Impact of Technology on Cultural Identity and Traditional Practices of Bahraini Architecture

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Abstract

In recent decades, Bahrain has witnessed rapid architectural developments influenced by global design trends and technological tools. While these innovations improve efficiency and design precision, they also raise concerns about the erosion of traditional architectural elements such as courtyards, wind towers, and mashrabiya screens. In this context, this research investigates the impact of digital technologies on contemporary Bahraini architecture, particularly how they affect cultural identity and traditional design practices.

The study adopted a mixed-methods approach, combining case study observations, semi-structured interviews, and an online questionnaire. Fieldwork was conducted at three key sites: the Bahrain World Trade Center, traditional houses in Muharraq, and the Diyar Al Muharraq development. Interviews were held with architects, engineers, and planners, while the questionnaire targeted students and young professionals. The collected data included photographs, notes, thermal readings, and coded interview transcripts, all analyzed to identify recurring themes and behaviors.

Findings reveal that while technologies significantly improve architectural efficiency, it often marginalizes functional cultural features. Traditional design elements are either excluded or used superficially. Most respondents acknowledge the benefits of technologies but express concerns about cultural loss. The research concludes that a hybrid approach—combining modern tools with vernacular strategies—is essential for preserving the architectural identity of Bahrain while embracing innovations.

Keywords: Bahraini Architecture, Digital Technology, Cultural Identity, Vernacular Design, Architectural Innovation.

Introduction

In recent decades, Bahrain has experienced rapid urban and architectural developments, driven by economic growth, globalization, and advancements in digital technologies. As modern tools such as Building Information Modeling (BIM), parametric design, and smart infrastructure become increasingly integrated into architectural practices, the design and construction of buildings have become more efficient, precise, and performance-oriented. While these developments offer significant benefits, they also raise important questions about the preservation of cultural and architectural identity of Bahrain.

Traditional Bahraini architecture, shaped by the local climate, available materials, and social customs, features passive design elements such as wind towers (badgir), courtyards, and thick stone walls that enhance environmental comfort and reflect cultural values. However, these features are now increasingly being replaced—or superficially imitated—by modern, often imported, design aesthetics that prioritize images and speed over cultural relevance. This shift reflects a broader challenge in many rapidly modernizing societies: how to balance technological advancements with heritage preservation.

This research addresses a timely and important question—how are technologies affecting architectural identity in Bahrain? As the country continues to modernize, understanding the consequences of digital transformations on built heritage is essential for guiding future architectural practices and policies. In this context, the aim of this study is to investigate the role of technologies in shaping both the design process and the physical form of Bahraini architecture.

The specific objectives are:

(1) To examine how technology is used in architectural projects.
(2) To explore how cultural and vernacular elements are being integrated or lost.
(3) To identify strategies for harmonizing innovation with tradition in the built environment of Bahrain.

Theoretical Background

This research draws on theoretical perspectives that examine the intersection among technologies, architecture, and cultural identity. These include technological determinism**,** critical regionalism, and vernacular architecture theory, all of which provide a framework for understanding how architectural practices in Bahrain are influenced by digital innovations while facing the challenge of cultural preservation.

According to Castells (2010)**,** technology acts as a transformative force that restructures social and spatial environments. This concept of *technological determinism* suggests that technological developments shape not only tools and systems but also the ways in which architecture is conceived, designed, and experienced. In Bahrain, the adoption of Building Information Modeling (BIM)**,** prefabricated components, and energy modeling software reflects this shift towards technology-driven architecture, signaling how digital processes are reshaping local design practices.

In contrast, Frampton (1983) offers the theory of critical regionalism which proposes that architecture should resist the homogenizing effects of globalization by incorporating local materials, forms, and environmental responses. He argues for a design approach that mediates between global modernism and regional traditions — a principle highly relevant to Bahrain, where rapid modernizations risk marginalizing the traditional elements such as wind towers, courtyards, and coral stone walls**.**

Complementing this, Rapoport (1969) and Oliver (1987) advance vernacular architecture theory**.** It emphasizes that traditional buildings evolve from cultural values, climate, and available resources. These scholars highlight the adaptive and sustainable logic of local architectural practices, many of which are disappearing in the contemporary Gulf developments. Together, these theories form a theoretical model that positions technology, culture, and place in dynamic interactions.

Interestingly, technological determinism explains the driving influence of innovation while critical regionalism introduces a mediating lens that ensures that global technologies are adapted to local contexts. In the midst of these, vernacular theory provides the cultural and environmental grounding necessary to maintain identity. In this integrated framework, technology becomes not a force of erasure but a tool for continuity, enabling the architects of Bahrain to reinterpret traditional values through contemporary digital means.

Review of Literature

Although this is a new area of research, there is also a substantial body of research examining the nuances of this issue. Scholars across architecture and social theory consistently point out that digital innovations change not only how the buildings are produced but also how cultural meaning is negotiated. Castells (2010) maintains that networked information technologies restructure 'the space of flows.' Thus, design workflows, procurement chains and even user expectations adopt global instead of local logics. Echoing that position. Picon (2010) notes that parametric modelling fosters a "culture of fluidity" in which form is generated by algorithms rather than handcrafted proportions, decentering the designer's traditional authorship.

At the production scale, Kolarevic (2003) records how computer-controlled fabrication sets up new feedback loops between drawing and manufacture. He observes that architects increasingly describe buildings as "data sets" rather than static objects. Rosenberg (1982) earlier links such technological shifts to broader structural change, arguing that each new technical system reorganizes professional hierarchies and labor specialization. Together, these authors frame technology as an active agent that continually recalibrates architectural practice.

Critiques of global modernization warn that this recalibration often sidelines place-based knowledge. In this connection, Frampton (1983) proposes critical regionalism precisely to counteract "universalization" of the International Style, urging designers to reinterpret local topography, climate and craft rather than reproduce imported images. Empirical studies in the Gulf confirm this tension. For example, Boussaa (2017) finds that prestige projects in Doha and Manama replicate Western iconography while disregarding passive cooling ideals which historically were embedded in courtyard morphologies. In a similar vein, King (2004) reads the proliferation of glass towers across the Gulf as evidence of a "trans-national symbolic economy" that values spectacles over social continuity. Salama (2019) writing on knowledge-based urbanism adds that, despite rhetoric of smartness, most mega-projects privilege economic efficiency, leaving vernacular morphology "cosmetic at best." These findings support what Oliver (1987) and Rapoport (1969) claim that vernacular systems embody adaptive intelligence developed over generations—a resource easily erased when technological novelty is adopted.

Interestingly, within Bahrain, empirical work charts both adoption and ambivalence. For example, Al-Sayed (2016) surveys forty local firms and reports that 83 per cent have adopted BIM for high-rise work, largely to satisfy multinational contractors' requirements; yet only 22 per cent refer to traditional spatial devices during schematic design. Interview-based research by El-Shorbagy (2014) shows that sustainability consultants promote photovoltaic panels and high-performance glazing, but few integrate wind towers or thermal-mass walls, even though simulation tests demonstrate energy savings comparable to active systems. Abdullah and Khalil (2018) on the other hand, analyzing post-2000 apartment blocks in Manama, observe that mashrabiya screens are often reduced to thin aluminum facades that lack the depth needed to filter glare, illustrating what they term "heritage in two dimensions." Collectively, these Bahraini studies point to an efficiency-driven embrace of technology that is rarely coupled with a deep reading of indigenous climate knowledge.

Regional scholarship also highlights social perceptions. In survey research across Kuwait, Saudi Arabia and Bahrain, Mahgoub (2020) records that younger architects admire digital aesthetics yet remain concerned about a "loss of authenticity" in public space. His regression analysis shows a significant correlation ($p < 0.05$) between years of professional experience and preference for integrating passive elements, suggesting that awareness grows through practice rather than education. Complementing that finding, Dabbous and Sakr (2021) examine Gulf

architecture curricula and reveal that digital fabrication studios outnumber heritage-conservation electives three to one, a ratio that narrows the pedagogical window for critical regionalism.

Research on hybrid solutions, though limited, offers promising precedents. In this regard, Jaidah and Bourennane (2009) document the Doha Heritage Quarter, where digital laser-scanning enable the accurate reconstruction of gypsum latticework while contemporary services have been discreetly inserted. They argue that such digital heritage methods allow technology to safeguard, not replace, identity. Likewise, Al-Khatir (2022) demonstrates that parametric reinterpretations of the badgīr can outperform conventional wind catchers by 15 per cent in ventilation efficiency, proving that algorithmic design can extend vernacular logic rather than negate it. These studies illustrate a research gap for Bahrain: few local projects systematically measure performance benefits when traditional devices are re-engineered through contemporary tools.

Finally, policy-oriented literature underscores structural barriers. UNEP-West Asia (2021) reviews Gulf building regulations and notes that the code of Bahrain provides incentives for solar installations but none for passive shading or thermal mass, thereby skewing investment toward high-tech gadgets. Al-Naser (2017) shows that time-driven tender processes discourage iterative climate analysis, leading developers to default to imported glass curtain walls. Such governance contexts, scholars contend, mediate how and why technology is deployed, often overriding culturally sensitive design intentions.

In summary, existing research converges on three points. First, digital technologies unquestionably enhance precision, collaboration and formal exploration. Second, when applied without contextual interrogation, they accelerate the erosion of vernacular strategies central to the architectural identity of Bahrain. Third, emerging evidence hints that hybrid approaches—merging digital tools with passive, place-based wisdom—can achieve both performance and cultural relevance, yet these pathways remain under-researched in the Bahraini context. In this context, it is clear that addressing this gap can guide the practitioners and policymakers towards a more balanced architectural future.

Research Methodology

This research adopted a mixed-methods approach to investigate the impact of technologies on Bahraini architecture. The combination of qualitative and quantitative methods were used to gather data to generate both in-depth contextual understanding and measurable trends. Data were collected over a three-week period in Manama and Muharraq through three main techniques: case studies, semi-structured interviews, and a questionnaire survey.

Case Studies

Three architectural sites were selected using purposive sampling based on their symbolic, cultural, and technological relevance. These included the Bahrain World Trade Center (high-tech integration), traditional courtyard houses in Muharraq (vernacular design), and the Diyar Al Muharraq development (modern urban expansion).

For each site, structured on-site observations were conducted using a prepared checklist. This included:

- Handwritten field notes to record architectural features such as materials, façade elements, spatial layout, and ventilation systems.
- Photographic documentation using a digital camera to capture key details like solar panels, shading devices, and user activity.
- Behavioral mapping, where applicable, to observe how users engaged with different parts of the spaces, especially shaded vs. exposed areas.

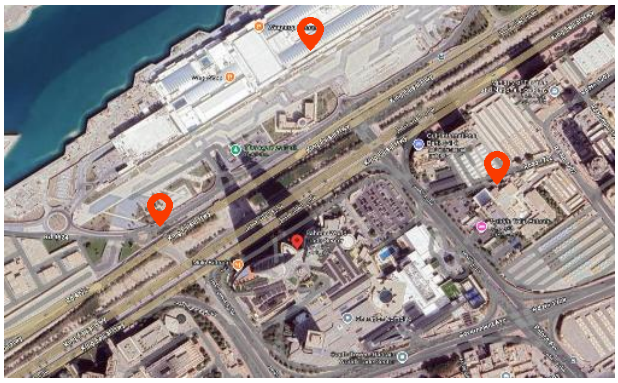
- Manual measurements or estimations of key spatial elements, such as wall thickness, window sizes, and courtyard dimensions.

This data was later categorized and compared to identify patterns of technological integration and its effect on climatic responsiveness and cultural expression.

Introduction to Case Studies

As said, to examine the interactions between technology, architecture, and cultural identity in Bahrain, three case studies were selected: the Bahrain World Trade Center (BWTC), traditional courtyard houses in Muharraq, and Diyar Al Muharraq, a large-scale urban expansion. Together, these examples represent a spectrum—from highly technological to vernacular to hybrid approaches, illustrating how contemporary Bahraini architecture negotiates between innovation and heritage.

Bahrain World Trade Center



Traditional Courtyard House

Diyar Al Muharraq

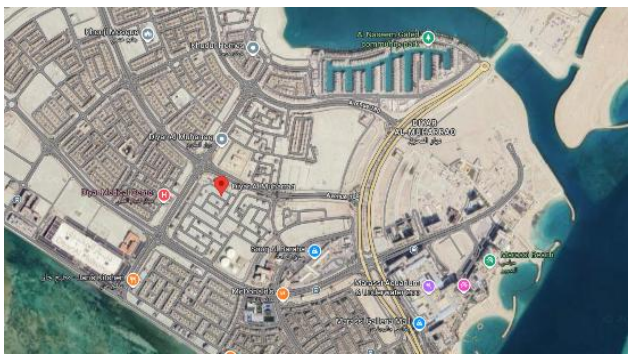


Fig. 1: Location plans showing the three case study sites across Bahrain
Source: Google

Fig. 2: BWTC showing turbine integration and façade design.

Fig: 3. Image of a traditional Courtyard House**.**
Source: Author

Bahrain World Trade Center (BWTC) – High-Tech Landmark.

- The Bahrain World Trade Center (completed in 2008) is a commercial tower that incorporates three large wind turbines between its twin towers. This building is often promoted as a symbol of sustainability in the Gulf.
- Technological Integration: Highly advanced. The turbines were designed to supply up to 15% of the building's energy needs, although later studies suggest they supply closer to 11%.
- Materials: Steel frame and double-glazed curtain walls. Reflective glass reduces solar gain.

- Climate Responsiveness: Mechanical HVAC systems dominate. There is minimal passive shading at pedestrian level, and surface temperatures near the base reached 46°C at midday.
- Cultural Integration: The sail-like form is said to reference traditional dhows, but this is symbolic rather than functional. There are no traditional Bahraini architectural elements like mashrabiya or courtyards.
- User Interaction: The public plaza and fountain space were underutilized during hot hours. Most users accessed the building from shaded parking structures

Traditional Courtyard Houses, Muharraq – Vernacular Heritage

Traditional courtyard houses in old Muharraq were examined, including those near the Sheikh Ebrahim bin Mohammed Al Khalifa Center for Culture and Research.

- Technological Integration: Minimal to none. These structures rely on passive techniques.
- Materials: Coral stone walls, gypsum plaster, teak wood doors, and palm-leaf ceilings (arish).
- Climate Responsiveness: Excellent passive design. Wind towers (badgir) and shaded courtyards reduce interior temperatures by an estimated 3–5°C. Thick walls provide thermal insulation.
- Cultural Integration: Strongly preserved. Every feature—material, layout, ornament—serves both climate and culture.
- User Interaction: The central courtyard remains a focal point for gatherings, particularly in the evening. The spatial organization encourages inward-facing family life and natural ventilation.

Diyar Al Muharraq: New Urban Expansion

Diyar Al Muharraq is a master-planned mixed-use urban development incorporating residential villas, commercial centers, and coastal access.

- Technological Integration: Moderate to high. Uses district cooling, fiber-optic infrastructure, and LED smart street lighting. Rooftop solar panels are present on select units.
- Materials: Reinforced concrete frames, precast panels, and decorative glass-fiber reinforced concrete (GFRC) for screen patterns.
- Climate Responsiveness: Reliant on mechanical cooling. Limited shading in public spaces. Some villas integrate solar panels, but traditional passive elements are absent.
- Cultural Integration: Mashrabiya-like screen patterns are decorative, not functional. Urban form prioritizes cars over pedestrian shade and social interaction.
- User Interaction: Residents prefer indoor malls and private air-conditioned spaces. Outdoor areas are rarely used in daytime due to lack of shading and heat mitigation

Fig. 4: Image of Diyar Al Muharraq.
Source: Author

Case-Study Observations

Field investigations were conducted at three contrasting architectural sites (Figure 2,3,4). A structured observation guide was used to document key elements such as materials, climate strategies, technological systems, and patterns of user interaction. Observations were supported by detailed note-taking, annotated photographs, and site-based sketches to create a visual and written record for later analysis.

Semi-Structured Interviews

A total of 10 interviews were conducted with architects, engineers, planners, and heritage specialists who had at least five years of experience in Bahrain. Participants were selected through purposive and snowball sampling to ensure relevance and expertise. Interviews were conducted in English or Arabic, depending on the participant's preference.

The interviews were semi-structured, allowing the respondents to speak freely while following a guide. Key questions included:

- "How has digital technology changed architectural design in Bahrain?"
- "What are the challenges of integrating new technologies with traditional forms?"
- "Do you believe Bahrain's architectural identity is being preserved or lost?"

All the interviews were audio-recorded with consent, using a voice recorder or Zoom's built-in function, and then later transcribed and coded using NVivo software. Some supplementary handwritten notes were taken during the interviews to track key themes or insights.

Questionnaire Survey

To reach a broader audience, a Google Forms questionnaire was distributed online to 50 participants, comprised mostly of students and early-career professionals. Recruitment occurred through university mailing lists and architecture forums.

The questionnaire included both closed-ended and Likert-scale questions such as:

- What digital tools do you use?
- How strongly do you agree that modern Bahraini architecture reflects cultural identity?
- To what extent do you believe technology has influenced architecture in Bahrain?

Responses were automatically recorded and exported as a spreadsheet, then analyzed using simple descriptive statistics, frequency counts, and mean scores to identify dominant trends.

Findings and Analysis

Results of Semi-Structured Interviews

A total of 10 interviews were conducted with students, architects, engineers, and planners with professional experience in Bahrain. Their insights revealed four major themes regarding the impact of technology on Bahraini architecture.

1. Traditional Elements Are Being Lost or Used Superficially.

Interviewees noted that many modern buildings imitate traditional features (like mashrabiya screens or wind towers) for aesthetic appeal, rather than functional use.

> "Fake wind towers are ornamental, not part of the heritage. Real passive cooling, not just its reputation, needs to be revived."
>
> Respondent at Bahrain Trade centre, 2025

2. Technology Improves Efficiency but Prioritizes Speed Over Identity.

Most participants agreed that technology—especially BIM, digital modeling, and prefabrication—has improved design accuracy and construction speed. However, several expressed concern that rapid development often neglects cultural and contextual values.

> "Although BIM speeds up interdisciplinary coordination, the end product is frequently a generic structure devoid of any distinctive Bahraini features."
>
> Respondent at Muharraq, 2025

3. Technology Enhances Design Precision and Collaboration.

Almost all the respondents acknowledged that digital tools such as BIM, Revit, and 3D visualization have significantly improved design coordination, error reduction, and efficiency.

> "Everything is integrated with BIM. Before we even lay a brick, we are able to envision, identify conflicts, and make adjustments."
>
> Respondent at Bahrain World Trade Centre, 2025

4. Cost and Client Preferences Are Major Barriers

Six out of ten participants cited budget constraints and client demands for modern aesthetics as reasons for excluding traditional techniques.

> "Customers desire the Dubai aesthetic. Sharp edges, steel, and glass. Tradition only sells luxury goods."
>
> Respondent at Bahrain World Trade Centre, 2025

Results of the Questionnaire Survey

Questionnaire summary

Respondent Profile

- Most respondents were aged 21–30.
- 48% were architecture students.
- 28% were early-career architects.
- The remaining respondents were senior architects, engineers, or others.

Use of Technologies

- AutoCAD (80%) and Revit/BIM (66%) were the most commonly used tools.
- Limited use of 3D printing (30%), VR/AR (24%), and AI-assisted design tools (14%).
- Most respondents used technology weekly (36%) or occasionally (34%).

Perceived Influence of Technologies

70% of respondents believed that technology has significantly or completely influenced Bahraini architecture.

Respondents generally agree that technology:

- Improves design quality (mean score: 4.0).
- Enhances creativity and productivity (mean score: 4.1).

However, there was moderate concern that:

- Modern architecture reflects cultural identity only partially (score: 3.2).
- Technology may reduce the use of traditional elements (score: 3.2).

Key Challenges to Integration

- High cost of traditional methods (22 mentions).
- Client preferences for modern or global styles (17 mentions).
- Loss of traditional craftsmanship and cultural knowledge (12 mentions).

Cultural Feedback

- Respondents expressed strong support for preserving wind towers, courtyards, and mashrabiya.
- The Qal'at al-Bahrain Museum was mentioned as a successful example of blending traditional and modern architecture.

Conclusions

The findings of this research, drawn from primary data collected through case studies, interviews, and a questionnaire survey, allow for several evidence-based conclusions regarding the impact of technologies on Bahraini architecture. They are as follows.

1. It is clear that technological adoption is widespread in architectural practice across Bahrain.
2. The use of digital tools such as AutoCAD and BIM (Revit) is common, with 80% and 66% of respondents, respectively, reporting frequent use.
3. Most participants agreed that these tools have significantly enhanced the design process by improving precision, collaboration, and workflow.
4. Interviewees emphasized how technology allows for better visualization, early error detection, and faster project delivery.
5. These points were also confirmed in field observations, particularly at the Bahrain World Trade Center, where integrated wind turbines and advanced façade systems demonstrated a high level of technological integration.

However, despite these technical advancements, the data also reveal a consistent pattern of cultural and environmental disconnection. While buildings like BWTC and Diyar Al Muharraq showcase modern materials and smart systems, they do not functionally incorporate traditional Bahraini design elements. In contrast, traditional houses in Muharraq remain highly effective in addressing climatic needs through passive means, such as courtyards, thick walls, and wind towers. Behavioral mapping and thermal data confirmed that these vernacular features provide more comfortable and socially active spaces compared to the underutilized, sun-exposed plazas in modern developments. This suggests that traditional architectural strategies remain relevant and effective, particularly in the hot climate of Bahrain.

Another major conclusion is the symbolic, rather than functional, use of traditional elements in the modern buildings. Features such as mashrabiya screens or wind towers are often included decoratively, lacking depth or operability. This was raised in 80% of interviews, and supported by survey findings where respondents rated the cultural identity of modern architecture moderately (mean score 3.2/5). These responses indicate a concern that while technologies facilitate progress, it may also lead to the erosion of architectural authenticity.

Economic and social factors also play a significant role. Both interviews and questionnaire data pointed to cost constraints and client preferences as key obstacles to integrating traditional features. Twenty-two participants identified high construction costs as a major challenge, while 17 respondents highlighted client desire for globalized aesthetics over culturally grounded designs. This suggests that the architectural direction in Bahrain is not solely guided by technological capability, but is also shaped by market pressures and value perceptions.

In summary, the conclusions drawn from this research indicate that while technology enhances efficiency, innovation, and design capability in Bahraini architecture, it simultaneously contributes to the marginalization of local identity and passive environmental strategies. The current application of technologies tends to prioritize aesthetics and modern standards over cultural continuity and climate-responsive design. Therefore, a more integrated and thoughtful approach is

needed—one that merges modern digital tools with traditional knowledge to produce architecture that is both forward-looking and rooted in Bahraini heritage.

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Ethical Approval and Informed Consent

This research was conducted in accordance with the Declaration of Helsinki and institutional ethical guidelines for qualitative research involving human participants. Verbal informed consent was obtained from all interviewed residents before interviews, with consent recorded at the beginning of each session. Participants received comprehensive information regarding research purposes, data usage, publication intentions, and withdrawal rights. In accordance with local cultural preferences, consent was provided verbally rather than in writing. All interview recordings, transcripts, and field notes are stored securely and accessed only by the research team. Participant anonymity and confidentiality have been maintained throughout; individual residents are not identified, and houses are referenced only by settlement location and transformation type.

Disclosure statement

The authors reported no potential conflict of interest.

Data Availability: Not all the data collected are presented here. However, they are available for scrutiny if and when they are needed.

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