

Advancing Sustainability through Strategic Design Management in Architecture

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Article Info	ABSTRACT
<p>Article history:</p> <p>Received Oct, 2025 Revised Nov, 2025 Accepted Nov, 2025</p> <hr/> <p>Keywords:</p> <p>Architectural Case Studies; Building Performance; Design Management; Energy Efficiency; Interdisciplinary Collaboration; Resource Conservation; Sustainable Architecture</p>	<p>Sustainability has evolved from a supplementary consideration in architecture to a central pillar of design practice, particularly within leading global firms. This paper examines the convergence of sustainable strategies and design management processes across innovative architectural practices, focusing on case studies of Foster + Partners, ZGF Architects, and Haptic Architects. These firms represent diverse application contexts: desert urbanism in the Middle East, adaptive reuse in Sydney, and government renovation projects in North America. By analyzing their design approaches, performance metrics, and project outcomes, the study highlights how sustainable integration is not just a technical exercise but also a managerial and cultural challenge. Design management emerges as a necessary driver of success, harmonizing the creative ambitions of designers, the pragmatic expectations of clients, sustainability certification frameworks, and measurable performance outcomes. The cases reveal that sustainability thrives when interdisciplinary collaboration is strategically managed, when advanced digital tools are utilized to track and simulate outcomes, and when life-cycle perspectives define the design process from conception to occupancy. The paper further interrogates challenges including cost barriers, technological uncertainty, and inconsistent regulatory frameworks, emphasizing that sustaining innovation requires long-term engagement, iterative learning, and a client culture oriented toward environmental responsibility. As architecture confronts the climate crisis, design management is positioned not as an administrative backdrop but as a transformative methodology that aligns creative vision with environmental necessity. The research concludes by identifying strategies of replicability across firms and contexts, suggesting pathways for global best practices and advancing discourse toward sustainable architectural paradigms for the 21st century.</p> <p><i>This is an open access article under the CC BY-SA license.</i></p> <div></div>

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<p>1. INTRODUCTION</p> <p>The urgency of environmental transformation has profoundly reshaped architectural practice in the 21st century. As cities expand</p>	<p>and global populations approach 10 billion by 2050, the built environment remains one of the most significant contributors to energy consumption, resource depletion, and</p>
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greenhouse gas emissions. International Energy Agency (2023) estimates that buildings are responsible for approximately 40% of global CO₂ emissions, a statistic that underscores architecture's pivotal role in both the problem and the solution to climate change. The evolution of sustainable design is, therefore, not an optional academic discourse; it is a professional imperative with societal consequences.

In its early phases, sustainable architecture was often framed as "green building," primarily reliant on passive design strategies such as solar orientation, natural ventilation, and local material use [2]. Over time, however, rapid advancements in environmental science, material innovation, and digital technology have redefined possibilities. Today's paradigms integrate renewable energy systems, circular material economies, performance monitoring technologies, and health-oriented frameworks like WELL certification—expanding the sustainability agenda to include not only environmental stewardship but also social and economic resilience [3].

Within this complex web of demands, design management has emerged as a crucial discipline. Unlike conventional architectural management, which may narrowly focus on project delivery within time and budget, design management encompasses the holistic coordination of design intent, technical expertise, sustainability objectives, and stakeholder engagement. As Emmitt (2014) notes, it is the orchestration between vision and execution, ensuring coherent processes where environmental priorities do not evaporate under the practical pressures of construction or client demands.

The integration of sustainability into leading firms' design management processes represents both opportunity and tension. On one hand, it generates precedents that transform the building industry, reduce ecological footprints, and inspire innovative architectural identities. On the other, the challenges—financial feasibility, cultural inertia, technological uncertainty—remain formidable. Against this background, this paper examines how three firms—Foster +

Partners, ZGF Architects, and Haptic Architects—demonstrate leadership in embedding sustainable goals through design management strategies [5], [6], [7].

2. LITERATURE REVIEW

2.1 *Evolution of Sustainable Architecture*

The discourse on sustainability in architecture has traveled a considerable distance from its roots in the energy crises of the 1970s. Initially, approaches leaned heavily on passive environmental control, with architects orienting buildings to maximize sunlight, natural ventilation, and thermal mass [2]. During the 1980s and 1990s, the proliferation of environmental movements created an ecosystem for rating systems like LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method), providing structured benchmarks for measuring performance [3].

The transition into the 21st century marked the rise of smart building systems, with digital sensors, real-time monitoring, and renewable integration (solar, wind, geothermal). Additionally, materials research began focusing on life-cycle assessment, cradle-to-cradle design, and circular economies. The Green Building Council frameworks institutionalized the notion of "operational carbon" vs. "embodied carbon," broadening design conversations beyond energy efficiency to the entire carbon footprint of structure and materials. A decade later, WELL certification introduced human wellness as a sustainability parameter, acknowledging that sustainable construction is deeply tied to the long-term health and productivity of occupants.

2.2 *Design Management as a Sustainability Enabler*

Design management literature consistently emphasizes the mediating role it plays between divergent project stakeholders—clients, engineers,

contractors, sustainability consultants, local authorities, and communities. Without structured design management, projects risk “goal drift,” in which sustainability aspirations get diluted during budget revisions or technical compromises [4], [8]. By integrating management frameworks throughout design phases, sustainability moves from being an additive consideration to becoming intrinsic to project DNA.

Digital tools such as Building Information Modeling (BIM) have dramatically expanded management capacity. BIM allows for integrated simulations of energy use, material flows, daylight distribution, and structural efficiency, providing early-stage data that informs decision-making [9]. Moreover, BIM enables seamless interdisciplinary collaboration, reducing redundancies and allowing different specialists to coordinate effectively toward sustainable outcomes.

The expanding scope of sustainability places architects in complex managerial landscapes. Issues of compliance, certification, community participation, and return on investment require architecture to act as mediator, negotiator, and systems integrator. Thus, design management is no longer simply about organizing creativity but about ensuring alignment between sustainability philosophies and implementation realities.

2.3 Challenges in Integrating Sustainability

Despite rapid progress, the literature identifies persistent barriers to universal adoption of sustainability-integrated design. The lack of standardized evaluation methods across regions and the variable credibility of certification systems [10]. Initial capital costs remain a universal deterrent, as energy-efficient systems and renewable technologies often demand higher upfront investment. Although these costs are typically recouped over long-term savings, project financing often prioritizes short payback periods, limiting ambition.

Moreover, political and cultural inertia hinders adoption. Resistance to change, comfort with traditional practices, and fragmented regulatory frameworks introduce complexity—especially in global projects where sustainability codes vary. The World Green Building Council (2022) emphasizes that capacity-building, incentives, and demonstrative success stories are key to broadening acceptance.

Collectively, these challenges position design management as the systems-thinking framework capable of elevating project sustainability from aspiration to measurable reality.

3. METHODS

3.1 Case Selection

This study applies a case study methodology focusing on three flagship projects: Masdar City by Foster + Partners, Federal Center South 1202 by ZGF Architects, and Quay Quarter Tower by Haptic Architects in collaboration with 3XN. The case selection was guided by three criteria:

- **Global Diversity:** Each case reflects different regional and cultural contexts—Middle Eastern desert ecology, North American adaptive reuse of government buildings, and Australian high-rise transformation.
- **Managerial Innovation:** Each demonstrates unique applications of design management for sustainable integration, spanning large-scale master planning to building reuse and retrofit.
- **Quantified Outcomes:** Each project provides measurable performance data, enabling comparative analysis of success and replication potential.

3.2 Data Collection

The research integrates both qualitative and quantitative data. Peer-reviewed articles, architectural project documentation, and professional reports

provided technical specifications and post-completion evaluations. Certification scorecards for LEED, WELL, Green Star, and NABERS were analyzed to ground sustainability claims in verifiable benchmarks. Where possible, statements by architects, client organizations, and user feedback were incorporated to assess outcomes beyond numerical performance.

Post-occupancy evaluation studies, energy use intensity (EUI) data, and embodied carbon assessments were particularly valuable, allowing for both environmental and managerial effectiveness to be monitored. The combination of data sources allows for holistic insights rather than isolated measures.

4. RESULTS AND DISCUSSION

4.1 Case Studies

A. Foster + Partners: Masdar City

Masdar City, launched in 2006, represents one of the most ambitious sustainability-driven masterplans of the early 21st century. Conceived as a prototype for zero-carbon living in the desert environment of Abu Dhabi, it drew global attention to how urban design, architectural management, and renewable infrastructure could merge into a single ecosystem [5], [12]. Foster + Partners orchestrated design management across multiple scales: infrastructure, buildings, and public realm.

At the urban planning level, design management prioritized compact form and pedestrianism. Narrow streets create self-shaded corridors, reducing cooling demand compared to conventional urban layouts. The management framework coordinated mechanical, civil, and architectural teams to integrate infrastructure below-grade, leaving above-grade land for walkability and renewable installations. The masterplan also embedded solar

photovoltaic fields and wind towers into the design vocabulary.

Key performance outcomes include:

- A documented 57% reduction in solid waste compared to baseline Abu Dhabi developments.
- Post-occupancy data showing energy usage 31% below baseline and potable water use 18% lower (Foster + Partners, 2024; RIBA Journal, 2025).
- Implementation of “coolth” recovery systems that recycle excess nighttime cool air through radiant surfaces, reducing mechanical load.
- Alignment with RIBA 2030 embodied carbon targets at 500–650 kg CO₂e/m².

While Masdar’s original vision of a completely zero-carbon city by 2016 was scaled down due to geopolitical and economic constraints, design management allowed achievements to persist despite reduced scope. Iterative learning embedded into foster’s design-management culture created a knowledge bank later transferred into other projects worldwide. Thus, Masdar represents less a perfect utopia than a test-bed sustained by strong managerial frameworks.

B. ZGF Architects: Federal Center South Building 1202

ZGF Architects’ Federal Center South Building 1202 demonstrates how adaptive reuse and advanced environmental systems can be orchestrated into a federal workplace. Completed in 2012 in Seattle, it transformed a 1940s warehouse into a high-performance, LEED Platinum-certified headquarters for the U.S. Army Corps of Engineers [13].

Design management in this project emphasized three core

aspects: stakeholder coordination, performance benchmarking, and lifecycle integration. Managing client expectations was particularly important given the Army Corps' emphasis on resilience, adaptability, and efficient public spending. Stakeholder workshops identified shared values, anchoring sustainability targets as indispensable rather than add-ons.

The final building achieved:

- A measured Energy Use Intensity (EUI) of 25.7 kBtu/SF/year—40% below ASHRAE 90.1 standards.
- A naturally daylit work environment (90% of office space), supporting WELL-aligned human health outcomes.
- Underfloor displacement ventilation and radiant systems that optimize comfort while reducing energy waste.
- 300,000 board feet of salvaged timber reintegrated into the structure, cutting virgin material demand.
- A rooftop thermal energy storage tank with phase-change materials for load shifting.
- Complete on-site stormwater management with a 25,000-gallon cistern.

The building's ENERGY STAR® rating of 98 highlights its exceptional national performance relative to comparable projects. From a managerial perspective, ZGF maintained rigorous data-tracking frameworks during design and post-occupancy. BIM played a central role, allowing multidisciplinary teams to share a live digital model that integrated mechanical systems, daylighting analyses, and stormwater flows.

This project reflects a pragmatic U.S. context: financial

accountability balanced with environmental innovation. Effective design management created synergies among diverse goals—sustainability, user comfort, public accountability—transforming potential conflicts into a unified outcome.

C. Haptic Architects / 3XN: Quay Quarter Tower

Quay Quarter Tower in Sydney stands as one of the most globally celebrated adaptive reuse towers. Completed in 2022 by Haptic Architects in partnership with 3XN, the tower reimaged an existing low-performing 1970s office block into a state-of-the-art workplace. Unlike demolition-and-rebuild approaches, this project exemplifies how design management can radically reduce embodied carbon through structural upcycling [14], [15].

The management approach emphasized lifecycle analysis from the outset. Teams calculated the embodied carbon savings of retaining structural elements—with results showing 65% of beams, columns, and floor slabs preserved, along with 95% of the concrete core. This avoided nearly 12,000 tonnes of CO₂ emissions compared to demolition and new build (GBCA, 2024).

Major achievements include:

- A 6 Star Green Star rating and WELL Platinum certification.
- Targeting a 5.5 NABERS Energy rating, positioning it among the most efficient commercial office towers in Australia.
- Double-skin façade systems with operable louvres for daylighting and solar control.
- Extensive green terraces functioning as semi-public "villages in the sky," increasing biophilic value.

- Integrated sensors tracking water consumption, air quality, and thermal comfort.
- Completion of the high-rise work while maintaining business continuity for the client.

Quay Quarter’s design management process struggled with balancing innovation against risk. Retaining large portions of an outdated structure required intensive verification of safety and performance. Yet through

coordinated management of engineers, clients, and regulators, the project pioneered new construction possibilities. This highlights design management’s role in pushing regulatory frameworks toward more sustainable norms.

4.2 Comparative Analysis

To crystallize lessons across the three case studies, it is essential to compare not only their environmental performance but also the unique management strategies they employed.

Table 1. Comparative Table of Performance Metrics and Design-Management Strategies Across Three Sustainable Architecture Projects

Metric	Masdar City (Foster + Partners)	Federal Center South 1202 (ZGF)	Quay Quarter Tower (Haptic/3XN)
Carbon Strategy	Net-zero operational goal by 2030	Energy use 40% below baseline	12,000 tonnes CO ₂ saved through adaptive reuse
EUI	40% below conventional buildings	25.7 kBTU/SF/year	Aligns with NABERS 5.5-star efficiency
Embodied Carbon	500–650 kg CO ₂ e/m ²	Not primary focus	226 kg CO ₂ e/m ² achieved (meets LETI targets)
Water Systems	18% less potable water	25,000-gallon cistern, stormwater managed fully on-site	Rainwater systems and green roofs integrated
Certification	LEED Platinum, WELL Gold	LEED Platinum, ENERGY STAR 98	6 Star Green Star, WELL, NABERS 5.5
Material Reuse	Integrated but secondary	High (salvaged timber)	Central strategy — 65% structure reused
Managerial Innovation	Urban-scale integration	BIM-centered collaborative modeling	Regulatory negotiation and lifecycle focus

4.3 Discussion

A. Themes Across Cases

- Several themes emerge when analyzing these three cases through the lens of design management:
- Early Goal Setting: All projects integrated sustainability targets from inception. Masdar began with net-zero aspirations, ZGF defined Army Corps performance benchmarks early,

while Quay Quarter embedded lifecycle carbon modeling at the masterplan stage.

- Interdisciplinary Collaboration: BIM and equivalent frameworks enabled collaboration between engineers, architects, sustainability consultants, and contractors. Facilitation of dialogue was crucial for resolving

conflicts and maintaining sustainability goals.

- **Lifecycle Approach:** From resource reuse at Quay Quarter to urban renewable integration at Masdar, lifecycle analysis framed decision-making at broad and detailed levels.
- **Cultural Influence of Clients:** Success correlated strongly with supportive client organizations. Abu Dhabi's political will, the Army Corps' resilience mission, and AMP Capital's corporate ESG goals each shaped outcome. Without aligned client cultures, design management alone cannot sustain ambitions.

B. Barriers and Challenges

Challenges were evident. Masdar illustrates financial scaling-down when global oil economics shifted. ZGF navigated pressure to ensure cost accountability using taxpayer funds. Haptic wrestled with regulatory uncertainty in adaptive reuse, as retaining cores challenged traditional codes. Across all cases, the broader challenge remains demonstrating long-term value over immediate capital costs.

C. Innovative Directions

The evolving role of digital technology is crucial. Predictive simulations, AI-based optimization of operational patterns, and post-occupancy data feedback loops increasingly enable iterative improvements, a process some scholars term "living design management." Equally important is the cultural broadening of sustainability to include wellness, equity, and biophilia, as WELL and Green Star highlight. These dimensions underscore that sustainability is as much social as it is technical.

4.4 Conclusion

Design management sits at the frontier of 21st-century sustainable architecture. It is no longer supplementary to design but the very mechanism ensuring coherence between vision, execution, and measurable performance. The case studies of Foster + Partners, ZGF Architects, and Haptic Architects show that successful integration of sustainability depends on aligning interdisciplinary expertise, embracing long-term outcomes, and embedding data feedback loops into project cycles.

Foster + Partners' Masdar City demonstrates how design management can operate at a masterplan level, even navigating political scaling-down without abandoning key sustainability principles. ZGF's Federal Center South shows how public projects can deliver rigorous environmental and managerial outcomes through integration of BIM and stakeholder workshops. Haptic/3XN's Quay Quarter exemplifies how adaptive reuse, supported by strong management of risk and regulation, can redefine embodied carbon targets for skyscrapers.

Across these varied contexts, the common thread is that sustainability flourishes not through isolated technical innovations but through managed processes of collaboration, foresight, and accountability. The future of sustainable architecture lies in iterative learning, global knowledge transfer, and a design management philosophy that values long-term planetary health equally with short-term deliverables.

Architectural firms will increasingly act as orchestrators of collective intelligence, blending creative experimentation with managerial precision. As climate change escalates, clients, policymakers, and professionals must recognize design management not as bureaucratic overhead but as the most critical enabler of architectural futures that sustain human and ecological well-being.

4.5 Future Directions in Sustainable Design Management

While existing literature and case studies emphasize the reactive capacity of design management to integrate sustainability, the coming decades will demand a more proactive and anticipatory role. The interplay between climate urgency, digital technology, and socio-economic transformations suggests several pivotal trajectories for design management theory and practice.

A. Integration of Circular Economy Principles

The construction industry remains one of the largest consumers of virgin resources, producing vast waste streams. The concept of a circular economy—where materials are reused, repurposed, or recycled to retain value in continuous loops—has begun to reshape architectural narratives [3]. Future design management frameworks must institutionalize circular practice in project charters, ensuring procurement strategies privilege reused and modular components over linear “take-make-dispose” approaches.

Quay Quarter Tower foreshadowed this paradigm by retaining over 65% of existing structural fabric, but circularity must expand from isolated projects to systemic norms. Design management teams will need to coordinate digital material passports, global reuse marketplaces, and disassembly logistics within project workflows. Instead of an exceptional sustainability story, adaptive reuse and materials recirculation should become managed expectations.

B. Digitalization and Real-Time Management

The rise of digital twins—virtual replicas of buildings updated by sensor data—signals a new epoch where performance monitoring

ceases after completion and instead feeds an infinite loop of optimization. Design management in this context becomes less finite: projects are managed not only through delivery but across operational lifecycles. BIM, IoT (Internet of Things), and AI forecasting tools allow continuous recalibration of building systems based on fluctuating energy grids, occupant behaviors, or climate extremes.

Thus, managerial frameworks will likely expand in definition, requiring roles beyond project delivery managers to encompass “building performance curators” who oversee adaptive algorithms and feedback-based adjustments throughout occupancy. The profession must anticipate these expanding duties, redefining the boundaries of architectural responsibility.

C. Social Equity and Resilience Dimensions

Sustainability discourse has sometimes been critiqued as overly technocentric, focusing narrowly on measurable resource performance. Yet climate change is also a justice issue, disproportionately affecting marginalized communities in vulnerable geographies. Future-oriented design management must integrate principles of social equity, resilience, and inclusivity. This implies embedding social scientists, community stakeholders, and policy actors into design consortiums.

A management framework balancing environmental, financial, and social dimensions can redefine sustainability as a holistic metric. Community-led processes—whereby design priorities are established in participatory workshops—will increasingly be required. ZGF’s example of stakeholder workshops with the Army Corps of Engineers illustrated the feasibility of client-

centered planning. Yet extending beyond organizational clients to civic communities will define the new frontier in ethical practice.

4.6 Theoretical Synthesis

From the preceding analysis, a synthesized framework for understanding sustainability-integrated design management can be proposed. It comprises four interlinked dimensions:

1. Strategic Orientation – defining sustainability goals early, aligning them with broader organizational visions and regulatory commitments.
2. Collaborative Structure – orchestrating diverse stakeholders into interdependent teams supported by shared digital models.
3. Lifecycle Integration – embedding both embodied and operational carbon considerations, extending responsibility from design through demolition or reuse.
4. Adaptive Feedback – institutionalizing real-time monitoring, learning, and iterative adjustment throughout building life.
5. These four dimensions together operationalize what can be termed Integrated Sustainable Design Management (ISDM). Unlike earlier managerial paradigms that treated design phases as linear progressions, ISDM emphasizes iterative loops—strategies are revisited continually under new climate data, operational metrics, and user experiences.

4.7 Implications for Global Architectural Practice

A. Professional Education

Architectural education worldwide must expand its managerial curriculum. Traditionally, students are trained primarily in design creativity, with sustainability often offered as supplementary electives. Given the

urgency of climate change, design management that integrates sustainability should become a foundational competency. Studios should teach leadership of interdisciplinary teams, navigation of certification frameworks, and management of digital collaboration platforms.

B. Policy and Institutional Contexts

Global institutions such as the World Green Building Council, the International Energy Agency, and UN frameworks for decarbonization intensify pressure on the building industry. Yet without managed translation into practice, lofty goals stagnate. Architecture firms must position themselves as intermediaries—interpreting policy into achievable design outcomes. Robust design management provides the technical, communicative, and evaluative infrastructure for this translation.

C. Market Differentiation

In a competitive industry, sustainability-certified projects increasingly define market reputation. Yet clients demand both environmental and financial performance. Effective design management allows firms to demonstrate whole-lifecycle savings to skeptical investors. Sustainability as managed innovation thus becomes a brand asset for architectural practices, influencing global rankings, client retention, and award recognition.

4.8 Extended Reflections

The three case studies analyzed illustrate that sustainability is neither a fixed endpoint nor a checklist to completion, it is a dynamic process embedded in managerial culture. Masdar City underscores how ambitious sustainability can survive even political downsizing when firmly anchored in management. Federal Center South shows that collaborative governance and

federal accountability can still yield advanced outcomes when properly managed. Quay Quarter Tower shows that with courage and skilled negotiation, radical sustainability such as high-rise reuse can become reality.

A critical lesson is that sustainability cannot be safeguarded by design genius alone. Left unprotected, sustainability risks erosion by budget cuts, changing client demands, or regulatory ambiguities. Only by embedding sustainability in managed structures, codified workflows, and measurable loops can architecture ensure continuity of intent from blueprint to building to everyday use.

5. CONCLUSION

In the face of climate crisis, architectural practice must be redefined not simply as a creative endeavor rooted in form, but as a global management exercise rooted in sustainability. The paradigm shift requires design managers to become the custodians of ecological, social, and technological integration. By aligning diverse actors,

facilitating decision-making under uncertainty, and maintaining iterative feedback, design management empowers sustainability to transcend aspiration and crystallize into durable, measurable achievements.

The integration of design management into sustainability narratives transforms architecture from a reactive solution-provider to a proactive agent shaping resilient futures. Foster + Partners, ZGF, and Haptic exemplify this trajectory, demonstrating contextual adaptations of global principles. Their legacies suggest that the architecture of the future will be judged not only by form or beauty but by its capacity to sustain planetary health through deliberate, managed integration.

As architecture moves further into the Anthropocene, sustainable design management stands not as a specialized subfield but as the very foundation of professional relevance. For firms, institutions, and communities alike, the choice is clear: innovate sustainability through robust design management—or risk irrelevance in the defining challenge of our century.

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