	High (veil reduces direct visibility; partial silhouettes)
Heat Gain (expected)	Lower when screen closed (external shading)	Lower in courtyard/recess zones (self-shading)	Lower at façade (veil reduces direct solar exposure)

Simplified Comparative Simulation Plan (Same Assumptions Across all the Case Studies)

Tool/Type: basic daylight/solar exposure comparison (concept-level).

Common Assumptions: same orientation reference, same sky condition, same time window (e.g., morning / noon / afternoon), same “screen ON vs OFF” logic.

Table 04: Simplified Comparative Simulation Plan

Source: Research

Simulation Comparison	Case Study A	Case Study B	Case Study C
Scenario 1	Screen more open vs more closed	Screened window vs unscreened	Veil present vs no veil
Scenario 2	High exposure façade vs low zone	Courtyard enclosure (high) vs edge zone	Veil stand-off (tighter) vs loose dare proxy
Output to record	Relative solar exposure ranking (high/med/low) + glare risks	Relative courtyard shade ratio (high/med/low) + comfort note	Relative daylight diffusion (high/med/low) + privacy note

Table 05: Raw “AI-Assisted interpretation” Output Log

Source: Research

Output	Case Study A	Case Study B	Case Study C
Solar Exposure / Glaring Potential	Low–Med (closed) / Med (open)	Low (courtyard/recess) / Med (edges)	Low–Med (veil) / Med (openings without veil)
Glare Risk	Low (closed) / med (open)	Low–Med (screened + recessed)	Low (diffused)
Privacy Performance	High (closed)	High	High
Daylight Character	Variable / adaptive	Controlled / indirect	Diffused / softened

Questionnaire Data

A short Likert-scale questionnaire was conducted to record user perceptions of shading performance in Case B (Siyadi House) and Case C (Dar Al Muharraq), with 15 respondents per case (n = 15) using a five-point scale from Strongly Agree to Strongly Disagree.

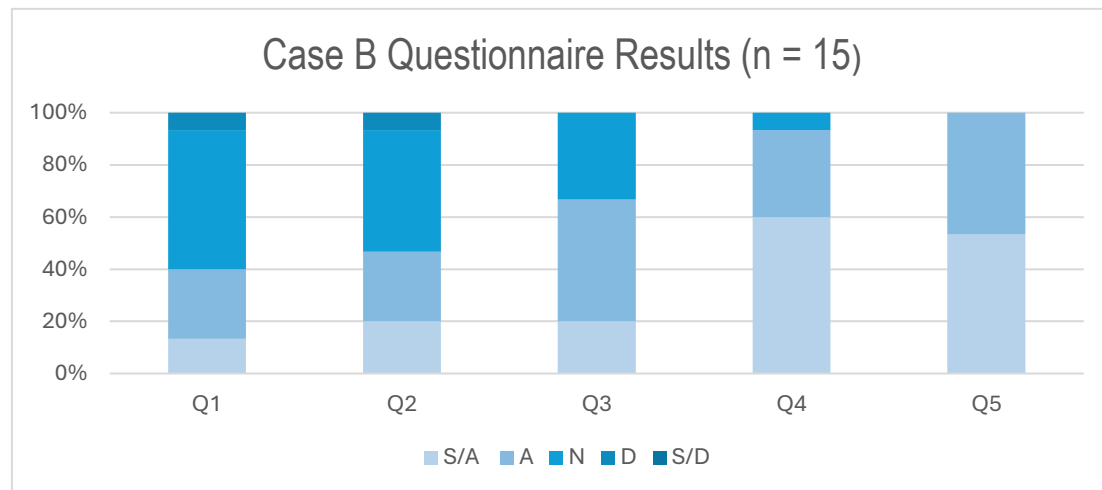
Table 06: Questionnaire Data

Source: Research

Case Study B						
items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Q1: Thermal comfort feels acceptable in this space	2	4	8	1	-	15
Q2: Daylight is comfortable (not too harsh/glary)	3	4	7	1	-	15
Q3: Privacy feels acceptable in / near opening	3	7	5	-	-	15
Q4: Shading makes the space usable longer	9	5	1	-	-	15
Q5: Overall, this feels culturally appropriate	8	7	-	-	-	15

Table 07: Case Study B Questionnaire Data

Source: Research

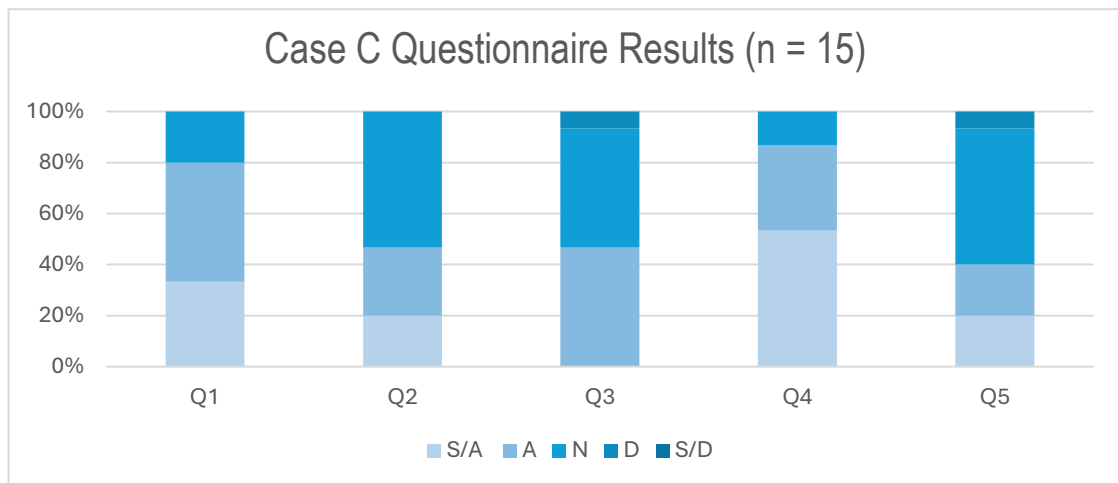


Case Study B - Siyadi House: Overall, responses lean positively for privacy and cultural appropriateness, while thermal and daylight comfort are more mixed with many neutral responses.

Table 08: Questionnaire Data -Case Study C
Source: Research

Case Study C						
items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Q1. Thermal comfort feels acceptable in this space	5	7	3	-	-	15
Q2. Daylight is comfortable (not too harsh/glary)	3	4	8	-	-	15
Q3. Privacy feels acceptable in / near opening	-	7	7	1	-	15
Q4. Shading makes the space usable longer	8	5	2	-	-	15
Q5. Overall, this feels culturally appropriate	3	3	8	1	-	15

Table 09: Questionnaire Data - Case Study C
Source: Research



The Case Study C (Dar Al Muharraq): Overall, the responses show the strong agreement that shading improves usability and comfort, with privacy generally acceptable, but cultural appropriateness is more divided (more neutral/disagree).

Interview Data

Three semi-structured interviews were conducted to gain deeper insight into how users and staff perceive vernacular shading strategies in the selected Bahrain case studies (Case B and Case C). The interviews explored comfort, daylight/glare, privacy, cultural appropriateness, and how shading influences use patterns and length of stay. Responses were recorded as written notes and summarized using participant codes to maintain anonymity.

Total No of Interviews: 3 (approximately 10 minutes each)

Participants: Interview 1 (Case Study B - Staff Member)

- Participant's role: Staff member / employer
- Location: Siyadi House / Siyadi Pearl Museum, Muharraq, Bahrain

Interview 2 (Case Study C - Staff Member)

- Participant role: Guide / staff member
- Location: Dar Al Muharraq, Muharraq, Bahrain

Interview 3 (Visitor – both the Case Study B and the Case Study C)

- Participant's role: Visitor (Experienced both the sites)
- Location: Muharraq, Bahrain

Interview Questions

1. In your words, what is the main purpose of the shading here (comfort / privacy / identity)?
2. When do people feel most comfortable here (time of day / season), and why?
3. How does the shading affect daylight and glare (too bright, soft, dim, etc.)?
4. How does it support privacy (visibility, views, sense of being watched)?
5. Does the shading change how long people stay or how they use the space?
6. If you could improve one thing about the shading/courtyard system, what would it be?

Case Study B: Siyadi House / Siyadi Pearl Museum, Muharraq

Interview code: INT-B1

Case Study: B, Bahrain

Participant's role: Staff member

Setting: Courtyard and circulation near the shaded openings

Q1: In your words, what is the main purpose of the shading here (comfort / privacy / identity)?

A1 (Staff): It is “mainly privacy and comfort together. The courtyard layout and screened openings reduce harsh sun and keep the place culturally appropriate, especially around windows and upper openings.”

Q2: When do people feel most comfortable here (time of day / season), and why?

A2 (Staff): As I see it, “People are most comfortable in late morning and afternoon in cooler months. The courtyard stays calmer because the walls create shade, and airflow feels better compared to the street side.”

Q3: How does the shading affect daylight and glare (too bright, soft, dim, etc.)?

A3 (Staff): “Daylight becomes softer and more controlled. The recessed openings and shutters reduce direct glare, so inside spaces don't feel blinding, especially near the courtyard edges.”

Q4: How does it support privacy (visibility, views, sense of being watched)?

A4 (Staff): “It limits direct views from outside. From inside, you can still get light and some air, but visually it feels protected people don't feel exposed in the openings.”

Q5: Does the shading change how long people stay or how they use the space?

A5 (Staff): “Yes. The visitors tend to pause longer in shaded courtyard zones and under arcades, especially when the sun is strong. People also choose shaded edges for sitting or waiting rather than open sun areas.”

Q6: if you could improve one thing about the shading/courtyard system, what would it be?

A6 (Staff): “I would add more continuous shaded seating and improve comfort in peak summer like enhancing airflow pathways or adding subtle shading elements in the courtyard without changing the heritage character.”

Case Study C: Dar Al Muharraq, Muharraq - mesh “mashrabiya” veil / curtain facade

Interview code: INT-C1

Case Study: C, Bahrain)

Participant's role: Guide

Setting: Street-facing façade under the metal mesh veil, at the entrance threshold (public lane context).

Q1: in your words, what is the main purpose of the shading here (comfort / privacy / identity)?**A1 (Guide):** “The main purpose is privacy and glare control, but it also supports comfort by filtering harsh sun. At the same time, the veil gives the building a local identity it reads like a contemporary mashrabiya.”**Q2:** when do people feel most comfortable here (time of day / season), and why?**A2 (Guide):** “People feel most comfortable in the afternoon, because the mesh reduces direct sun and the street feels less exposed. In cooler months, visitors stay longer outside because the shade makes the micro-space more pleasant.”**Q3:** how does the shading affect daylight and glare (too bright, soft, dim, etc.)?**A3 (Guide):** “The daylight becomes soft and diffused, not sharp. You still get brightness, but glare is reduced, especially near the main openings. It feels calmer visually compared to bare glass.”**Q4:** how does it support privacy (visibility, views, sense of being watched)?**A4 (Guide):** “From outside, the veil creates partial visibility, you don't get direct clear views inside. From inside, you can still look out more comfortably, but the space feels less exposed to the street.”**Q5:** Does the shading change how long people stay or how they use the space?**A5 (Guide):** “Yes. People tend to pause longer near the entrance and take photos because the shade makes it comfortable to stand. Without the veil, that edge would feel hotter and more visually exposed, so people would pass through faster.”**Q6:** if you could improve one thing about the shading/screen system, what would it be?**A6 (Guide):** “I would add a slightly deeper stand-off or secondary layer at the most exposed side, so the shade is stronger in peak summer hours, while keeping the same appearance and concept.”**Visitor interviews: Both the Case Study B and the Case Study C**

Interview ID: int-bc1

Case Study: B, Siyadi house and C, Dar Al Muharraq

Participant's Role: visitor

Setting: visitor who has experienced both case band case c

Q1: In your words, what is the main purpose of the shading here (comfort / privacy / identity)?**A1 (visitor):** “both are doing comfort and privacy, but in different ways. Siyadi uses the courtyard and deep openings to protect you, while dar al muharraq uses the veil like a modern screen. Both also feel connected to local identity.”**Q2:** When do people feel most comfortable here (time of day / season), and why?**A2 (visitor):** “Siyadi feels comfortable for longer because the courtyard is protected and shaded. Dar Al Muharraq feels best near the entrance under the veil, especially later in the day. In winter both are nicer, but Siyadi still feels cooler.”

Q3: How does the shading affect daylight and glare (too bright, soft, dim, etc.)?

A3 (visitor): “at Siyadi, the light is softer and indirect because of recesses and the courtyard. At Dar Al Muharraaq the light is still bright, but it becomes diffused. The veil reduces the harsh glare you would get with clear glass.”

Q4: How does it support privacy (visibility, views, sense of being watched)?

A4 (visitor): “Siyadi feels private because it turns inward, so you don’t feel watched from outside. Dar Al Muharraaq feels private because the veil blocks direct views so people outside can’t see details inside.”

Q5: Does the shading change how long people stay or how they use the space?

A5 (visitor): “Yes. In Siyadi, I stayed longer in the courtyard and shaded edges. In Dar Al Muharraaq, people pause near the façade and take photos because the shade makes it comfortable to stop, but the courtyard encourages longer staying.”

Q6: If you could improve one thing about the shading systems, what would it be?

A6 (visitor): “for Siyadi, I would add more seating in shaded zones. For Dar Al Muharraaq, I would improve airflow behind the veil and provide more shaded waiting spots near the entrance.”

Analysis and Discussion

This section interprets patterns emerging from the collected datasets involving case documentation and variable checklists, documentation-based performance notes/AI-assisted logs, questionnaire frequencies/charts, and semi-structured interviews. The aim is to explain how different contemporary reinterpretations of vernacular shading such as mashrabiya-like screens and courtyards, relate to comfort defined by glare/daylight, privacy, usability, and cultural appropriateness across all the Cases A, B & C.

Table 10: Cross-case analysis matrix (Cases A, B & C) summarizing design variables and observed outcomes
Source: Research

Analysis Lense	Case Study A	Case Study B	Case Study C
Shading Logic / Mechanism	Responsive kinetic screen; variable open/closed states	Layered shading: courtyard enclosure + recesses + shutters/arcades	Full-height mesh veil; diffusing “curtain” layer; stand-off varies
Daylight Character	Variable/adaptive (changes with screen state)	Controlled/indirect (recesses + courtyard bounce light)	Diffused/softened (reduced contrast, filtered brightness)
Glare / Direct Sun	Strong reduction when “closed”; higher daylight when “open”	Reduced by recesses + shutters; courtyard self-shading	Reduced by veil diffusion; glare softened at street openings
Solar Exposure	Low-med (closed) / med (open)	Low (courtyard/recess) / med (edges)	Low-med (veil) / med (without veil)
Privacy Mechanism	Highest when screen more “closed”	Inward orientation + recessed/screened openings	Partial screening: blocks clear street visibility; allows outward looking
Usability / Stay Pattern	Primarily performance-driven façade behavior (limited user-stay evidence in this study)	Façade behavior (limited user-stay evidence in this study) Longer pauses + sitting in shaded courtyard edges/arcades	Shorter but frequent stops at entrance/street edge (waiting/photos)
User Feedback (questionnaire)	N/A	Strong privacy + cultural appropriateness;	Strong shading-usability agreement; privacy

		thermal/daylight more mixed	acceptable; cultural fit more divided
Interview Themes (what explains the number)	N/A	Comfort tied to microclimate + shade; controlled daylight; privacy through inwardness	Comfort tied to entrance shade; diffused daylight; privacy via veil screening
Key Interpretations	Performance depends on variable control (state/openness/depth)	Best overall microclimate driver via enclosure + layering	Strong glare diffusion + street-edge privacy; cultural acceptance depends on lived usability

Cross-Case Comparison of Design Variables

The design variables show three distinct shading logics. The case study A (Al Bahr Towers) represents a high-coverage, deep, responsive screen with variable openness (open/closed states). The case study B (Siyadi House/Pearl Museum) combines courtyard enclosure with recessed openings and timber shutters, producing layered shading and strong self-shading effects. The case study C (Dar Al Muharra) relies on a very high-coverage mesh “veil” acting as a diffusing layer at the street edge, with semi-adjustability through a curtain-like logic and changing stand-off.

Reading across these case studies suggests that performance is not defined by “having a mashrabiya pattern,” but by how multiple variables combine (coverage, depth/stand-off, enclosure, and openness). In the case studies of context of Bahrain, enclosure and layered shading-The case study B-operate as a microclimate strategy, while veil diffusion/filtering-The case study C-operates as a street-edge comfort and privacy strategy. The case study A demonstrates the logic of responsive modulation where openness is actively adjusted.

Comfort and Daylight/Glare: ‘Controlled’ vs ‘Diffused’ Outcomes

The documentation-based performance notes and the comparative log point towards a consistent daylight pattern. The case study B trends towards controlled/indirect daylight, where recesses and shutters reduce direct sun and glare while the courtyard supports calmer light conditions and shaded circulation. The case study C trends toward diffused/softened daylight: brightness remains present, but the veil reduces harsh glare and contrast at the street-facing opening. The case study A shows an adaptive pattern: comfort improves when the system is more ‘closed,’ while daylight/visibility increases when more ‘open.’

This supports the idea that climate-responsive shading should reduce glare and expected heat gain while maintaining usable daylight (Olgyay, 1963; Givoni, 1998). In this dataset, the case study B achieves this primarily through enclosure, depth and layered shading, while the case study C achieves it through diffusion/filtering, and the case study A through dynamic adjustment.

Privacy: Different Mechanisms Achieving Similar Outcomes

Across the case studies, privacy is achieved through different architectural mechanisms, but the direction is consistent. The case study A indicates privacy is strongest when the system is more ‘closed,’ with openness increasing outward visibility and view potential. The case study B strengthens privacy through inward orientation, recessed openings, and screened/shuttered windows, reducing direct views from outside while supporting comfortable internal use. The case study C achieves privacy through partial screening: the veil blocks clear visibility from the street and reduces visual exposure, while still allowing some outward looking from inside.

Therefore, privacy is not simply a strict ‘privacy vs daylight’ trade-off; rather, privacy is shaped by how openness is controlled. This involves fixed density, recess depth, and/or operability. This aligns with privacy as a form of visual control that is affected by environmental and behavioral mechanisms (Westin, 1967; Altman, 1975).

Usability and Behavior: Shading Affects How Long the People Stay

A clear behavioral pattern appears when comparing documentation observations and interviews. The case study B supports longer occupation inside and around courtyard edges (shaded circulation and arcades). The courtyard acts as a usable microclimate and encourages pausing, sitting, and longer stays. The case study C encourages shorter but frequent pauses at the façade/entrance zone where the veil creates a comfortable edge condition for waiting/stopping (and sometimes taking photos), but it does not function like a central “stay-longer” space in the same way as a courtyard.

This suggests two valid but different outcomes: ‘courtyard comfort for extended occupation’ represented by the case study B, versus ‘street-edge comfort for brief occupation’ (represented by the case study C). Both reinterpret vernacular shading, but they produce different user behaviors and spatial patterns.

Questionnaire Patterns, where Agreement is the Strongest and Where it is Mixed

The questionnaire frequencies (n = 15 per case study for B and C) reinforce the cross-case reading. Case study B responses lean strongly positive for privacy and cultural appropriateness, while thermal/daylight comfort results are more mixed (with a noticeable neutral share). This suggests that users clearly recognize privacy and cultural benefits of the courtyard and screened openings, but comfort perceptions vary by time, position, and personal sensitivity. The case study C shows a strong agreement that shading improves usability and comfort, with privacy generally acceptable; however, cultural appropriateness is more divided (more neutral/disagree responses). This suggests the veil performs effectively as a shading device, but some users interpret cultural ‘fit’ differently when the strategy is contemporary and less visibly traditional.

Overall, user feedback indicates that comfort and usability are supported in both cases, but cultural evaluation depends on recognizability, meaning, and lived usability not performance alone.

Interview Themes: Interpreting ‘Meanings’ Behind the Numbers

The interview themes help explain why some questionnaire items are mixed. Comfort is repeatedly linked to shade and microclimate control. The case study B is calmer/cooler due to enclosure and shaded circulation; the case study C is the strongest at the entrance under the veil. Daylight is described as shifting from ‘controlled’ represented by the case study B to ‘diffused’ represented by the case study C. Privacy is achieved through inwardness and screened openings as present in the case study B versus veil screening and reduced street visibility present in the case study C. Interviews also link shading to length of stay. There was a longer pauses in the case study B vs shorter stops in the case study C. Suggested improvements focus on usability without changing the identity. This means more shaded seating, airflow refinement, or strengthening the shade at the exposed edges.

Main Discussion Takeaway: Performance-Informed Reinterpretations vs Symbolic Use

Across the dataset, the strongest pattern is that vernacular strategies perform best when design variables are aligned with exposure and use, not when the element is only visual. The case study B shows how courtyard enclosure and layered shading combine into a coherent microclimate and privacy system. The case study C shows how a contemporary veil can still function as a mashrabiya-like layer through diffusion and screening at the street edge, even if cultural interpretation varies across users. Together, the checklist, performance notes, questionnaire results, and interview themes support performance-informed reinterpretation of shading strategies rather than symbolic replication.

Conclusions

This study examined how contemporary architecture reinterprets two vernacular shading strategies relevant to Bahrain mashrabiya-like screens and courtyard-based shading and how these reinterpretations perform in relation to comfort (daylight/glare), privacy, and usability. Evidence was triangulated across three case studies (Al Bahr Towers as a Gulf benchmark; Siyadi House as a Bahraini heritage courtyard + timber shading case; Dar Al Muharraq as a Bahraini contemporary mesh “veil” case), supported by documentation-based performance notes, a simplified comparative simulation plan, questionnaire response frequencies (case studies B and C, $n = 15$ each), and three semi-structured interviews (case study B staff, case study C guide, and one visitor who experienced both).

Across the cases, the findings show that shading performance is not defined by “having a mashrabiya pattern,” but by how specific design variables align with climate exposure and user needs. The case study A demonstrates a performance-driven approach where façade shading is treated as a responsive system; this supports the idea that screen openness, depth/stand-off, and exposure control directly shape glare risk and daylight character. In Bahrain, the case study B shows that courtyard enclosure and layered shading (recesses, arcades, and timber shutters) create strong self-shading and a stable microclimate, resulting in high perceived privacy and longer comfort-based occupancy. The case study C shows that a full-height veil strategy can effectively diffuse daylight and reduce glare at the street edge while maintaining a softer visibility condition; however, user responses indicate that “cultural appropriateness” can be more divided in contemporary reinterpretations, suggesting that cultural acceptance is influenced not only by visual reference but also by how the space supports familiar patterns of use and comfort.

User-based data reinforces these patterns. Questionnaire results indicate generally positive responses toward shading improving usability and comfort in both the case study B and the case study C, with the case study B showing strong agreement for privacy/cultural appropriateness while thermal/daylight comfort responses are more mixed (higher neutral responses). The case study C shows strong agreement that shading supports usability and comfort, with privacy generally acceptable, but more divided responses regarding cultural appropriateness. Interview themes support the same conclusion: comfort is repeatedly linked to shade and microclimate control; daylight shifts from “controlled” (the case study B) to “diffused” (the case study C); privacy is achieved through different mechanisms (inward courtyard logic vs. veiled screening); and shading influences behavior and length of stay (longer pauses in courtyard edges vs. shorter street-edge stops). Suggested improvements in both cases focus on usability enhancements (shaded seating, airflow refinement) without changing identity.

Key Conclusions

1. Performance comes from variables, not motifs: depth/stand-off, porosity/openness, coverage, and layering determine glare control, privacy, and comfort more than decorative patterning alone.
2. Courtyard enclosure remains a strong microclimate driver in Bahrain-context cases, supporting comfort and longer occupancy through self-shading and calmer edge conditions (Case B).
3. Veil-based screening effectively diffuses glare and supports street-edge privacy comfort (Case C), but cultural appropriateness can be more contested.
4. Privacy is achieved through different mechanisms: inward courtyard/recess logic (Case B) vs. partial visibility filtering (Case C).
5. User data and interviews align with documentation-based evidence, strengthening reliability through triangulation across methods.
6. Best-performing reinterpretations are climate and user-aligned, supporting performance-informed shading strategies rather than symbolic replication.

These conclusions are drawn from small comparative datasets involving only three case studies and user feedback in case studies B & C. Although findings from case studies are not generalizable, they are intended to guide performance-informed reinterpretation in similar contexts in Bahrain.

Recommendations

Based on the documented observations, questionnaire results, and interview themes, the following recommendations support performance-informed reinterpretations of mashrabiya screens and courtyard strategies in Bahrain:

1. **Design for performance, not pattern:** Treat mashrabiya/screen systems as climate devices by prioritizing porosity/openness, stand-off distance, and shading coverage according to sun exposure and user needs.
2. **Use layered shading (avoid single-layer facades) where possible:** Combine recesses, arcades, shutters/screens, and controlled openings to reduce glare while maintaining usable daylight (as seen in Case B).
3. **Strengthen courtyard microclimate intentionally:** Where courtyards are used, ensure sufficient enclosure and shaded circulation edges to improve comfort and support longer social use, especially in warmer periods.
4. **Street-edge veil/screens should balance privacy + permeability:** For mesh/veil re-interpretations (Case C), maintain filtered visibility and glare diffusion, while improving airflow behind the veil and adding shaded waiting/seating near entrances.
5. **Align “cultural appropriateness” with daily usability:** Support cultural continuity by designing shading that matches lived patterns (privacy expectations, pause/stay zones, circulation comfort), not only by applying vernacular visual references.
6. **Use consistent evaluation checks in future projects:** Apply a consistent checklist across projects screen type, coverage, openness, depth, layering, courtyard enclosure) and compare “screen ON vs OFF” assumptions to keep assessments consistent across cases.

Despite these findings and conclusions, this study has strengths and weaknesses. In a sense, this is one of the first occasions that the reinterpretations of traditional colling strategies as being applied to contemporary buildings in Bahrain have been closely examined. Its findings therefore are extremely helpful in bringing to public attention the possibilities and nuances of re-interpreting traditional techniques for modern use. On the other hand, however, this study involved only two case studies, which provides only limited insights.

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