



Original scientific paper

Floating Urbanism as a Blue Economy Strategy for Coastal Development: Integrating Urban Resilience and Cultural Identity

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ABSTRACT

Coastal development in Bahrain, which aims to achieve both economic and urban growth, is highly dependent on land reclamation. This approach, however, is associated with ecological degradation and increased climatic risks. Floating urbanism has emerged as a paradigm for resilient and adaptive architecture through its ability to respond to the effects of climate change and to address urban growth. Despite its adoption by a range of countries, floating urbanism has not been fully explored in Bahrain and the Gulf countries, specifically, in terms of its environmental, socio-cultural, and economic feasibility. The paper investigates the potential of floating urbanism as a replacement for land reclamation, by exploring its viability through a design-based approach exemplified by a floating museum district proposal and assessed via a Multi-Criteria Decision Analysis. Three development scenarios are examined: 1) reclamation, 2) hybrid, and 3) fully floating, across five dimensions: environmental, technical, socio-cultural, economic, and governance. The floating scenario achieved the highest aggregate score (4.096/5), especially in the environmental and socio-cultural dimensions, although there were challenges related to governance and implementation costs. The study contributes to coastal development and planning strategies by proposing a decision-making framework that integrates environmental, cultural, and economic considerations. It further demonstrates how floating urbanism can contribute to socioeconomic development through cultural tourism, coastal regeneration, and the blue economy.

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Highlights:

- The fully floating scenario outperforms conventional land reclamation, though governance remains the main challenge.
- The proposed floating museum district supports coastal regeneration, cultural tourism, blue economy activities, and urban resilience.
- A transferable decision-support framework is proposed to assist policymakers and planners in developing coastal development strategies.

Contribution to the field statement:

The study integrates an MCDA and a design-based research approach to explore how floating urbanism can reshape the relationship between people, water, and the public realm. The findings contribute to the discussion on coastal economic development by demonstrating how floating cultural infrastructure can support tourism development and blue economy activities.

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1. Introduction

Over the past 50 years, Bahrain's land footprint has expanded steadily through large-scale land reclamation projects, undertaken primarily to accommodate urban growth, population increase, and economic development. However, land reclamation carries substantial ecological costs, including damage to coral reefs and seagrass beds, coastal degradation, and disruption of long-standing human–sea relationships. Climate change compounds these pressures: given Bahrain's low-lying topography, projected sea-level rise threatens infrastructure, ecosystems, and long-term urban resilience (Glavovic et al., 2022; Schipper et al., 2022; Supreme Council for Environment, 2020). Reclamation has also generated considerable public dissatisfaction, with many Bahraini citizens expressing concern over its impact on marine life and on the traditional bond between Bahraini communities and the sea—a bond rooted in Bahrain's identity as an archipelago whose social and economic life has historically revolved around water (Al-Nabi, 2012).

In response to these challenges, this paper examines floating architecture as an alternative to land reclamation (Ruzzo et al., 2026), highlighting its capacity to enable coexistence with natural systems (Ido & Shimrit, 2015) and to offer a resilient, sustainable pathway for accommodating urban growth (El-Shihy, 2024; Wang et al., 2019). At present, Bahrain's engagement with floating architecture remains limited to a small number of public structures, notably a floating restaurant and floating docks and walkways. By contrast, floating structures have been implemented more extensively elsewhere, including in the Netherlands, Sweden, and South Korea, illustrating the international momentum this typology has gained.

Despite this growing global interest, the feasibility of floating urbanism within the coastal cities of the Gulf remains largely unexamined. No existing studies address its socio-cultural, economic, and environmental implications specifically within the Bahraini context, nor has research systematically explored its potential contribution to economic diversification, tourism development, and the blue economy in Bahrain. This gap is significant given the scale of Bahrain's ongoing land reclamation and the mounting ecological and climatic risks associated with it. The present research addresses this gap by integrating a design-based approach with a Multi-Criteria Decision Analysis (MCDA)—among the first studies to combine these methods in examining the implications of floating urbanism for coastal regeneration, cultural continuity, urban economic development, and resilience in Bahrain.

Accordingly, the research is guided by three questions: (Q1) How does floating architecture compare to land reclamation in Bahrain's environmental and regulatory context, in terms of ecological impacts, urban economy, and technical reliability? (Q2) How can a floating museum district be theorized as a socio-spatial paradigm reshaping the relationship between land and water? (Q3) What design principles and evaluation metrics support decision-making for future floating projects?

The significance of this study lies in its contribution to assessing floating urbanism as a viable alternative to land reclamation in Bahrain and comparable coastal contexts. Through an MCDA model evaluating the economic, technical, environmental, socio-cultural, and governance dimensions of a floating museum district proposal, the research offers a decision-support framework applicable to urban planning in vulnerable coastal cities. It demonstrates how floating urbanism can support waterfront regeneration, cultural tourism, blue economy activities, and long-term coastal development strategies, while generating socioeconomic value through cultural development, waterfront investment, public engagement, and economic diversification.

The remainder of the paper is organized as follows. Section 2 provides a background literature review addressing Q1, within which the theoretical framework engages Q2 by exploring the floating museum district as a socio-spatial paradigm. Section 3 details the study's methodology, followed by the findings and discussion in Section 4, which address Q3, and the conclusion in Section 5. Figure 1 illustrates the overall structure of the study.

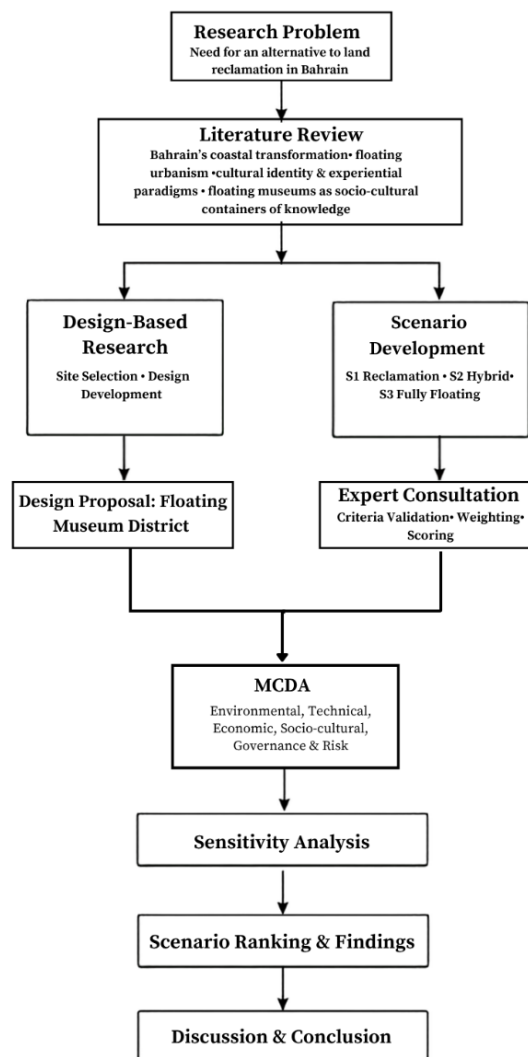


Figure 1. Structure of the Study.

2. Literature Review

The literature review covers four main aspects of the research: Bahrain's coastal transformation, floating urbanism, a theoretical framework explored through cultural identity and experiential paradigms, and floating museums as socio-cultural containers of knowledge. This last sub-section sets out how a floating museum can support certain social and environmental goals.

2.1. Bahrain's Coastal Transformation

Bahrain's relationship with the sea has been strongly established for millennia. The country was once defined by its history of pearl diving, fishing, and boatbuilding. This relationship was not only economically important for the country, but also shaped its identity and culture. Successive waves of land reclamation have transformed that connection: coastlines that were liveable spaces are now built over or simply unreachable. Moreover, climate projections will compound this, with sea-level rise estimates of 30 to 100 cm by the end of the century placing the land at genuine risk of flooding (Al-Jeneid et al., 2008; Ali et al., 2024; Almazroui et al., 2022; Normand et al., 2023).

Global reports similarly indicate that coastal cities are among the most vulnerable urban systems worldwide. Adaptation and resilience strategies beyond conventional land expansion practices are essential to overcoming climate-related threats (Glavovic et al., 2022; Magnan et al., 2022; Niamir & Pachauri, 2023; Sengupta et al., 2023; Wannewitz et al., 2024). Despite these concerns, land reclamation remains the sole strategy adopted for land expansion in Bahrain, indicating an urgent need

to explore other paradigms. Such paradigms could address both environmental and socio-cultural issues.

2.2 Floating Urbanism as an Alternative to Coastal Development Strategies

Floating urbanism and floating architecture are seen as alternative paradigms of urban growth (Sáenz de Tejada et al., 2024) and resilient alternatives to land reclamation (Gorzka et al., 2026). Although both terms are used in the literature, they convey different levels of complexity in relation to developments above or in water. Floating architecture is mainly concerned with permanent buoyant structures that are built on water and respond to the fluctuating water levels (Gorzka et al., 2026); these may comprise dwellings or service units. Floating urbanism, on the other hand, is a broader concept; it includes a wider network of integrated systems, including dwellings, infrastructure, public services, and urban services (Januszkiewicz et al., 2024). Floating urbanism provides a resilient alternative to urban sprawl and a solution to land scarcity, reducing vulnerability to flooding and sea-level rise. Koen Olthuis's work explores the potential of the sea for human habitation rather than viewing it mainly as a barrier. He maintains that a floating development is a way of responding to urban growth while accommodating a changing environment (Olthuis, 2010). Examples of global precedents include Schoonschip in Amsterdam, a pioneering floating urbanism project featuring low-rise neighbourhoods that incorporate technology and integrated systems such as renewable energy and closed-loop systems. It has a zero-waste policy and is designed to enable a circular economy (Bax et al., 2022; Hubmann, 2022; Moral, 2025). Oceanix Busan in South Korea, and the Maldives' floating city similarly feature self-sufficient floating communities, offering innovative responses to environmental risks and providing economic resilience strategies for future urban developments (Varga & Csiszárík-Kocsir, 2023). Nonetheless, on the Gulf coasts, there are only a few fully realized floating projects, mainly in the United Arab Emirates (Kartheekeyan et al., 2024), while the other sea-based structures are artificial islands. In Bahrain, floating architecture is explored in a few small-scale projects, such as a floating restaurant and floating docks and walkways.

2.3. Cultural Identity and Experiential Paradigms

Waterfront developments in coastal cities are increasingly associated with urban development and the manifestation of cultural identity (Simic, 2020). Museums, when used in a waterfront development, can play an important role in strengthening cultural identity and supporting tourism and public engagement. Museums today are no longer mere containers of knowledge; they are living spaces that engage visitors in rich cultural, educational, and emotional experiences. The design of a floating museum is based on several theories that collectively inform the socio-cultural dimension of floating architecture. The first theory, phenomenology, frames architecture as a multi-sensory, embodied, and emotional experience. In such spaces, a person feels grounded, connected, and aware (Norberg-Schulz, 1980; Pallasmaa, 2024). The second theory is spatial storytelling and narrative architecture. According to this idea, design unfolds like a book whose story is told through movement and rhythm, as users navigate the exhibition spaces. The third theory, architecture as a catalyst for change, emphasises the emotional resonance of architecture; spaces can stay with you, shifting your behaviour, values, and ecological awareness (Zumthor, 2006). Finally, there is Kevin Lynch's theory of legibility and wayfinding, according to which spaces are legible, easy to understand, navigate, and remember (Lynch, 1964). He identified five core elements that help people form mental maps of a place: paths, edges, districts, nodes, and landmarks. Collectively, these ideas form a theoretical framework for the design of the floating museum featured in this study. They support urban resilience, a positive cultural identity for the host community, and a stimulating experience for visitors.

2.4. Floating Museums as Socio-Cultural Containers of Knowledge

Floating museums have been recognized as catalysts for community engagement, while providing direct connection to the waterfront. They are multifunctional urban assets that combine history, culture, economy, tourism, and environmental benefits. They stand as a model for coastal development that operates across six dimensions. This section discusses the six interconnected dimensions that

contribute to exploring how floating museums can support the goals of urban resilience, socioeconomic development, and environmental sustainability, with reference to Bahrain.

2.4.1. Environmental Dimension

The most fundamental environmental characteristic of a floating museum relates to the fact that it is not built on land, not even reclaimed land. By floating rather than occupying space on the seabed, the platform leaves the seabed intact. By incorporating other sustainable strategies such as the use of bio-receptive surfaces, it goes even further, actively regenerating what reclamation typically destroys. For example, the Voronoi eco-concrete, the mangrove shells, and the perimeter bio-mesh create habitats for fish, crustaceans, algae, seagrass, barnacles, and pearl oysters; the floating units function as artificial marine habitats rather than merely as structural elements (Ido & Shimrit, 2015; Song et al., 2023).

The platform also responds to the sea-level projections that land reclamation ignores. It rises with water levels, can be relocated if conditions change, and can expand without using any land – all of which matters considerably in a country facing a projected sea-level rise of 30 to 100 cm by the end of the century (El-Shihy, 2024). Other environmentally beneficial features could include solar panels, piezoelectric pavements, phase change material walls, cool roofs, and greywater recycling, further reducing the operational footprint of any floating infrastructure (Filali et al., 2022; Kalogirou, 2023).

2.4.2. Social Dimension

Decades of coastal development have separated Bahrainis from the sea, both physically and, one might argue, psychologically. Access to water and the ability to interact with it have measurable positive effects on mental and physical well-being. The floating museum restores that connection in a way that is genuinely open to everyone, so that coastal access is not reserved for particular users (Gehl, 2012). In coastal areas where limited access is a concern, a floating modular typology can alter this perspective through the incorporation of different social opportunities such as entry plazas, the waterfront edge, the water taxi connection, and the pocket social spaces distributed across different levels, creating a place where people with quite different purposes – tourists, students, families, professionals – can coexist without competing for the same experience (Carmona, 2021; Gehl, 2012).

2.4.3 Cultural Dimension

Bahrain's maritime traditions and the social life of waterfront communities shaped the country for centuries. That identity has steadily receded as reclamation and urban development have physically separated people from the sea. Much of the current waterfront development across the Gulf compounds this loss, importing generic architectural languages that bear no relationship to place (Dayaratne, 2020).

The floating museum should reconnect users with Bahrain's maritime culture through both its location and its design. Together, they could form a cultural axis connecting Bahrain's past with its possible futures (Lynch, 1964; Norberg-Schulz, 1980; Till, 2009). UNESCO (2016) is explicit about the importance of preserving culture and cultural identity. This is regarded as essential for maintaining cultural continuity and strengthening social coherence and long-term resilience. Built environments can either support or undermine these (UNESCO, 2016).

2.4.4. Educational Dimension

Museums in general are conceived as learning environments. The 21st-century museum is no longer simply a place that holds artefacts; it is a place where spatial experiences, sustainable practices, community engagement, and learning all happen at the same time. (Orr, 2004) describes this as place-based learning, and decades of research confirm that it produces more lasting change than conventional instruction (Falk & Dierking, 2016).

As well as catering for individual visitors, museums are designed to function as research and teaching platforms for schools, universities, and professionals, offering workshops, applied classes, and live research opportunities. Within the context of a floating museum, educational experiences can be directly linked to marine ecology, coastal ecosystems, climate adaptation, and sustainable development (Anderson, 2023).

2.4.5. Economic and Tourism Dimension

Unlike conventional coastal development, the floating museum does not require land reclamation, does not permanently alter the seabed, and can be reconfigured or relocated – characteristics that make it a lower-risk long-term investment compared to the alternatives (Wang & Tay, 2011; Wang et al., 2019). Coastal developments can also generate tourism, employment, and economic growth while maintaining sustainable practices (Mahgoub, 2022). From a blue economy perspective, the floating museum could be viewed as an adaptive coastal development that supports a resilient coastal economy through cultural tourism, heritage preservation, and waterfront regeneration (Bennett et al., 2019; Cisneros-Montemayor et al., 2021; Moretti, 2023), and provides opportunities for local artisans and entrepreneurs to contribute directly through activities that reflect heritage and culture and enhance the economy (Richards, 2020).

As a destination that combines maritime heritage, genuine waterfront access, sustainability, and architectural novelty, it has year-round draw, making it precisely the kind of experience that cultural tourism research consistently identifies as most compelling in the longer term (Anderson, 2023; Eck et al., 2023).

2.4.6 Technical Dimension

Advances in technology, materials, and engineering have enabled the realization of floating structures. Such advances include modular floating platforms, adaptive mooring systems, lightweight materials, and smart monitoring technologies (Xia et al., 2025). Examples of floating projects in the Netherlands and South Korea demonstrate that floating districts can withstand variations in sea level and changing environmental conditions. The use of eco-materials, such as eco-concrete and bio-receptive materials, and modular construction further enhance the environmental performance of these systems, positively impacting marine ecosystems (Eroglu & Ozbahceci, 2026; Song et al., 2023). Additionally, mooring systems, alongside corrosion-resistant materials and hydrodynamic designs, provide the required integrity and safety levels in such structures. The integration of such systems with renewable and smart monitoring supports the development of resilient, sustainable, and innovative coastal development buildings, such as a floating museum (Amaechi et al., 2022; Lamas-Pardo et al., 2015). Furthermore, in comparison to conventional reclamation, floating systems offer greater flexibility in terms of possibilities of expansion and relocation.

3. Materials and Methods

In this study, a design-based approach is adopted to explore the feasibility of floating urbanism as an alternative to land reclamation practices in Bahrain. The approach enables the translation of environmental, socio-cultural, and spatial considerations into a design proposal for a floating museum district. An MCDA is used to complement the qualitative design exploration to systematically evaluate three proposed coastal development scenarios: land reclamation, a hybrid approach, and a fully floating model. The methodology covers both qualitative design and a quantitative comparative analysis of the three scenarios. Assessment of the three scenarios is carried out across five main dimensions: environmental performance, technical performance, economic feasibility, socio-cultural value, and governance and risk. A literature review was conducted first. This was followed by the selection of the site, development of the design proposal, development of the scenarios, expert consultation, and finally MCDA was carried out.

3.1 Design-based approach

The design-based approach is an integral part of the study, where the floating museum functions as a methodological tool rather than a result. This approach is based on the theories that govern the design of the socio-cultural aspects of a museum. The theories, outlined in section 2.3, were applied in the project as follows: The first theory was phenomenology, and the design responded to this theory by enabling the sensory experience visitors may undergo in the exhibition zone. This is where movement, touch, sound, and the change of light from dark enclosed spaces to open, glazed, elevated zones create an emotional narrative in the exhibition space (Pallasmaa, 2024). The second theory, spatial

storytelling and narrative architecture, guided the design of the spatial experience of the visitors (Norberg-Schulz, 1980). This idea blends seamlessly with the scope of this proposal. It creates spaces with immersive experiences and connects people to their coastal identity through storytelling. The third theory guided the design of the floating museum by designing zones that act as catalysts for change (Zumthor, 2006), making sustainability felt rather than just read. What is lost can be visualised, and what is possible can be touched. Thus, it encourages visitors to reflect on Bahrain’s future by introducing a floating architectural project that links the sea to the land. The final theory guided the design by incorporating a clear circulation spine that gives the project structure (Lynch, 1964). Additionally, zones are grouped into recognisable districts, connected by bridges and intersections, which provide moments of pause and serve as visual landmarks, while water edges define the boundaries without full enclosure. These strategies enhance the museum’s identity and help visitors to find their way around, ensuring that they are engaged and comfortable in the floating museum district. This theoretical framework informed the design of the floating district, guiding the creation of an immersive, memorable, and educational experience. The concept of floating buildings creates awareness of resilient architecture as a response to future challenges.

3.1.1 Site Selection

The site chosen for the project is in northern Manama. This area currently offers no pedestrian access, no public activity, and no reason for most people to be there. Several factors were considered when selecting the site (Table 1). First, it was suitable for floating structures; criteria for this include water depth, stability of the seabed, water quality, and safety as regards the wind and waves. Second, it was suitable for a cultural landmark in terms of appropriate sensory experiences, good visibility from main roads and highways, close proximity to roads and pedestrian paths, potential to create an iconic, symbolic form, and potential to enhance waterfront use without blocking views or access (El-Shihy, 2024; Lynch, 1964; Rogers, 2008; UN-Habitat, 2020). Finally, land proposed for future reclamation can offer the option of floating architecture as an alternative.

Table 1: Site Selection Criteria.

	Category	Criterion	Justification	Reference
Floating	Water stability	Shallow (3–5m), stable seabed	Needed for safe, cost-efficient anchoring and stability	(El-Shihy, 2024)
	Water quality	Good, clean water	Supports usability, ecology, and durability	(El-Shihy, 2024)
	Wind and wave safety	Partial protection from dominant winds and strong currents	Improves safety, comfort, and structural performance	(El-Shihy, 2024)
Landmark	Quality of surroundings	Appropriate sensory experience	Enhances public perception and spatial experience	(Lynch, 1964)
	Visibility	High visibility from main roads and highways	Maximizes public recognition and identity	(Lynch, 1964)
	Accessibility	Close to roads and pedestrian paths	Ensures easy access and encourages high visitor turnout	(UN-Habitat, 2020)
	Landmark context	Potential to create iconic, symbolic form	Requires spatial dominance and design visibility	(Rogers, 2008)
	Urban integration	Enhances waterfront use without blocking views or access	Preserves open space and supports urban continuity	(UN-Habitat, 2020)

Figure 2 presents the characteristics of the location of the selected site.

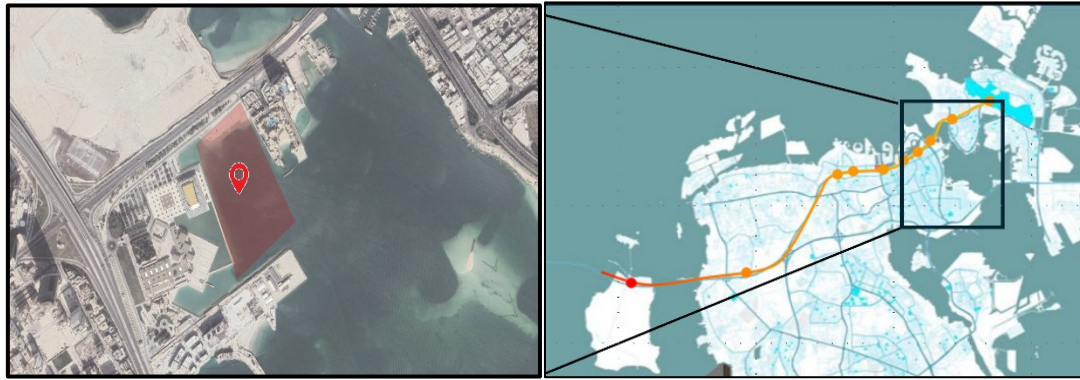


Figure 2. The Site Selected for the Floating District.
(Source: Google Maps)

3.1.2 Structural Systems

The structure of the floating museum enables the heavier parts to be separated from the lighter ones. Heavy elements, such as the shading canopy, are supported directly from seabed piles rather than from the floating deck. This approach keeps the platform's own load manageable and avoids concentrating stress at the float level. Everything on the deck itself is lightweight and modular. The system comprises five main components.

3.1.2.1. The Pontoon

Drawing on floating infrastructure research (Lamas-Pardo et al., 2015; Wang & Wang, 2015), the pontoon is a three-layer assembly:

- Top: 1.0 m of expanded polystyrene (EPS) core primary buoyancy and thermal insulation (Ossa & Romo, 2011);
- Middle: 1.5 m of eco-concrete in a Voronoi mesh pattern, 3D printed structural stiffness, with a textured bio-receptive surface designed for marine colonization;
- Bottom: 0.5 m of high-density EPS encased in marine-grade concrete for additional buoyant lift and impact resistance.

Total depth: 3.2 m, with approximately 1.5 m submerged. Load check per m²: buoyant force = 1,500 kg (1,000 kg/m³ × 1.5 m); platform self-weight ≈ 1,200 kg/m²; reserve buoyancy = 300 kg/m² for occupants and events validated by the structural engineer. The Voronoi mesh also serves a secondary structural purpose: by breaking incoming waves, it reduces impact forces on the pontoon surface and improves overall platform stability.

3.1.2.2 Modular Platform

The platform is assembled from prefabricated modules 12×15 m and 18×15 m fabricated offsite and transported by boat (El-Shihy, 2024). All building structures sit within module boundaries. Cantilever extensions, light steps and edge platforms project beyond modules, supported solely by the structural frame rather than buoyancy. Modules are connected using flexible expansion joints and hinged aluminium connectors that accommodate wave movement and thermal expansion. A flexible ramp links the platform to the mainland and adjusts to tidal changes automatically (El-Shihy, 2024).

3.1.2.3 Mooring System

Pile-guided stabilization allows the platform to rise and fall within the 2 m tidal range while remaining fixed laterally (Bolshev et al., 2024):

- Recycled steel piles (0.5 m in diameter, zinc- or aluminium-coated) are driven into the seabed as vertical guides (Melchers et al., 2025);
- Glass-fibre-reinforced polymers (GFRP) or recycled high-density polyethylene (HDPE) pile guides attach to the platform and slide freely along the piles vertically with the tide, but not laterally (El-Shihy, 2024);
- Low-cement grout seals each pile base to prevent lateral movement under wave loading (Hu et al., 2023);

- Eco-concrete pile caps and geotextile mud mats distribute loads and create marine habitat at the seabed level (Perkol-Finkel et al., 2018; Strain et al., 2018).

3.1.2.4. Services and Buildings

A 20 cm service cavity beneath removable modular tiles runs the full length of the platform, housing all wiring, plumbing, and drainage. Maintenance requires no major structural disruption; tiles are simply lifted (El-Shihy, 2024; UN-Habitat, 2020). Rainwater is collected through platform joints, filtered, and stored for landscape irrigation (Naserisafavi et al., 2022).

The buildings use 50 mm autoclaved aerated concrete (AAC) panels for its lightweight structure and for fire resistance, utilize exterior insulation finishing system (EIFS) cladding for insulation and weathering, and a phase change material layer (melting point 29–31°C) for passive thermal control that reduces dependence on mechanical cooling (Alassaad et al., 2025).

3.1.2.5 Smart Monitoring

Sensors embedded throughout the platform monitor seven parameters in real time (Wang & Tay, 2011), as indicated in Table 2.

Table 2: Monitored Parameters in a Floating Architecture Project.

Parameter monitored	Method	Purpose
Platform tilt	Inclinometers on deck	Detect imbalance under load
Vertical movement	Displacement sensors on pile sleeves	Track tidal motion and drift
Structural stress	Strain gauges in slab	Monitor load transfer under buildings
Pile condition	Corrosion sensors on steel	Detect salt degradation over time
Marine habitat	Underwater cameras in Voronoi layer	Track coral and species growth
Water quality	pH, oxygen, turbidity sensors	Assess ecosystem health
Surface climate	On-deck weather station	Log wind, heat, and humidity

Source: (Wang & Tay, 2011); Wang et al. (2011).

3.1.3 The Project Zones

The project (Figures 3, 4, and 5a, b, c, d) stands as an interpretation of a floating district as an active ecological interface. The facade is suggestive of a fishing net. The exhibition zone includes a maritime heritage wing. The outdoor spaces recall the tradition of waterfront *majlis*. And the project’s placement adjacent to the Bahrain National Museum is intentional rather than incidental.

There are three main zones in the project, each with its own character, yet they serve as a single continuous lived experience. The three zones, in addition to the support zone, are summarised in Table 3.

Table 3: The Museum Zones.

Zone	Programme	Spatial character	Grid
Exhibition zone- The story	This zone presents the argument between nature, the built environment, and technology. It presents the different scenarios for the future, and incorporates a viewing deck showing the overall project as a living experience of the solution to the problem	Each zone represents its story	Urban grid
Waterfront -The result	Sensory connection to sea, open edge	Open, light, calm	Landscape grid
Sustainability hub- The process	Recycling, knowledge, fashion, farm, and restaurant	Distributed, hands-on	Landscape grid
Support area	Entry plaza, parking, service, circulation spine, pocket social spaces	Welcoming, provide easy circulation with gathering spots	Both grids



Figure 3. The Floating Museum District: Key plan and layout.
(source: authors)

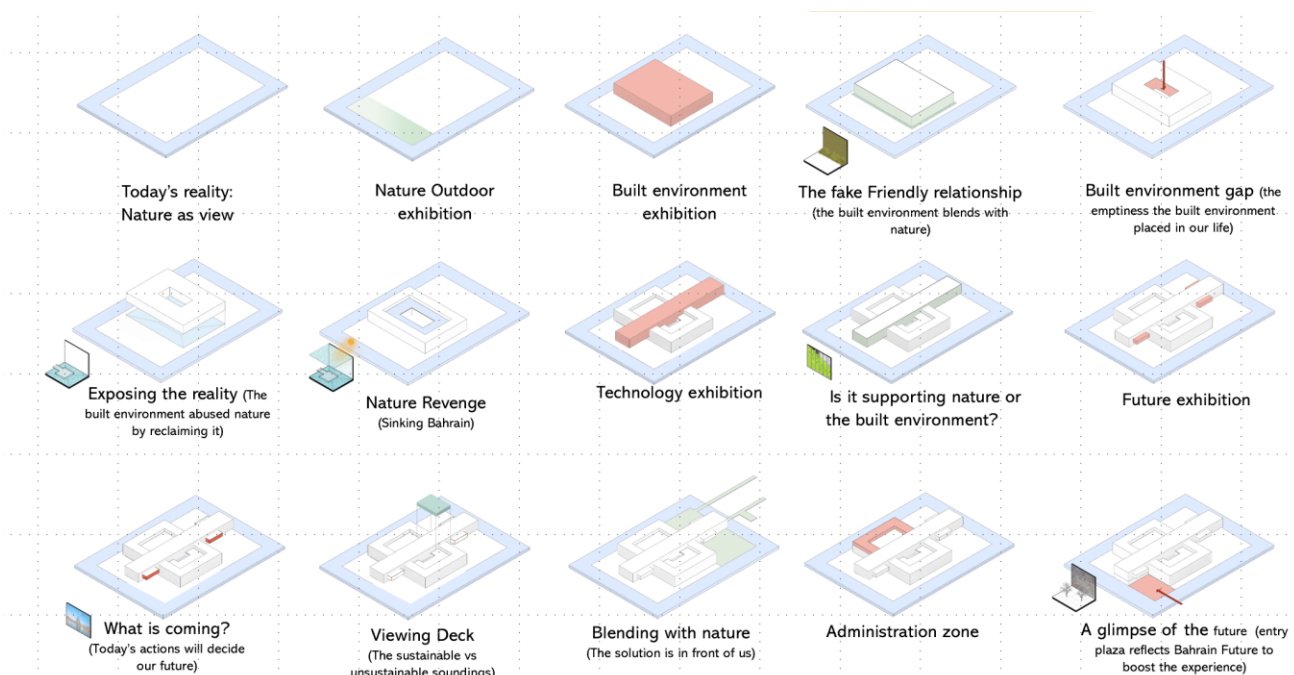


Figure 4. Building Form Narrative: The building form tells the story, conveying meaning through its geometry, materiality, and spatial sequence, applying the narrative of architecture.
(Source: authors)



(a) Master plan.



(b) Main space connecting all zones.



(c) Reconnection with nature: waterfront zone.



(d) Outdoor public spaces: supporting area.

Figure 5. Revit Generated Images of the Proposed Floating Museum District.

(Source: authors)

3.2 Multi-Criteria Decision Analysis (MCDA) Framework

The study utilizes a scenario-based MCDA (Skidmore & Cohon, 2023) to evaluate the feasibility of floating urbanism as an alternative to land reclamation in Bahrain. MCDA was chosen because of its suitability for making complex spatial and environmental decisions when several criteria are to be considered, often with a conflicting nature (Digkoglou et al., 2024).

3.2.1 Scenario Definition

Three scenarios were evaluated in this study, as follows:

S1 (Scenario One): the business-as-usual approach, where conventional land reclamation is assessed.

S2 (Scenario Two): the hybrid approach that includes fixed piers and floating clusters.

S3 (Scenario Three): the fully floating modular system.

The three scenarios differ in their levels of environmental adaptation, technical complexity and cost, and in their governance.

3.2.2 Evaluation Criteria

The evaluation criteria were selected because of their recurrence in floating urbanism, sustainable coastal development, and MCDA studies and literature reviews (Digkoglou et al., 2024; Wątróbski et al., 2019) as key dimensions influencing feasibility and long-term performance. The five dimensions and their associated indicators used for the evaluation process are as follows:

1 – Environmental Performance

Indicators: seabed disturbance, habitat potential, water quality, and embodied carbon.

2 – Technical Performance

Indicators: buoyancy vs. freeboard reliability, durability vs. maintenance, mooring stability, utility integration.

3 – Economic Feasibility

Indicators: capital, operational expenditure, and life cycle cost.

4 – Socio-cultural Value

Indicators: accessibility vs. inclusion, public engagement, programming, and cultural identity.

5 – Governance and Risk

Indicators: regulatory compatibility, safety vs. evacuation and delivery risk.

3.2.3 Expert Consultation

Eleven experts were consulted as part of this study, in the following fields: (1) four urban planners from the public and private sectors, three architects, one environmental/Geographic Information Systems expert, two business and investment feasibility specialists, and one floating development practitioner. The experts reviewed the MCDA framework, validated the evaluation criteria, and contributed to the weighting process to ensure its alignment with Bahrain's sustainable coastal development vision. They also contributed to the scenario scoring process.

3.2.4 Weighting Strategy

Weights were identified on the basis of literature findings and expert consultations. Experts reviewed the proposed weighting strategy and provided feedback regarding its suitability for Bahrain's sustainable coastal developments. The weights were distributed across the five dimensions, as mentioned above, to reflect Bahrain's coastal priorities. Owing to Bahrain's vulnerable coastline and strong cultural bond with the waterfront, weights were distributed to reflect this relationship, while keeping in mind the importance of the other dimensions. Table 4 presents the weight of each dimension alongside the justification for each.

Table 4: Dimension Weights and Justification.

Dimension	Weight	Justification
Environmental performance	40%	High ecological sensitivity to Bahrain's marine environment and future resilience
Technical performance	25%	Structural reliability and erection complexity
Economic feasibility	15%	Long-term investment perspective
Socio-cultural value	15%	Cultural identity and public access to water
Governance and risk	5%	Regulatory framework and implementation

3.2.5 Scoring Method

Each scenario was scored on a five-point scale for each dimension, where 1 represents a very poor performance and 5 an excellent performance. Table 5 summarises the scoring system.

Table 5: Scoring System.

Performance	Score
Very poor	1
Poor	2
Moderate	3
Good	4
Excellent	5

Scores represent a comparative ranking among the three scenarios rather than an absolute measurement. The scoring of each dimension was based on evidence from the literature review and validated through consultation with the eleven experts.

3.2.6 Aggregation and Final Scoring

The weighted score of each scenario was calculated using a linear additive model (Skidmore & Cohon, 2023), where the score obtained was multiplied by the assigned weights as follows:

$$S = \sum_{i=1}^n (w_i \times s_i)$$

Where:

S = overall score of the scenario

w_i = weight of the dimension

s_i = score given to each dimension

n = number of criteria

Table 4, presented earlier, showcases the weights of each dimension.

3.2.7 Sensitivity Analysis

To assess the robustness of the MCDA, a sensitivity test was conducted by adjusting the weights of the dimensions and examining the impact of the changes on the scenario ranking. Variations included a 10% increase and 10% decrease, according to Table 6 (below). These variations were selected by prioritising an increase in certain dimensions. For instance, Test 1 prioritises economic and governance considerations, Test 2 prioritizes economic performance while reducing the environmental weights, and Test 3 prioritises socio-cultural considerations. The aim of the variation is to examine its impact on the ranking of the scenarios. The ranking across all three tests remained unchanged, which indicates that the results are relatively robust to moderate weight variations.

Table 6: Sensitivity Test Weight Variations.

Dimension	Base weight	Test 1	Test 2	Test 3
Environmental performance	40%	40%	30%	30%
Technical performance	25%	15%	15%	15%
Economic feasibility	15%	25%	25%	15%
Socio-cultural value	15%	5%	15%	25%
Governance and risk	5%	15%	15%	15%

The methodology depends partly on expert judgment and conceptual design assumptions, which introduces a degree of subjectivity into the evaluation process. This should therefore be considered a supporting tool rather than a definitive prediction of implementation outcomes.

4. Results

This section illustrates the results of the MCDA used to evaluate the three scenarios: S1, the conventional land reclamation alternative, S2, the hybrid approach which combines fixed piers and a floating cluster, and S3, the fully floating modular district. The results are presented in terms of the selected dimensions first, and then the overall scoring. Table 7 presents the scorecard for the three scenarios tested in this research.

Table 7: MCDA Scorecard.

Category	Weight	S1 (Reclaimed)	S2 (Hybrid)	S3 (Floating)	Key observation
Environmental performance	40%	1.33	3.00	4.67	Floating performs best
Technical performance	25%	5.00	4.00	3.71	Reclaimed performs best
Economic feasibility	15%	3.67	3.00	3.00	Similar performance
Socio-cultural value	15%	3.00	4.00	4.67	Floating performs best
Governance & risk	5%	4.80	3.50	3.00	Reclaimed performs best

4.1 Environmental Performance

In terms of environmental performance, S3 received the highest score (4.67), in comparison to the reclamation scenario S1, which had the lowest score (1.33), and the hybrid S2 received an intermediate score of (3.00). This reflects the environmental degradation associated with S1 as a result of ecological loss, dredging, and infill, as opposed to the environmental benefits associated with S3, which minimize seabed disturbance while supporting habitat regeneration through the use of bio-receptive materials and ability to adapt to the changing sea level. The hybrid scenario received a moderate score owing to the reduction in reclaimed land but the continuing necessity of a partially fixed coastal structure.

4.2 Technical Performance

In terms of technical performance, S1 received the highest score (5.00), followed by S2, which received a score of (4.00), and S3, which received a score of (3.71). These figures reflect standard construction practice and familiarity with the existing implementation processes in the country. S3's lower score could be attributed to the increased technical demands due to its complex technical

implementation methods and associated construction stability achieved through buoyancy management, modular lightweight constructions, monitoring, and predictive maintenance approaches. The hybrid approach, S2, on the other hand, relies partially on fixed structures, thereby enabling partial familiarity with the fixed structural components but generating uncertainty as a result of the complex floating component.

4.3 Economic Feasibility

The three scenarios received relatively close scores, with S2 and S3 scoring (3.00) and S1 scoring a slightly higher score at (3.67), which is expected as a result of familiarity with reclamation practices and higher investor confidence associated with conventional coastal developments. Despite the upfront costs associated with S3, especially during the construction phase, floating modular districts offer a resilient solution, with long-term benefits achieved through a reduction in environmental risks, allowing flexible expansion, relocatability, and sustainable practices. Additionally, they could offer greater economic potential through tourism opportunities, waterfront regeneration, and blue economy activities. Therefore, this scenario might contribute to long-term economic value. S2's similar score is attributed to the combination of the flexibility of the floating structure with the familiarity of the fixed component.

4.4 Socio-Cultural Value

As for socio-cultural value, S3 received the highest score (4.67), while S2 received a score of (4.00) and S1 (3.00). This high score reflects Bahrain's strong connection with water, as S3 acts as an extension of the public realm on water, while providing educational, cultural, and public engagement opportunities. With S1, a similar relationship cannot be achieved, as reclamation at present is mainly perceived by the public as a disturbance of the waterfront through privatization and does not provide the same public access and cultural interaction with the coast. S2, on the other hand, achieved a moderate score, as a result of its combined fixed and floating modules, which provide partial public access and all the cultural benefits of the floating district although they still retain characteristics of conventional coastal expansion.

4.5 Governance and Risk

Finally, in terms of the Governance and Risk dimension, S1 obtained the highest score (4.80) as a result of the established governmental regulations in this regard. The hybrid scenario, S2, scored (3.50), while the fully floating modular district scored (3.00). S3's score, the lowest, reflects the absence of dedicated regulatory frameworks for floating developments in Bahrain. This is perceived as one of the main barriers to such a development, with multiple uncertainties associated with permissions, ownership, emergency procedures, and other governance- and risk-related uncertainties. The slightly higher score of the hybrid scenario is a result of the combination of familiar land-based planning practices with emerging floating development approaches, which involves some implementation uncertainties.

4.6 Aggregate MCDA Results and Sensitivity Analyses

When applying the assigned weight to each dimension, it was found that S1 scored the lowest with a total of (3.023). This was followed by S2 with a total score of (3.425), and S3 with (4.096), the highest aggregate score. These results indicate the contextual priority of both the environmental and the socio-cultural domains in future urbanism and adaptive design in Bahrain, owing to its ecological vulnerability and cultural identity. The MCDA radar diagram (Figure 6) illustrates the individual scores of the five dimensions for each scenario. Furthermore, while conducting the sensitivity analysis, the ranking of the three scenarios remained the same, implying the robustness of the results under different weighting alternatives. Table 8 presents the weighted values of the aggregate MCDA results and three tests.

Table 8: Sensitivity Test Aggregate Results.

Scenarios	Base	Test 1	Test 2	Test 3
S1	3.023	3.070	3.237	3.170
S2	3.425	3.275	3.375	3.475
S3	4.096	3.858	3.858	4.025

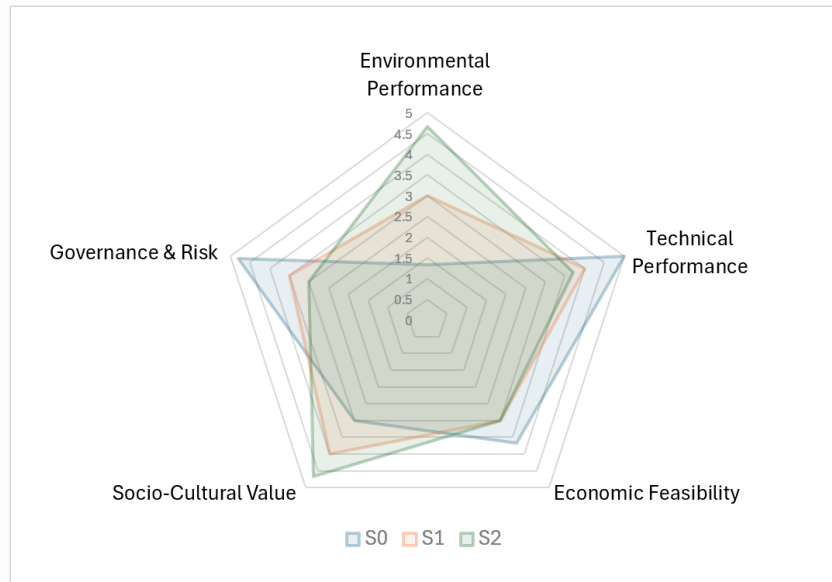


Figure 6. MCDA Radar Diagram.
(Source: authors)

5. Discussion

The study investigated the feasibility of floating urbanism in the context of Bahrain, framing this approach as an alternative to land reclamation. The study combined a design-based research approach with a Multi-Criteria Decision Analysis (MCDA). This section will first explore the role of the floating museum as a civic feature, and then discuss the MCDA findings, and finally consider the implications of the study for practice and research.

5.1 The Floating Museum District as a Socio-Spatial Paradigm

The three-zone structure of the museum district is not simply an organizational device; it conveys one of the project's central messages. Each zone translates a specific body of architectural theory into a spatial experience that can be felt rather than merely read. The sequence is intentional: it moves the visitor from awareness to aspiration to action (Ricoeur, 1991). Zone One, the exhibition zone, does not present information about environmental damage; it attempts to make the visitor feel it. Six spaces unfold in deliberate sequence: an entry plaza, an outdoor nature exhibition, a built environment exhibition, a technology exhibition, an exhibition centred on the future, and a viewing deck. The spatial quality shifts in register as the content shifts in theme. The built environment section is heavy, dark, and compressed. The exhibition space concerned with the future contains more glass and more height, with more light entering. From the viewing deck, the visitor is elevated above the platform, able to see the sustainable museum district below and the unsustainable city surrounding it. Zumthor (2006) describes this as emotional resonance: the quality of spaces that stay with you after you leave, not because they were visually striking, but because they left an impact on you. Zone Two, the waterfront, represents the results; this area is open to the sea. The sound of water, the movement of light across its surface, the feel of wind – these are not aestheticized or framed, but present and immediate. Pallasmaa (2024) argues that architecture's most powerful effects are registered through the body, not appraised by the eye alone. This zone is built around that premise. It also draws on a behavioural principle identified by Merino-Barbancho et al. (2023), namely that showing people what is genuinely achievable before asking them to participate makes the effort feel worthwhile rather than burdensome.

(Merino-Barbancho et al., 2023). The experience of the waterfront, in other words, is designed to make what is in Zone Three feel more achievable. Finally, Zone Three, the sustainability hub, represents the process; it does not instruct visitors in sustainable living, it builds an environment in which acting in a way that supports sustainability feels natural and, crucially, social. Visitors plant food that will be cooked at the adjacent restaurant. They repair objects in the recycling hub. They dye fabric with plants cultivated on-site. Mostafavi and Doherty (2016) describe this as decentralized learning: discovery that feels self-directed because, to a meaningful degree, it is (Mostafavi & Doherty, 2016). Rather than a single consolidated building, the hub is a series of connected spaces, each with its own programme and pathway (Mostafavi & Doherty, 2016). Orr (2004) argues that this kind of place-based, experiential engagement produces more durable change than any amount of conventional instruction - a finding that a substantial body of subsequent research has consistently supported (Falk & Dierking, 2016; Orr, 2004). The design proposal, therefore, acts as a spatial translation of the MCDA findings. The strongest dimensions of the floating scenario are highlighted and explicitly incorporated in the design. The environmental dimension is exemplified in the fully floating modular structure and ecological integration through materials and structural systems. The socio-cultural dimension is achieved through public engagement and access to the sea. The museum district, therefore, not only functions as a cultural destination but also as a demonstration of future coastal development in Bahrain. Beyond its function as a museum, the design points to a unique relationship between land and water. In comparison to land reclamation, which extends land into water by replacing marine environments, the floating district recognizes the presence of water and maintains its ecological values. Therefore, as discussed earlier, it transforms the waterfront into an inhabitable public space rather than a physical edge separating land and sea.

In this sense, the floating museum can be viewed as a socio-spatial paradigm that reshapes the relationship between people, infrastructure, and the coastal environment. Through cultural activities, public engagement, and access to the waterfront, the project becomes a civic, cultural, and ecological asset, thereby reinforcing Bahrain's maritime identity and demonstrating alternative options to coastal development.

5.2 Floating Urbanism as an Alternative to Land Reclamation

According to our MCDA, coastal development achieved through reclamation continues to perform strongly in terms of technical familiarity and governance-readiness. Floating urbanism, on the other hand, demonstrates higher potential in environmental performance, public engagement, and long-term flexibility. The findings therefore demonstrate the strengths, weaknesses, and limitations of these two coastal development approaches.

5.2.1 Environmental Performance

The score of the fully floating scenario in the environmental performance domain indicates the importance of exploring other coastline expansion alternatives in the country. The degradation and damage to marine habitats are strongly linked to the reclamation model, and shifting to a fully floating model would offer an opportunity for active ecological participation through structural logic, spatial configuration, and the selection of suitable materials. The findings suggest that future coastal developments in Bahrain should consider environmental performance as a primary decision-making factor to ensure a transition towards sustainable practices in the country (Ido & Shimrit, 2015; (van der Meulen et al., 2023).

5.2.2 Technical Performance

Although the fully floating modular district scored less well in technical performance in comparison to the conventional reclamation option, this result does not undermine its technical adequacy but rather is attributable to the familiarity and maturity of the conventional model. Incorporating a large floating platform in a tidal environment requires precise engineering across several interdependent systems. The project addresses this through validated buoyancy calculations, the pile-guided mooring system, flexible inter-module connectors, and the embedded monitoring network, all drawn from and cross-referenced against tested international precedents (El-Shihy, 2024; Lamas-Pardo et al., 2015). Therefore, the lower technical score should not be understood as a lack of feasibility but as an

indication of an emerging technology and practice that has not reached its maturity level in Bahrain's context.

5.2.3 Economic Feasibility

In terms of economic feasibility, all three scenarios received similar scores, with the score received by the reclamation scenario being the highest of the three. From an urban economic perspective, the findings suggest that floating urbanism generates additional value in comparison to the conventional model. Despite the additional land supply created by the reclamation model, the fully floating model creates economic opportunities through tourism development, waterfront activities, cultural activities, public engagement, and the blue economy. Therefore, the modularity, flexibility, and relocatability offered by the floating district suggest that long-term spatial assets are preferable to fixed land investments, in spite of the higher initial costs. In terms of economic value, the fully floating model should be viewed as an investment in long-term adaptive architecture and socioeconomic benefit. The project's modularity and flexibility offer opportunities for growth, reconfiguration, and relocation, which could be seen as adding extra value (OECD, 2020; Wang & Tay, 2011; Wang et al., 2019). Beyond direct financial returns, the fully floating model creates socioeconomic value through the visitor attraction, cultural activities, local entrepreneurship, and waterfront activities. These benefits support broader economic diversification strategies while reinforcing Bahrain's cultural and maritime identity.

5.2.4 Socio-Cultural Value

The fully floating model received the highest score in the socio-cultural dimension, reflecting the re-establishment of the relationship with the waterfront. The floating district acts as a public and participatory type of project. It both offers a direct connection with the sea, not as a boundary or visual edge, but rather as an interactive experience, where people are close to the water through the pedestrian paths, the waterfront interaction, and the water-based arrival. Furthermore, the museum acts as a catalyst for behaviour change by giving visitors an experience of sustainability. Environmental awareness and knowledge are not perceived through representations but rather through an experiential learning process. This contributes to the high score of the fully floating scenario in the MCDA.

5.2.5 Governance & Risk

Bahrain currently has no legal framework for floating architecture. This is a genuine constraint, and it would be misleading to minimize it. At the same time, demonstrator projects of this kind have historically been part of how regulatory frameworks develop, by generating the evidence base and practical experience that policymakers need to build appropriate governance structures (OECD, 2020; Wang et al., 2019). The floating museum could plausibly play that role. In the MCDA, the floating district received a low score in governance and risk, indicating that it remains the main challenge in this study. Bahrain currently lacks a regulatory framework for floating architecture. Therefore, this project could be perceived as a pilot study, based on international precedents, serving as a potential framework for future implementation.

Collectively, the findings indicate that floating urbanism performs best in dimensions related to environmental performance, long-term sustainability, and socio-cultural value, while the reclamation model remained stronger in technical maturity and governance-readiness. The findings suggest that future coastal development should consider a strategic approach that evaluates environmental, economic, social, and governance priorities.

5.3 Transferable Decision-Making Framework and Contribution

One of the main contributions of this study is the integration of a design-based approach and an MCDA, which bridges the gap between design exploration and decision-making assessment. Furthermore, within the Bahrain context, research on floating urbanism remains limited; therefore, this study contributes to the emerging body of knowledge on floating urbanism in Bahrain. The proposed evaluation framework (the MCDA) enables the assessment of floating and fixed developments across five dimensions, incorporating other considerations into the design process apart from the conventional engineering or economic considerations.

Although the framework was tested through the design of a floating museum district, the applicability could be extended beyond this particular project. It could be applied to other floating projects such as a residential project, another type of public space, or even a mixed-use district, by adapting the weights and relative project-specific indicators. This suggests that the framework should not be applied strictly, but rather, that a degree of flexibility is essential to respond to the different environmental, social, and institutional considerations.

The research, therefore, demonstrates how a design can function as an evaluative tool rather than a final outcome. The floating museum district draws on the most appropriate architectural principles, developing them into a tangible, spatial, experiential proposal that can be evaluated with an MCDA. The project, hence, operates on a broader level of evaluating the feasibility of floating urbanism in Bahrain, rather than being considered an isolated architectural solution.

The contribution of the study can be summarized on three levels. Theoretically, the study frames floating urbanism as a socio-spatial model that reshapes the relationship between land, water, and the public realm. Methodologically, it demonstrates how a design-based approach and MCDA could be integrated to evaluate coastal development strategies. Practically, it could provide a decision-making framework for future assessment of floating developments, using the criteria of environmental performance, technical performance, economic feasibility, socio-cultural value, and governance and risk.

As a result, the significance of the study extends beyond the proposed floating museum district itself, to take a systematic approach that includes a framework for evaluating the feasibility of floating urbanism within climate-vulnerable coastal cities. It offers a decision-making tool that could be used by futures planners to seek a balance between environmental, economic, cultural, and urban resilience when designing coastal developments.

5.4 Implications and Limitations

The findings of this study have several implications for coastal developments in Bahrain and similar coastal countries. Through the integration of design-based research and MCDA, the study demonstrates that floating urbanism could provide several benefits, including socio-cultural and economic benefits, and provision of long-term urban resilience, in addition to its environmental benefits. The study also revealed a number of challenges, most specifically in relation to implementation and regulation and governance-readiness. The following sections discuss the main implications and acknowledge its limitations.

5.4.1 Planning and Policy Implications

The findings suggest several implications for coastal planning and policy development in Bahrain. First, floating urbanism should be perceived as an alternative to coastal development rather than a direct replacement for reclamation. The results suggest that floating urbanism offers minimal damage to ecosystems and marine habitats while improving socio-cultural cohesion and adaptability. Second, the low governance score highlights the need for regulatory frameworks addressing ownership, permit procedures, operational responsibilities, management, and maintenance for floating structures.

5.4.2 Urban Economic Implications

Floating urbanism presents emerging opportunities for urban economic development through tourism, cultural developments, waterfront regeneration, research activities, and the blue economy (Altwayjri et al., 2026; Gorzka et al., 2026; Harris & Thompson, 2023). While reclamation provides value through the creation of additional land, floating urbanism may create additional economic value through public waterfront engagement, cultural importance, environmental enhancement, and adaptive infrastructure. The findings therefore support a broader understanding of coastal development, where water functions as an integral urban asset rather than a mere space for reclamation.

5.4.3 Implications for Practice

From a practical standpoint, the study demonstrates how design-based research can be used to translate strategic planning objectives into a tangible spatial proposal. The project illustrates how environmental adaptation, public engagement, and cultural identity, in addition to economic opportunities, can be integrated into a single development project. A similar framework model could be applicable to

housing, mixed-use developments, tourist destinations, and public waterfronts for practitioners such as architects. Architecture is not merely a physical structure, but rather it can be viewed as a dialogue between environmental awareness and social necessity. Finally, for policymakers, such projects act as pilot studies for initiating regulatory frameworks. In general, this study presents a context-specific strategy for low-lying coastal areas facing future uncertainty.

5.4.4 Limitations

Several limitations should be acknowledged in this study. First, the MCDA involves subjective weighing, with priorities based on the focus of the study. Second, although the project serves as a test for the validity of floating urbanism, it remains a proposed design and lacks post-occupancy data, which limits information on user behaviour, maintenance demands, and institutional management. Third, the study focuses on the context of Bahrain through a single floating museum district, limiting the possibility of generalising the findings. Finally, detailed life cycle cost modelling and engineering validation are beyond the scope of this research. Despite these limitations, the study provides insight into the potential of floating urbanism as a resilience strategy that responds to a country's coastal development policies and plans. It provides solutions to urban growth in low-lying coastal cities while supporting ecological sustainability and marine life.

6. Conclusion

The study highlights the feasibility of floating urbanism as a paradigm that responds to climate change and urban growth, specifically in the Kingdom of Bahrain, where socio-cultural bonds with the waterfront are an integral part of life. The study utilises a design-based research approach and MCDA, allowing a better understanding of the feasibility of floating architecture in the country through tests using five dimensions: environmental performance, technical performance, economic feasibility, socio-cultural value, and governance and risk. Three scenarios – the business-as-usual reclamation option, a hybrid alternative with fixed piers and a partial floating component, and a fully floating modular district – are tested in the study. After the three scenarios had been assessed in relation to the five dimensions, the results indicated that the reclamation scenario scored the highest in the technical and governance dimensions because of familiarity and an established framework. The fully floating scenario, on the other hand, scored the highest in the environmental and socio-cultural dimensions, owing to the extensive environmental benefits and the direct connection to the waterfront it offered to the public. The floating museum district illustrates the applicability of floating urbanism to the need for resilient architecture. Its modular and expanding systems contribute to this. In addition, it increases public awareness of environmental challenges and encourages public participation in combating them. The museum exemplifies how the general public, through a spatial experience, can regain their bond with the waterfront, and at the same time, how the museum can function as a participatory environment, where sustainability is a lived experience (Falk & Dierking, 2016).

The integration of design-based research and MCDA suggests a transferable framework for evaluating future floating developments through the environmental, technical, economic, socio-cultural, and governance dimensions.

This research contributes theoretically by presenting floating urbanism as a socio-spatial model for coastal development, methodologically through the integration of a design-based research approach and MCDA, and practically by providing a decision support framework for planners, architects, and policymakers to explore other coastal development strategies in Bahrain and similar coastal countries. From a socioeconomic perspective, the study demonstrates that floating urbanism can function not only as an environmental adaptation strategy but also as a mechanism for supporting tourism development, waterfront regeneration, the blue economy, and cultural entrepreneurship. Consequently, floating developments may contribute to economic diversification while strengthening cultural identity and urban resilience.

Future research should focus on detailed life cycle cost assessment, public acceptance studies, regulatory framework development, engineering validation, and monitoring of implemented floating projects.

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Conflicts of Interest

The author(s) declare(s) no conflicts of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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