Open Access

Advances in Environmental and Engineering Research

LIDSEN Publishing Inc.

Review

A Systems Guide to Sustainable Construction Across the Project Life Cycle: A Technical Review from Impacts to Interventions

Vinayak Kaushal *, Allison Pham

Civil Engineering Department, University of Texas, Arlington, TX, USA; E-Mails: vinayak.kaushal@uta.edu; atp0753@mavs.uta.edu

* **Correspondence:** Vinayak Kaushal; E-Mail: vinayak.kaushal@uta.edu

Academic Editor: Grigorios L. Kyriakopoulos

Adv Environ Eng Res
2026, volume 7, issue 3
doi:10.21926/aeer.2603028

Received: December 31, 2025
Accepted: August 09, 2026
Published: August 20, 2026

Abstract

Sustainable construction practices and robust waste management strategies provide a viable pathway to mitigate these challenges. By integrating resource-efficient design, circular economy principles, and environmentally responsible technologies, the industry can significantly reduce its ecological burden. This paper presents a synthesis of environmental impacts from construction and a practical playbook of interventions spanning design, delivery, operations, and end-of-life. The study is organized as a systems guide: mapping life-cycle impact pathways (materials, energy, emissions, runoff, and noise) and pairing each with project-level governance, metrics, and technologies-eco-design, circularity, BIM and LCA, stormwater compliance, and performance-based certification. Recent policy and market updates (EPA's 2022 Construction General Permit; LEED v4 energy update effective March 1, 2024; global buildings status reports) and introduce four original schematics for implementation. This technical review provides actionable guidance for owners, designers, and constructors to reduce waste, air and water pollution, and noise while improving project outcomes and community well-being.

Keywords

Sustainable construction; life-cycle assessment; circular economy; stormwater; noise mitigation; LEED; BIM; LCA

1. Introduction

Buildings and construction account for a substantial share of global energy consumption and CO_2 emissions; recent status reports emphasize the need to convert national and corporate climate targets into project-level delivery mechanisms [1, 2]. This paper operationalizes that translation by pairing life-cycle impact pathways with governance and metrics-so teams can move from abstract goals to enforceable decisions and measurable outcomes [1, 2].

Global assessments consistently attribute roughly one-third of energy use and energy-related CO_2 to buildings and construction, with cement and steel dominating embodied impacts [1, 2]. Policy momentum is rising across codes, finance, and certification, yet projects still require clear pathways from goals to site actions and metrics [1, 2].

[1]Figure 1 presents the Integrated Life-Cycle Environmental Control Framework (ILECF), which constitutes the core analytical contribution of this study. The framework organizes environmental impacts across four domains-waste, air, water, and noise-mapped onto the four principal stages of the construction life cycle. Each intersection captures domain-specific impacts and intervention strategies, while arrows represent interdependencies and feedback loops across stages and domains.

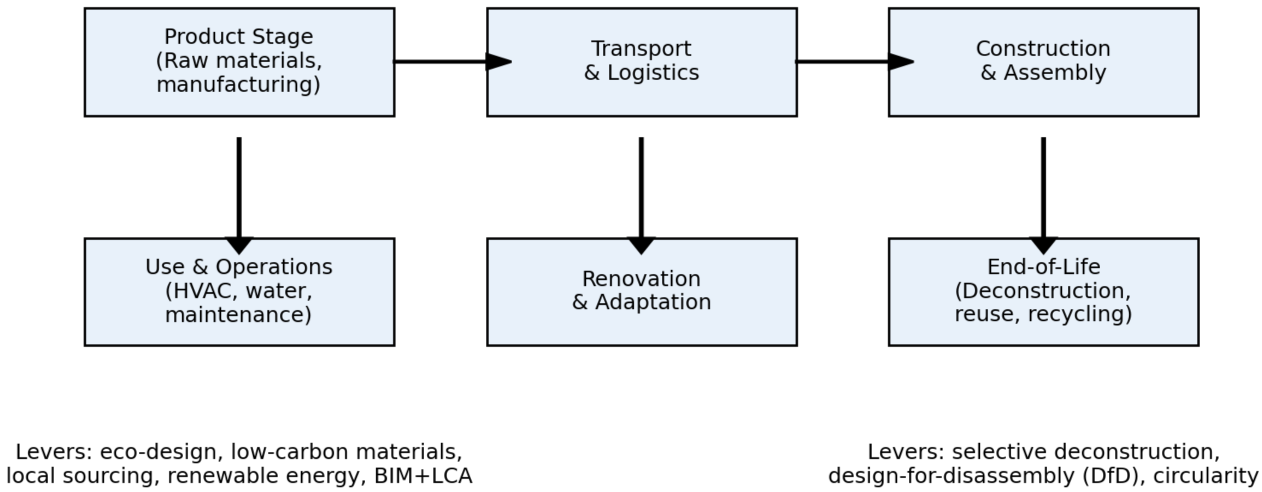

Figure 1 Construction Life-Cycle Impact Map with Mitigation Levers.

A key feature of the framework is its systems perspective, which highlights how decisions at early stages-particularly material selection and design configuration-propagate through downstream environmental outcomes. The framework is complemented by an overlay of governance mechanisms and enabling tools, including policy instruments, certification systems, and digital technologies such as BIM and LCA. This integrated structure allows for both comparative analysis of existing studies and development of coordinated intervention strategies.

---

[1] All figures in this study are analytically derived from the proposed framework and literature synthesis. Unlike conventional illustrative diagrams, these figures explicitly represent classification logic, decision hierarchies, and interdependencies across lifecycle stages and environmental domains, thereby supporting both theoretical analysis and practical application.

Recent studies have also explored alternative low-carbon materials such as coal gangue-based geopolymer cement, demonstrating significant potential for reducing environmental impacts through life cycle assessment (LCA) and life cycle impact assessment (LCIA). These findings highlight the importance of material innovation in addressing embodied carbon in construction [1].

1.1 Key Contributions and Framework Development

This study advances beyond conventional narrative reviews by proposing an Integrated Life-Cycle Environmental Control Framework (ILECF), which serves as both a classification system and a decision-support model for sustainable construction. The framework integrates environmental impact domains (waste, air, water, and noise) with project life-cycle stages (design, construction, operation, and end-of-life), while explicitly incorporating governance mechanisms, performance metrics, and digital tools such as BIM and LCA.

In addition, this study contributes:

1. A multi-dimensional classification matrix that organizes prior research by lifecycle stage, impact domain, methodological approach, and regional context;
2. A decision-making hierarchy and flow model that links sustainability targets with project-level implementation strategies;
3. A practical intervention matrix that incorporates quantitative metrics, cost considerations, and applicability conditions;
4. A systems-based analytical perspective highlighting interdependencies and trade-offs across environmental domains and lifecycle stages.

These contributions address existing gaps in the literature by transforming fragmented knowledge into a coherent, actionable framework for both research and industry practice.

2. Literature Review

A synthesis of peer-reviewed literature and contemporary practice guidance from the past two decades is presented across four environmental impact domains: waste, air, water, and noise. The review also incorporates recent developments in stormwater permitting and performance certification, with a focus on governance structures (who makes decisions), performance metrics (what should be measured), and proven implementation strategies (how actions are carried out). The discussion is supported by newly developed schematics, which are described in the following sections.

2.1 Construction Waste and Circularity

Beyond design-stage prevention, circular construction requires pre-demolition audits, selective deconstruction, and high-quality sorting to maximize material recovery and minimize hazards-practices increasingly codified in European guidance [3, 4].

Real-world example: WRAP’s offsite volumetric case projects documented significant reductions in site waste through standardized modules and factory-led QA/QC-highlighting how product platforms and logistics planning yield predictable outcomes.

Root causes of C&D waste-such as change orders, inaccurate take-offs, and poor coordination-should be managed with configuration control and standardized components to reduce rework and offcuts [5, 6].

Selective deconstruction, pre-demolition audits, and economic instruments elevate recovery value and minimize hazards in C&D streams [3, 4, 7].

Design-stage decisions-particularly unmanaged change orders and poor coordination-drive site waste; prevention begins with standardized components, configuration control, and prefabrication [6, 8].

Figure 2 illustrates the multi-dimensional classification framework used to structure the literature review. Studies are categorized simultaneously across life-cycle stages, environmental impact domains, and methodological approaches. This classification enables systematic comparison of research trends, identification of methodological biases, and recognition of regional disparities. For instance, LCA-based studies dominate material-related assessments in developed regions, whereas empirical monitoring studies are more prevalent in construction-phase analyses. The framework provides the foundation for critical synthesis and gap identification presented in this review.

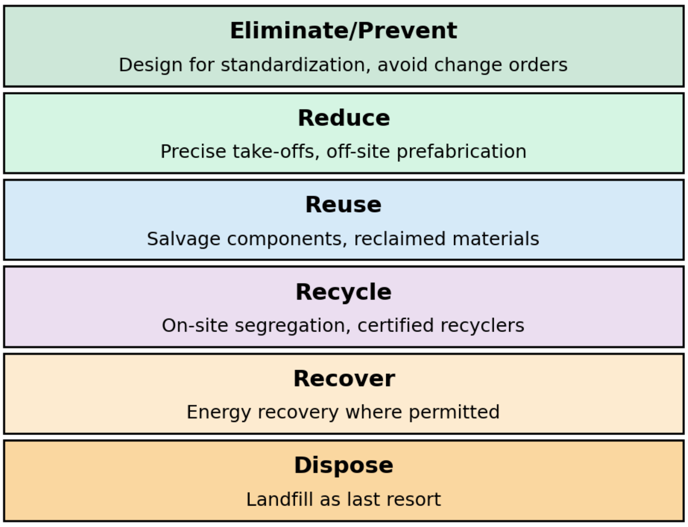

Figure 2 Construction Waste Management Hierarchy (Project-Level).

2.2 Air Pollution Across the Construction Life Cycle

Air pollution impacts in construction span multiple scales and lifecycle stages, involving distinct stakeholders, processes, and performance metrics. To improve clarity and analytical rigor, this study categorizes air-related impacts into three interconnected components: (1) on-site emissions during construction activities, (2) upstream emissions associated with material production and supply chains, and (3) operational-phase air quality and energy use. While each component differs in scale and control mechanisms, they are intrinsically linked through design decisions and project execution strategies.

2.2.1 Construction Phase: On-Site Emissions

On-site emissions are primarily generated from earthworks, demolition activities, material handling, and equipment operation. These include particulate matter (PM), dust, and combustionrelated pollutants from diesel-powered machinery. Mitigation strategies include wet suppression, wheel washing, equipment maintenance, electrification of tools, and traffic/logistics management to reduce congestion [9, 10].

2.2.2 Upstream Supply Chain Emissions

Material production-particularly cement and steel-accounts for a substantial share of lifecycle emissions. Recent innovations such as low-carbon concrete, geopolymer materials, and green steel demonstrate the potential to significantly reduce embodied carbon. Life Cycle Assessment (LCA) plays a critical role in evaluating these alternatives and guiding material selection [10-15].

2.2.3 Operational Phase: Indoor and Outdoor Air Quality

During the operational phase, HVAC systems, ventilation strategies, and building usage influence indoor and outdoor air quality. Commissioning, filtration technologies, and energy-efficient system design are essential to minimize emissions and protect occupant health [10, 15].

2.2.4 Cross-Lifecycle Interactions

Decisions made during the design stage-particularly material selection and building configuration-directly influence emissions across all three components. This demonstrates the importance of a lifecycle-integrated approach, where trade-offs between embodied and operational emissions must be carefully evaluated [11, 13, 14, 16].

2.3 Water Pollution: Stormwater and Runoff Control

Stormwater management translates environmental intent into site controls: under EPA's Construction General Permit (CGP), operators must prepare a SWPPP, submit an NOI via NeT, install BMPs, maintain inspection and records, implement corrective actions, and submit a NOT at completion [17].

Highway and site runoff transport sediments and sorbed toxics that reduce drainage capacity and impair aquatic ecosystems; effective controls combine source management with structural practices such as vegetated buffers, ponds, infiltration systems, constructed wetlands, and filters [18, 19].

In the U.S., the EPA's 2022 CGP operationalizes compliance through SWPPP preparation, NOI submission via NeT, BMP installation, inspections/records, corrective actions, and termination via NOT; a 2025 modification expanded eligibility in lands of exclusive federal jurisdiction [17].

Highway and site runoff transport sediments and sorbed toxics, reducing drainage capacity and impairing aquatic life; controls combine planning with vegetated buffers, ponds, infiltration, wetlands, and filters [18, 20].

Figure 3 presents a decision-support flowchart for implementing environmental interventions at the project level. The schematic links strategic objectives with regulatory requirements, certification pathways, and operational constraints. It integrates lifecycle-specific decisions with quantitative evaluation metrics, enabling project teams to assess trade-offs between cost, performance, and environmental outcomes. The iterative feedback loop ensures continuous improvement through monitoring and adaptive management, aligning project execution with sustainability targets.

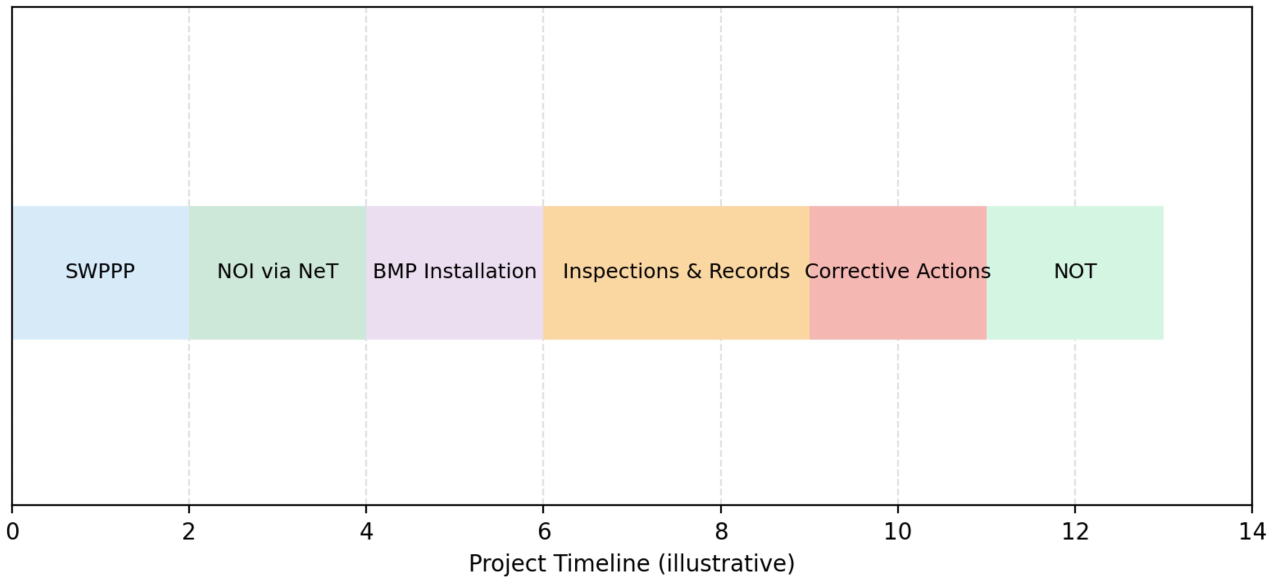

Figure 3 Stormwater Compliance Roadmap under EPA 2022 CGP.

2.4 Noise: Occupational and Community Health

OSHA limits and hearing conservation programs provide baseline worker protection, while site monitoring and time-of-day controls reduce community exposure [21, 22].

Construction noise has non-auditory health impacts-including cardiovascular stress and sleep disturbance-documented in clinical and epidemiological literature; mitigation must address source, path, and receiver [23, 24].

2.5 Performance Certification and Decarbonization Updates

LEED v4's 2024 energy update raises minimum performance thresholds and introduces dual metrics-source energy and GHG-alongside cost; on-site renewables now contribute toward prerequisite compliance, aligning v4 closer to v4.1 pathways [25, 26].

Real-world example: The UC Davis Manetti Shrem Museum of Art achieved LEED Platinum with significant reductions in energy and water use, waste diversion exceeding 80%, and transit/active mobility provisions-demonstrating how design, operations, and access policies combine for measurable environmental performance [25, 27].

LEED v4's 2024 energy update raises minimum performance thresholds and introduces dual metrics (source energy and GHG) alongside cost; on-site renewables now contribute to prerequisite compliance, aligning v4 more closely with v4.1 [25, 26].

2.6 BIM and LCA for Decision Support

Integrating BIM with LCA enables earlier, data-driven decisions on material and operational trade-offs; recent reviews catalog IFC exchange, BOQ imports, BIM viewers, and plugin workflows to calculate impacts within design environments [28].

Project teams should standardize data handoffs and select tools that support whole-life carbon metrics and circularity decisions-so configuration changes and product-platform choices are informed by quantified outcomes [28].

Recent reviews catalog IFC exchange, BOQ imports, BIM viewers, and plugin workflows that bring LCA into BIM environments, enabling earlier trade-offs on materials and operations; interoperability and standardization remain adoption barriers [28].

3. Methodology and Analysis

This study proposes an Integrated Life-Cycle Environmental Control Framework (ILECF) that systematically links environmental impact domains (waste, air, water, and noise) with project life-cycle stages (design, construction, operation, and end-of-life). Unlike prior reviews, the framework incorporates a systems engineering perspective, capturing interdependencies and feedback loops among decisions, environmental outcomes, and governance mechanisms. By structuring literature using methodological, regional, and lifecycle dimensions, the framework enables comparative analysis, identification of research gaps, and development of actionable guidance.

A peer-reviewed literature and current practice guidance across four impact domains-waste, air, water, and noise-and integrated updates in stormwater permitting and performance certification are synthesized covering the last 20 years. The focus is on governance (who decides), metrics (what to measure), and field-proven interventions (how to act), supported by newly designed schematics as discussed in the following sections.

4. Results

The following sections present the results of this study.

4.1 Decision Guide and Governance

Governance at feasibility should set configuration-freeze gates, interface matrices, and change-control boards; align procurement to factory slots and logistics windows to avoid idle modules or site crews [6].

Environmental due diligence should tie SWPPP/BMP commitments to CGP obligations and noise controls to OSHA/eCFR baselines; certification pathways (LEED v4 update, v4.1 substitutions) should be selected early to shape energy and GHG targets [17, 21, 22, 25, 26].

Sustainable construction outcomes depend on aligning decisions, metrics, and site practices across the life cycle-supported by policy frameworks and market guidance [1, 2].

By combining circular design, task-specific air and noise controls, stormwater compliance, and performance-based certification-enabled by BIM + LCA-projects can materially reduce environmental burdens while improving outcomes for workers and communities [3, 4, 28] (Table 1).

Table 1 Practical Decision-Making Guide.

Stage	Intervention	Metric	Cost Level	Applicability
Design	Prefabrication	Waste reduction%	Medium	Large projects
Construction	Dust suppression	PM reduction	Low	Universal
Operation	HVAC optimization	Energy use (kWh/m^2)	Medium	Buildings
End-of-life	Deconstruction	%reuse	Medium	Urban areas

The practical decision table synthesizes lifecycle-specific environmental interventions into a structured decision-support tool for project stakeholders. The table organizes recommended actions across the major phases of the project life cycle-design, construction, operation, and end-of-life-and evaluates each intervention based on performance metrics, implementation cost, and applicability conditions.

By integrating technical measures with decision criteria, the table translates the conceptual framework into an operational guide. For example, design-stage interventions such as prefabrication and modular construction are associated with measurable reductions in material waste and rework, while construction-phase measures such as dust suppression and stormwater controls are evaluated in terms of pollutant reduction efficiency and regulatory compliance. Operational-stage strategies, including HVAC optimization and energy performance monitoring, are linked to energy use intensity and indoor environmental quality metrics. End-of-life interventions, such as selective deconstruction and material recovery, are assessed based on reuse rates and circularity outcomes.

Importantly, the table provides a comparative perspective by indicating relative cost levels and implementation feasibility, enabling practitioners to balance environmental performance with economic and logistical constraints. This addresses a key gap in the literature, where recommendations are often presented in isolation without consideration of trade-offs or practical constraints.

Furthermore, the table supports stage-specific and scenario-based decision-making by clarifying which interventions are most effective under different project conditions (e.g., project size, regulatory context, and resource availability). By aligning interventions with measurable outcomes and decision criteria, the table enhances the usability of the review for industry practitioners and facilitates the development of tailored sustainable construction strategies.

Overall, the practical decision table operationalizes the integrated life-cycle framework presented in this study, bridging the gap between theoretical synthesis and real-world application, and providing a systematic foundation for evidence-based environmental management in construction projects.

5. Discussion

The following sections discuss the results of this study.

5.1 Practical Decision Framework for Sustainable Construction

To enhance practical applicability, this study translates the conceptual framework into a structured decision-support tool (Table 2). The table organizes lifecycle-specific environmental interventions and evaluates them based on measurable performance metrics, implementation cost, and applicability conditions.

Table 2 Lifecycle-Based Environmental Intervention and Decision Matrix.

Lifecycle Stage	Impact Domain	Intervention	Key Metric (Example Targets)	Decision Level	Cost Level	Implementation Complexity	Applicability	Co-benefits/ Trade-offs
Design	Waste	Prefabrication/Modular design	Waste reduction (%; 20-50%)	Strategic	Medium	Medium	Large/repetitive projects	↓ waste, ↑ quality; requires logistics planning
Design	Air	Low-carbon materials (geopolymer, green steel)	Embodied carbon ($kgCO_2/m^2$; ↓ 20-40%)	Strategic	Medium-High	Medium	All projects	↓ emissions; may ↑ material cost
Design	Water	Sustainable drainage design (SuDS)	Runoff reduction (%); TSS removal (%)	Strategic	Medium	Medium	Urban/regulated sites	↓ flooding risk; land requirement
Design	Noise	Site layout optimization	Noise level reduction (dB)	Strategic	Low	Low	Dense urban areas	↓ community disturbance
Construction	Waste	On-site sorting & recycling	Waste diversion rate (% >75%)	Operational	Low-Medium	Medium	Universal	↓ landfill; requires training
Construction	Air	Dust suppression (wetting, covering)	PM reduction (%; 30-80%)	Operational	Low	Low	Universal	Easy implementation; water use
Construction	Air	Equipment electrification	Emission reduction (%; 20-60%)	Tactical	Medium	Medium	Urban/regulated	↓ emissions, ↓ noise; ↑ capital cost
Construction	Water	Stormwater BMPs (sediment traps, barriers)	TSS removal efficiency (% >70%)	Compliance	Medium	Medium	Regulated sites	Compliance with EPA CGP
Construction	Noise	Time-of-day restrictions	Noise exposure compliance (dB limits)	Administrative	Low	Low	Urban projects	↓ complaints; ↓ productivity flexibility

Operation	Air	HVAC optimization & commissioning	Energy use intensity (kWh/m^2); IAQ index	Operational	Medium	Medium	Buildings	↓ energy + improved health
Operation	Water	Water reuse systems	Water use reduction (%; 20-40%)	Strategic	Medium	Medium	Institutional buildings	↓ utility cost
Operation	Noise	Acoustic insulation	Indoor noise levels (dB)	Operational	Medium	Low-Medium	Buildings	↑ occupant comfort
Operation	Waste	Facility waste management	Recycling rate (%)	Operational	Low	Low	All buildings	↓ waste disposal cost
End-of-Life	Waste	Selective deconstruction	Material recovery (%; 50-90%)	Strategic	Medium	High	Urban areas	Enables circular economy
End-of-Life	Air	Controlled demolition practices	Dust/emission reduction (%)	Operational	Medium	Medium	All projects	↓ environmental impact
End-of-Life	Water	Debris containment	Runoff contamination reduction (%)	Compliance	Low	Low	All projects	Prevents pollution
End-of-Life	Cross-domain	Material reuse markets	Circularity index (%)	Strategic	Medium	Medium	Regions with recycling infra	↓ resource extraction

Key quantitative indicators include embodied carbon ($kgCO_2/m^2$), waste diversion rates (%), particulate matter reduction efficiency (%), and noise exposure levels (dB thresholds). These metrics enable objective comparison of alternative interventions and support evidence-based decision-making.

By integrating environmental effectiveness with economic and operational considerations, the framework allows practitioners to balance sustainability goals with project constraints. This structured approach addresses a critical gap in existing literature, where recommendations are often presented without assessment of feasibility or trade-offs.

The practical decision table (Table 2) synthesizes lifecycle-specific interventions into a structured tool for project stakeholders. It links technical measures with performance metrics, cost considerations, and applicability conditions, enabling systematic evaluation of trade-offs. By aligning interventions with measurable outcomes, the table enhances decision-making transparency and supports tailored implementation strategies for different project contexts.

The inclusion of decision level, cost, and implementation complexity provides a structured hierarchy that supports multi-criteria decision-making and enables integration with digital tools such as BIM-LCA workflows.

While consensus exists on the importance of lifecycle thinking and circular practices, significant uncertainties remain. For example, trade-offs between embodied carbon reduction and operational performance are still debated, especially in rapidly urbanizing regions. Additionally, most empirical studies are concentrated in Europe and North America, leaving a critical gap in context-specific knowledge for developing economies.

6. Conclusions, Policy Implications and Future Works

The construction industry is a cornerstone of community development and economic progress, yet its activities exert considerable pressure on the environment. Among the most pressing concerns is the generation of construction and demolition waste, which can lead to soil and water contamination, depletion of natural resources, and degradation of ecosystems and landscapes. Improper disposal of this waste often introduces hazardous substances-such as heavy metals, asbestos, and volatile compounds-into landfills, amplifying risks to human health and nearby communities. These impacts underscore the urgent need to address the environmental footprint of construction and safeguard public well-being.

Sustainable construction practices and robust waste management strategies provide a viable pathway to mitigate these challenges. By integrating resource-efficient design, circular economy principles, and environmentally responsible technologies, the industry can significantly reduce its ecological burden. Moving forward, innovation and collaboration are essential to align construction processes with sustainability goals, ensuring that future generations inherit a habitable planet.

Each schematic was developed based on synthesis of literature and practice. For example, the governance-flow schematic integrates policy requirements (e.g., EPA CGP), certification systems (LEED), and project-level decisions to guide implementation across lifecycle stages.

The structured integration of interventions, metrics, and constraints also enables future development of decision-support systems and digital tools, particularly when combined with BIM and LCA-based analytics.

To advance sustainable development in construction, several strategic actions are recommended:

- Prioritize materials with low embodied energy and high recyclability, such as certified timber, recycled aggregates, and green steel. These choices reduce waste generation and conserve finite resources.
- Adopt design frameworks that minimize energy consumption, optimize water use, and incorporate passive strategies for heating and cooling. Certification systems like LEED or BREEAM can guide projects toward measurable sustainability outcomes.
- Construction logistics and workforce mobility contribute significantly to carbon emissions. Encouraging public transit, carpooling, and cycling for site personnel, along with optimizing delivery routes, can reduce the sector's transportation footprint.
- Training architects, engineers, contractors, and clients on sustainable design principles and life-cycle thinking is critical. A culture of sustainability within project teams fosters informed decision-making and long-term environmental stewardship.

These recommendations should be supported by rigorous research and pilot projects to validate their effectiveness and scalability. By embedding sustainability into every phase of construction-from design to demolition-the industry can enhance quality of life while preserving ecological integrity.

Author Contributions

Dr. Vinayak Kaushal conceived the review topic, designed the review framework, and supervised the study. Ms. Allison Pham conducted the literature search, screened the articles, and synthesized the findings. Dr. Vinayak Kaushal and Dr. Allison Pham jointly wrote the manuscript. Both authors reviewed, revised, and approved the final manuscript.

Competing Interests

The authors have declared that no competing interests exist.

AI-Assisted Technologies Statement

During the preparation of this work, the authors used Grammarly and GPT-4o to check for plagiarism and grammar. After using these tools, the authors carefully reviewed and edited all content and take full responsibility for the final version of the manuscript.

References

1. United Nations Environment Programme. Global status report for buildings and construction 2024/2025 [Internet]. Nairobi, Kenya: UNEP; 2025. Available from: https://www.unep.org/resources/report/global-status-report-buildings-and-construction-20242025.
2. World Green Building Council. A year of leadership and delivery: WorldGBC annual report 2024/2025 [Internet]. London, UK: WorldGBC; 2025. Available from: https://worldgbc.org/article/worldgbc-annual-report-2024-2025/.
3. European Commission, Joint Research Centre. Techno-economic and environmental assessment of construction and demolition waste management in the European Union [Internet]. Brussels, Belgium: European Commission, Joint Research Centre; 2024. Available

from: https://op.europa.eu/en/publication-detail/-/publication/01f8ebe4-b104-11ee-b164-01aa75ed71a1/language-en.

4. Interreg Europe. Policy brief: Sustainable and circular construction [Internet]. Lille, France: Interreg Europe; 2024. Available from: https://www.interregeurope.eu/find-policy-solutions/policy-briefs/sustainable-circular-construction.
5. Nagapan S, Rahman IBA, Asmi A. A review of construction waste cause factors. Prcoeedings of the Asian Conference on Real Estate: Sustainable Growth Managing Challenges (ACRE); 2011 October 03-05; Johor Bahru, Malaysia. Berlin, Germany: Springer.
6. Osmani M, Glass J, Price AD. Architects' perspectives on construction waste reduction by design. Waste Manage. 2008; 28: 1147-1158.
7. Polat G, Damci A, Turkoglu H, Gurgun AP. Identification of root causes of construction and demolition (C&D) waste: The case of Turkey. Procedia Eng. 2017; 196: 948-955.
8. Gulghane AA, Khandve P. Management for construction materials and control of construction waste in construction industry: A review. Int J Eng Res Appl. 2015; 5: 59-64.
9. Wu Z, Zhang X, Wu M. Mitigating construction dust pollution: State of the art and the way forward. J Clean Prod. 2016; 112: 1658-1666.
10. Wieser AA, Scherz M, Passer A, Kreiner H. Challenges of a healthy built environment: Air pollution in construction industry. Sustainability. 2021; 13: 10469.
11. Cover J. Mass timber: The new sustainable choice for tall buildings. Int J High-Rise Build. 2020; 9: 87-93.
12. Oliver CD, Nassar NT, Lippke BR, McCarter JB. Carbon, fossil fuel, and biodiversity mitigation with wood and forests. J Sustain For. 2014; 33: 248-275.
13. Iberdrola. Green steel: a material ready for industrial decarbonisation and widening the horizons of electrification [Internet]. Bilbao, Spain: Iberdrola; 2021. Available from: https://www.iberdrola.com/sustainability/green-steel.
14. Muslemani H, Liang X, Kaesehage K, Ascui F, Wilson J. Opportunities and challenges for decarbonizing steel production by creating markets for 'green steel' products. J Clean Prod. 2021; 315: 128127.
15. Schuldt SJ, Nicholson MR, Adams YA, Delorit JD. Weather-related construction delays in a changing climate: A systematic state-of-the-art review. Sustainability. 2021; 13: 2861.
16. Singh JK, Rout AK. Advances in green steel making technology-a review. Am J Mater Eng Technol. 2018; 6: 8-13.
17. U.S. Environmental Protection Agency (EPA). Modification to 2022 NPDES Construction General Permit (CGP) [Internet]. Washington, D.C.: Federal Register; 2025. Available from: https://www.federalregister.gov/documents/2025/04/15/2025-06320/modification-to-2022-national-pollutant-discharge-elimination-system-npdes-construction-general.
18. Barrett ME. A review and evaluation of literature pertaining to the quantity and control of pollution from highway runoff and construction. Darby, PA: Diane Publishing; 1995.
19. Belayutham S, Gonzalez VA, Yiu TW. A cleaner production-pollution prevention based framework for construction site induced water pollution. J Clean Prod. 2016; 135: 1363-1378.
20. Belayutham S, Gonzalez VA, Yiu TW. The dynamics of proximal and distal factors in construction site water pollution. J Clean Prod. 2016; 113: 54-65.

21. Occupational Safety and Health Administration. Occupational Noise Exposure-Noise in Construction [Internet]. Washington, D.C.: OSHA; [cited date 2025 December 27]. Available from: https://www.osha.gov/noise/construction.
22. eCFR. §1910.95 Occupational noise exposure [Internet]. Washington, D.C.: Federal Register; 2019 [cited date 2025 December 26]. Available from: https://www.ecfr.gov/current/title-29/subtitle-B/chapter-XVII/part-1910/subpart-G/section-1910.95.
23. Bello JP, Silva C, Nov O, Dubois RL, Arora A, Salamon J, et al. Sonyc: A system for monitoring, analyzing, and mitigating urban noise pollution. Commun ACM. 2019; 62: 68-77.
24. Razai MS, King E, Majeed A, James P. The impact of noise pollution on health. BMJ. 2025; 391: e081193.
25. U.S. Green Building Council. Applying the LEED v4 energy update to your project [Internet]. Washington, D.C.: USGBC; 2024. Available from: https://support.usgbc.org/hc/en-us/articles/24332416264595-Applying-the-LEED-v4-energy-update-to-your-project.
26. Canada Green Building Council. LEED v4 → LEED v4.1 Credit Mapping: Operations + Maintenance [Internet]. Ottawa, Canada: CaGBC; 2024. Available from: https://www.cagbc.org/wp-content/uploads/2024/01/LEED_v4_Credit_Mapping_Booklet.pdf.
27. UC Davis Manetti Shrem Museum of Art. Careers at USGBC [Internet]. Davis, CA: UC Davis Manetti Shrem Museum of Art; [cited date 2025 December 28]. Available from: https://www.usgbc.org/about/careers.
28. Chen Z, Chen L, Zhou X, Huang L, Sandanayake M, Yap PS. Recent technological advancements in BIM and LCA integration for sustainable construction: A review. Sustainability. 2024; 16: 1340.