Artificial Intelligence for Green Construction: An Islamic Ethical Framework Based on Maqāṣid al-Sharī'ah and Ḥifẓ al-Bī'ah

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Abstract

The construction industry faces growing pressure to improve resource efficiency and reduce environmental impacts throughout the building life cycle. Artificial intelligence (AI) offers opportunities to support these objectives through design optimization, energy prediction, resource-use monitoring, material selection, and waste management. However, technical efficiency alone does not guarantee environmental benefits or responsible technological adoption. This study develops a conceptual framework for evaluating AI applications in green construction by integrating environmental performance considerations with the ethical principles of Maqāṣid al-Sharī'ah, particularly Ḥifẓ al-Bī'ah (protection of the environment). It employs a qualitative conceptual-normative approach based on a focused interdisciplinary synthesis of literature on AI in construction, environmental sustainability, responsible AI, and Islamic ethical thought. The synthesis connects AI capabilities with five environmental performance dimensions: energy efficiency, water conservation, material efficiency, waste reduction, and life-cycle environmental impacts. These dimensions are interpreted through maṣlaḥah (benefit), prevention of mafsadah (harm), environmental responsibility, and human welfare. The proposed framework comprises four components: AI capabilities, environmental performance indicators, Islamic ethical evaluation, and responsible implementation. Its central contribution is to position ethical principles as guidance for selecting, implementing, and evaluating AI applications rather than as an afterthought. The framework also emphasizes measurable outcomes, explicit system boundaries, and potential trade-offs. As a conceptual proposal, it requires further assessment through expert consultation, case studies, and empirical research. It provides a foundation for responsible AI adoption in sustainable construction.

Keywords: artificial intelligence, green construction, maqāṣid al-sharī'ah, ḥifẓ al-bī'ah, environmental sustainability

Introduction

The built environment is central to contemporary sustainability debates because buildings and construction systems require substantial material and energy inputs and affect water use, waste generation, and greenhouse-gas emissions throughout their life cycles. The United Nations Environment Programme and Global Alliance for Buildings and Construction continue to identify decarbonization, low-carbon materials, energy efficiency, and circular construction as priorities for the sector (United Nations Environment Programme [UNEP] & Global Alliance for Buildings and Construction [GlobalABC], 2025). Green construction therefore requires coordinated decisions across planning, design, procurement, construction, operation, maintenance, renovation, and end-of-life management rather than isolated choices about individual products.

Artificial intelligence (AI) offers analytical capabilities that may support these decisions. Machine learning can be used for prediction and classification; computer vision can support monitoring; optimization algorithms can compare design alternatives; and data-driven systems can assist energy management, maintenance planning, and material-flow analysis. Reviews document AI applications across construction engineering and management and across the building life cycle, although the maturity and environmental evidence of these applications vary by task and context (Abioye et al., 2021; Adewale et al., 2024; Datta et al., 2024; Pan & Zhang, 2021; Regona et al., 2024). Research on AI-based decision-support systems also shows that construction sustainability assessment has historically emphasized economic objectives, making balanced environmental and social evaluation important (Smith & Wong, 2022).

AI should not, however, be treated as inherently sustainable. An algorithm may optimize a narrow variable while shifting environmental burdens to another life-cycle stage. Lower operational energy use, for example, may be accompanied by additional embodied impacts from materials or equipment. AI systems also depend on data, sensors, computing infrastructure, and organizational capability. Their use raises questions about reliability, transparency, privacy, accountability, and human oversight (Elmahjub, 2023; International Organization for Standardization & International Electrotechnical Commission, 2023; Organisation for Economic Co-operation and Development, 2019; UNESCO, 2021). Environmental claims must therefore be linked to appropriate indicators and boundaries, with attention to both anticipated and measured outcomes.

Islamic ethical thought offers a normative vocabulary for examining the purposes and consequences of such decisions. Maqāṣid al-Sharī‘ah concerns the purposes of Islamic law and the realization of human and social welfare. A systems-oriented approach emphasizes interrelatedness, multidimensionality, openness, and purposefulness in legal and ethical reasoning (Auda, 2008). Contemporary scholarship discusses environmental protection through ḥifẓ al-bī’ah and relates ecological responsibility to broader Islamic ethical principles (Kamali, 2025; Khuluq & Asmuni, 2025). In this paper, ḥifẓ al-bī’ah is used as an explicit contemporary environmental orientation; the paper does not assume that all scholars classify it identically within the classical hierarchy of the necessities.

A research opportunity lies in connecting three discussions that are often addressed separately: AI applications in construction, measurable environmental performance, and Islamic ethical evaluation. Existing reviews map construction-related AI capabilities and sustainability applications (Adewale et al., 2024; Awuzie et al., 2024; Oluleye et al., 2023), while Islamic

ethical scholarship develops normative approaches to technology and environmental responsibility (Elmahjub, 2023; Khuluq & Asmuni, 2025). This study proposes an integrated framework and addresses three research questions: (1) How can AI support resource efficiency and environmental performance across the construction life cycle? (2) How can Maqāṣid al-Sharī'ah, particularly ḥifẓ al-bī'ah, inform the ethical evaluation of AI applications in green construction? (3) How can AI capabilities, environmental indicators, and Islamic ethical principles be integrated into a conceptual framework for responsible green construction?

The contribution is conceptual and normative rather than empirical. The paper links AI capabilities to five environmental dimensions—energy, water, materials, waste, and life-cycle impacts—and interprets them through maṣlaḥah, prevention of mafsadah, environmental responsibility, and human welfare. It does not claim that the proposed framework has been empirically validated or that AI necessarily produces environmental benefits.

Methods

Research Design

This study uses a qualitative conceptual-normative design. It does not test a particular AI system, collect project-level environmental data, or estimate the causal effect of AI adoption. Instead, it develops a conceptual synthesis connecting technological functions, environmental performance, and Islamic ethical principles. This approach is suitable for clarifying constructs and proposing relationships for subsequent validation.

Literature Identification and Selection

The literature was identified through targeted scholarly searches and publisher or institutional pages available during manuscript development. The search focused on four intersecting areas: (1) AI and machine learning in construction; (2) green construction, building performance, circularity, and life-cycle assessment; (3) AI ethics and governance; and (4) Maqāṣid al-Sharī'ah and Islamic environmental ethics. Search phrases included combinations of 'artificial intelligence' and 'construction', 'AI' and 'sustainable buildings', 'AI' and 'construction sustainability', 'life-cycle assessment' and 'buildings', 'Maqāṣid al-Sharī'ah' and 'environment', and 'ḥifẓ al-bī'ah' and 'sustainability'. Sources were retained when they directly informed at least one of the framework's technological, environmental, or ethical components. Priority was given to peer-reviewed review articles, relevant scholarly books, international standards, and institutional publications.

This is a focused conceptual synthesis, not a systematic review. No PRISMA-style screening process, exhaustive database coverage, or complete record count is claimed. The literature identification was not conducted as a documented Scopus/Web of Science search protocol; therefore, database-specific coverage and indexing status must not be inferred from this method. The framework and claims should be read within these boundaries.

Analytical Procedure

The synthesis proceeded in four analytical steps. First, AI capabilities were organized into prediction, design optimization, monitoring, decision support, and waste-related analysis. Second, potential environmental outcomes were grouped into energy efficiency, water conservation, material efficiency, waste reduction, and life-cycle environmental impacts. Third, these outcomes were interpreted through ḥifẓ al-bī'ah, maṣlaḥah, prevention of mafsadah, and human welfare, while recognizing that ethical principles cannot be reduced automatically to a

single quantitative score. Fourth, the components were integrated into an iterative framework in which ethical considerations inform technology selection and evaluation before implementation, while measured outcomes and emerging risks inform subsequent revision.

Analytical Rigor and Scope

To avoid overstating the findings, the manuscript distinguishes literature-supported observations from normative interpretation and author-proposed relationships. Environmental indicators are illustrative and should be selected according to project type, data availability, and defined system boundaries. The framework is not a validated instrument, certification scheme, or substitute for engineering standards, life-cycle assessment, or professional judgment. Further validation is required through expert consultation and application to real construction cases.

Results

AI Capabilities in Green Construction

The synthesis identifies five AI capabilities relevant to green construction: predictive analysis, design optimization, resource-use monitoring, decision support, and waste-related analysis. These categories organize applications described across construction and building-life-cycle reviews (Abioye et al., 2021; Adewale et al., 2024; Datta et al., 2024; Pan & Zhang, 2021; Regona et al., 2024). Predictive analysis may support energy-demand forecasting, maintenance planning, and material-demand estimation. Design optimization may compare building configurations, material quantities, or construction alternatives against specified objectives. Monitoring may analyze sensor, building-management, equipment, or site data to identify abnormal consumption and deviations from planned performance. Decision support may help stakeholders compare material, energy-system, and construction-method alternatives. Waste-related analysis may support forecasting, classification, and identification of opportunities for reuse or recycling (Awuzie et al., 2024; Oluleye et al., 2023).

These capabilities provide informational and analytical support rather than guaranteed environmental outcomes. Their contribution depends on data quality, the objective optimized, the reliability of outputs, organizational capacity, and whether decision-makers act on the results. A prediction of energy savings is not equivalent to measured savings; a material recommendation must still meet safety, durability, and serviceability requirements.

Environmental Performance Dimensions

Five environmental dimensions are used to assess the potential or demonstrated contribution of AI. Energy efficiency can be examined through energy consumption, energy intensity, and savings against a stated baseline. Water conservation may be assessed through total water use, water intensity, leakage, and appropriate reuse. Material efficiency may be examined through material intensity, avoidable losses, reuse or recycled content, and embodied impacts. Waste reduction may use waste generated per unit of floor area, waste prevention, reuse/recycling rates, and disposal quantities. Life-cycle environmental impacts may include embodied carbon, operational greenhouse-gas emissions, life-cycle energy, and other context-relevant impacts. Life-cycle assessment standards provide a methodological basis for defining goals, system boundaries, and impact assessment (European Commission, 2021; International Organization for Standardization [ISO], 2006a, 2006b; Cabeza et al., 2014).

The dimensions should be interpreted together where feasible. An intervention that reduces operational energy may increase material demand; recycling may divert waste without

eliminating all environmental impacts; and an AI system itself may require electricity, sensors, data storage, and equipment. Accordingly, the proposed framework emphasizes transparent boundaries, suitable baselines, and disclosure of trade-offs rather than reliance on a single indicator. The present study does not conduct a project-specific life-cycle assessment or calculate numerical environmental savings.

Islamic Ethical Principles for Environmental Evaluation

Maqāṣid al-Sharī'ah supplies a normative orientation for evaluating technological decisions in relation to purpose, benefit, harm, and human welfare. A systems approach encourages attention to interdependence and the wider consequences of decisions rather than treating each performance objective in isolation (Auda, 2008). In this framework, ḥifẓ al-bī'ah is the central environmental orientation, connecting construction decisions to ecological protection and responsible resource use. Contemporary scholarship discusses its relationship to climate change and broader maqāṣid reasoning, while acknowledging ongoing conceptual development (Kamali, 2025; Khuluq & Asmuni, 2025).

Maṣlaḥah directs attention to meaningful benefits, such as resource conservation, improved building performance, and reduced material loss. Mafsadah directs attention to foreseeable harms, including environmental burden shifting, unreliable outputs, unsafe recommendations, privacy risks, and overreliance on automated decisions. Human welfare and accountability require that AI-supported decisions remain subject to professional review and that responsibility remain attributable to the people and institutions deploying the technology. These ethical considerations complement, rather than replace, engineering standards and environmental evidence. Broader AI ethics literature similarly emphasizes transparency, responsibility, fairness, and human oversight (Elmahjub, 2023; Floridi et al., 2018; Jobin et al., 2019; National Institute of Standards and Technology [NIST], 2023; UNESCO, 2021).

The Proposed Conceptual Framework

The synthesis yields a four-component framework: (1) AI capabilities; (2) environmental performance indicators; (3) Islamic ethical evaluation; and (4) responsible implementation. The framework is iterative rather than a simple linear chain. Ethical principles inform the choice of technology and objectives at the outset; indicators are then used to assess anticipated or measured outcomes; ethical review examines the significance of benefits, harms, and trade-offs; and implementation results inform monitoring and revision.

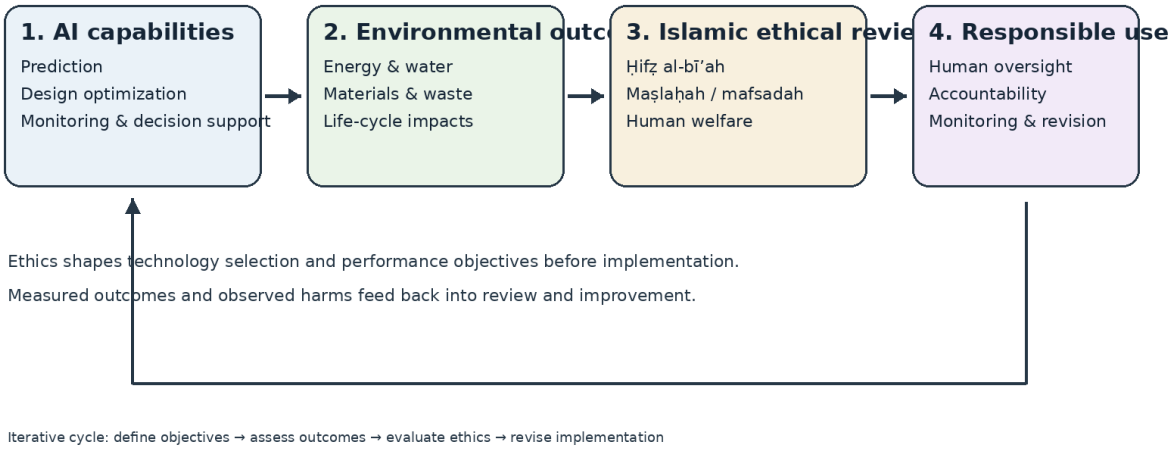
Table 1. Components of the proposed Islamic ethical framework for AI-enabled green construction

Component	Main focus	Illustrative indicators or questions	Function
1. AI capabilities	Prediction, optimization, monitoring, decision support, waste analysis	What task is AI performing? Are data and outputs reliable?	Identify the technological function and potential contribution
2. Environmental performance	Energy, water, materials, waste, life-cycle impacts	Energy/water use; material intensity; waste generated; embodied and operational impacts	Set measurable objectives and evaluate outcomes
3. Islamic ethical evaluation	Ḥifẓ al-bī'ah, maṣlaḥah, prevention of mafsadah, human welfare	Are benefits meaningful? Are harms prevented? Who bears risks and receives benefits?	Interpret environmental outcomes normatively
4. Responsible implementation	Governance, human oversight, accountability, monitoring	Are decisions reviewable? Are claims verified? Are responsibilities assigned?	Guide implementation and continuous improvement

Source: Developed by the author through conceptual synthesis of the literature.

The framework links technical functions to measurable environmental objectives and then to normative evaluation and implementation decisions. It distinguishes potential contribution from demonstrated performance: predicted improvements require verification against an appropriate baseline, while observed outcomes must be interpreted within stated system boundaries. Environmental indicators inform ethical judgments, and ethical principles influence which indicators, trade-offs, and stakeholder impacts should be considered. The framework is therefore an analytical guide, not an empirically validated scoring model.

Figure 1. Proposed conceptual framework for responsible AI-enabled green construction.



Discussion

Beyond Technical Efficiency

The framework distinguishes technical efficiency from environmentally responsible technological adoption. AI may support design optimization, resource prediction, and monitoring, but its environmental contribution depends on what is optimized and which consequences are included. Construction reviews document a wide range of AI applications, while sustainability-focused studies highlight the need to evaluate economic, environmental, and social objectives together (Abioye et al., 2021; International Energy Agency, 2023; Kibert, 2016; Smith & Wong, 2022; World Green Building Council, 2019). A system that minimizes operational energy without accounting for embodied impacts may shift rather than eliminate environmental burdens.

Life-cycle thinking is therefore essential. The environmental costs of digital infrastructure should be considered when material to the application, and the evaluation should distinguish anticipated benefits from measured outcomes. This approach is consistent with life-cycle assessment principles that require explicit goals, boundaries, and transparent interpretation (ISO, 2006a, 2006b). AI should be considered conditionally useful—not automatically sustainable—when its outputs are relevant, reliable, acted upon, and assessed against suitable environmental criteria.

Integrating Maqāṣid al-Sharī'ah and Ḥifẓ al-Bī'ah

The integration of maqāṣid introduces a normative dimension that extends beyond measuring environmental performance. Indicators can show whether energy use or waste has changed, but

ethical reasoning helps evaluate why those outcomes matter, who benefits, who bears the risks, and which harms require prevention. A systems-oriented understanding of maqāṣid supports attention to interrelated purposes and consequences (Auda, 2008). In this framework, ḥifẓ al-bī'ah directs attention to ecological responsibility; maṣlaḥah focuses on meaningful benefits; and prevention of mafsadah highlights foreseeable harms and unintended consequences.

The framework does not claim that Islamic principles replace engineering standards or empirical evidence, nor does it present a universal religious-compliance test for algorithms. Instead, ethical principles inform the selection and interpretation of environmental objectives and encourage accountability throughout implementation. This distinction permits a productive dialogue between Islamic ethical thought, environmental assessment, and responsible AI governance (Elmahjub, 2023; International Organization for Standardization & International Electrotechnical Commission, 2023; Organisation for Economic Co-operation and Development, 2019; UNESCO, 2021).

Theoretical Contributions and Practical Implications

The study offers three conceptual contributions. First, it connects AI capabilities to explicit environmental performance dimensions rather than treating adoption itself as evidence of sustainability. Second, it positions ḥifẓ al-bī'ah as a contemporary environmental orientation within a maqāṣid-informed evaluation, while acknowledging ongoing scholarly discussion about its conceptual status. Third, it proposes a practical structure linking technology, indicators, ethical interpretation, and responsible implementation. This responds to calls for improved integration of AI, circularity, and decarbonization in the built environment (Awuzie et al., 2024; Oluleye et al., 2023).

For project owners and developers, the framework suggests requiring AI proposals to identify the environmental problem, define performance indicators, disclose data limitations, and establish monitoring procedures. For engineers, AI-generated alternatives should be assessed against safety, durability, serviceability, applicable standards, and environmental trade-offs. For policymakers and sustainability assessors, AI-related sustainability claims should be transparent about baselines and boundaries. For Islamic scholars and institutions, the framework offers a basis for interdisciplinary engagement in which normative principles guide deliberation while engineering evidence supports performance claims. These implications remain proposals and have not been tested empirically in this study.

Limitations and Future Research

The study is conceptual and has not been validated through expert consensus, project case studies, or measured outcomes. The five environmental dimensions do not exhaust all possible impacts; biodiversity, land use, local air quality, and ecological disturbance may be relevant in particular contexts. The interpretation and operationalization of ḥifẓ al-bī'ah also require further scholarly examination. Moreover, concepts such as maṣlaḥah and mafsadah should not be reduced automatically to numerical scores. Future research should seek interdisciplinary expert feedback, apply the framework to selected AI applications, develop context-specific indicators, and compare its usefulness with established sustainability assessment and AI-governance approaches.

Conclusion

This study proposes a conceptual framework for evaluating AI applications in green construction through the integration of environmental performance assessment and Islamic ethical principles. The framework connects AI capabilities with five environmental dimensions, energy efficiency, water conservation, material efficiency, waste reduction, and life-cycle environmental impacts and evaluates these dimensions through ḥifẓ al-bī'ah, maṣlaḥah, prevention of mafsadah, and human welfare. Its principal contribution is to position ethical evaluation as an integral part of technology selection, implementation, and review rather than as an afterthought. The framework does not establish that AI necessarily produces environmental benefits and has not been empirically validated. Future research should assess its conceptual clarity through expert consultation, apply it to real construction projects, and develop transparent procedures for evaluating outcomes and trade-offs. The proposed approach provides a foundation for more accountable and environmentally responsible AI adoption in green construction.

Conflict of Interests

The author declares no conflict of interest.

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