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Reconstructing the PAI-STEAM Curriculum Based on *Maqāshid Al-Sharīʿa* in Civil Engineering Programs at Public Universities

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ABSTRACT

The construction sector in Indonesia faces an ethical crisis spanning structural failures that endanger life, pervasive corruption, and ecological degradation, problems that are fundamentally moral rather than merely technical. Islamic Religious Education (PAI) in public universities is institutionally positioned to address this crisis, yet in engineering faculties it remains normative-textual and epistemologically isolated from students' technical disciplines. This study aims to reconstruct an integrated PAI-STEAM curriculum for civil engineering programs by operationalizing the *maqāshid al-sharīʿa* as an ethics of infrastructure engineering aligned with global accreditation standards. Employing qualitative library research with a philosophical-hermeneutic approach, the study analyzes Islamic juridical sources and engineering-accreditation documents through transdisciplinary content analysis and creative synthesis. The study yields three principal results. First, integration requires dissolving the dichotomy of knowledge at the epistemological level, repositioning engineering laws as *sunnat Allāh* and the STEAM "Arts" component as an axiological gateway for ethical values. Second, the five *maqāshid* pillars (*hifdz al-nafs, hifdz al-bī'ah, hifdz al-māl, hifdz al-ʿaql,* and *hifdz al-dīn*) map onto assessable engineering domains that correspond directly to IABEE accreditation criteria, consolidated in a Complementarity Matrix. Third, an Integrated Project-Based Learning model (IPBL-OBE), anchored in a Green Eco-Mosque capstone project, translates these correspondences into measurable graduate outcomes. The study contributes a novel epistemological framework and a ready curriculum template, repositioning PAI from an accreditation-neutral formality into a substantive accreditation asset. The proposed framework is intended to serve as a practical reference for curriculum developers, PAI lecturers, and engineering faculty seeking to design accreditation-aligned, values-based learning experiences, while acknowledging that its pedagogical claims await empirical validation.

Introduction

The field of civil engineering in Indonesia today sits at the center of a real and costly ethical crisis. In the domain of public safety, a series of structural failures continues to claim lives. On 29 September 2025, a three-storey prayer hall at the Al-Khoziny Islamic boarding school in Sidoarjo, East Java, collapsed while students were performing the afternoon prayer,

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killing sixty-seven of them; the National Search and Rescue Agency attributed the disaster to construction failure, noting the absence of a staged support structure capable of bearing the load (Liputan6.com, 2025). Technical observers subsequently emphasized that the building had been vertically extended without a building permit and that its third floor had only just been cast: an accumulation of structural and procedural negligence rather than a single accident (Kompas, 2025).

The roots of this problem are frequently entangled with the moral dimension. The construction sector is among the most corruption-prone in Indonesia. Indonesia Corruption Watch consistently records procurement of construction goods and services as a leading locus of graft in its annual monitoring of corruption trends (ICW, 2024), and a study of industry actors found that 76 percent of respondents regarded construction projects as highly vulnerable to manipulation, from budgeting through to the tendering process (Prastica, 2024). This pattern is not unique to Indonesia: a review of the global literature similarly identifies the construction sector as persistently corruption-prone across both developed and developing economies (Monteiro et al., 2022). Such practices directly degrade the physical quality of infrastructure and, in turn, endanger the public. In the ecological domain, the sector's burden is no less severe: according to the United Nations Environment Programme, the buildings and construction sector accounts for roughly 37 percent of global energy-related carbon dioxide emissions, consumes about a third of the world's energy, and is responsible for nearly half of global material extraction (Kementerian Pekerjaan Umum, 2025).

These three problems (structural failures that threaten life, corruption that erodes public wealth, and environmental damage) are, at their core, ethical and spiritual in nature, not purely technical. This is precisely where Islamic Religious Education (*Pendidikan Agama Islam*, PAI) in public universities ought to assume a strategic role. PAI carries a prophetic mission to cultivate students who pair ritual devotion with professional integrity, a mission that matters most in a discipline such as civil engineering, which bears direct responsibility for building the physical infrastructure of civilization.

In practice, however, a wide gap separates the ideal function of PAI from the reality of its delivery within engineering faculties. PAI instruction in public universities often remains confined to a normative-textual approach that emphasizes cognitive and ritual dimensions alone, while neglecting the applied dimension that would connect it to the disciplines students actually pursue (Hadi, 2025). PAI is often taught as a self-contained entity, an *academic silo*, isolated from the realities of science and technology, so that civil engineering students come to regard the course as a mere formality for fulfilling credit requirements rather than a moral compass for their engineering practice. At the root of this lies the paradigm of epistemological dichotomy that remains deeply embedded in the higher education system.

At the same time, the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) has emerged as a paradigm of knowledge integration for solving complex problems. Within the discourse of Islamic education, a number of studies have successfully wedded STEAM to Islamic values (Adiyono et al., 2024). These studies, however, have so far been confined largely to primary education, madrasahs, and the pure sciences. Meanwhile, in the domain of contemporary *maqāshid al-sharīʿa*, Jasser Auda's thought (which conceives of the *sharīʿa* as an open and dynamic system) has been widely applied to the fields of law, quality management, and the digitalization of education (Sanusi, 2025). In the domain of engineering ethics, efforts to Islamize engineering education have likewise begun to take shape, for instance through the integration of the value of *tawhīd* into the technical terminology of engineering coursework (Radzol & Hamzah, 2023).

Nevertheless, no study to date has systematically brought these three domains together (PAI-STEAM integration, the operationalization of contemporary *maqāshid al-sharīʿa*, and global engineering accreditation standards) specifically within a heavy-engineering discipline such as civil engineering. This vacancy constitutes the novelty of the present study. A very recent and closely related effort proposes embedding Tawhidic epistemology into general engineering curricula in alignment with IEA Graduate Attributes (Gunawan, 2026); the present study differs by focusing specifically on civil engineering, by systematically mapping

the five *maqāshid* pillars onto IABEE accreditation criteria, and by proposing an accompanying project-based curriculum model. Rather than stopping at a general alignment of values, this study operationalizes the pillars of *maqāshid al-sharīʿa: hifdz al-māl* (preservation of wealth), *hifdz al-ʿaql* (preservation of intellect), *hifdz al-dīn* (preservation of religion), and *hifdz al-bīʾah* (preservation of the environment), into measurable technical parameters of infrastructure engineering, and links them directly to the IABEE and JABEE accreditation criteria through a concrete project-based curriculum model.

On the basis of this background, this conceptual-philosophical study is guided by three central questions. First, how can the integration of PAI-STEAM be epistemologically reconstructed within the discipline of civil engineering at public universities? Second, how can the values of contemporary *maqāshid al-sharīʿa* be operationalized into an ethics of infrastructure engineering that aligns with IABEE/JABEE accreditation standards? Third, how can an applicable PAI-STEAM curriculum model be formulated amid the structural constraints of university bureaucracy?

In line with these questions, this study aims to formulate an epistemological framework for PAI-STEAM integration for civil engineering students, to construct an operationalization of *maqāshid al-sharīʿa* as an ethics of infrastructure engineering compatible with global accreditation, and to formulate an implementable curriculum model that may serve as a strategic reference for curriculum developers in public universities.

The Prophetic Mission and Implementation Gaps of PAI in Public Universities

Within the Indonesian higher-education system, Islamic Religious Education (PAI) is a compulsory component of the national curriculum for all students, regardless of discipline. Its mandate extends beyond doctrinal transmission, aiming to shape graduates whose technical competence is anchored in ethical and spiritual maturity. In engineering faculties, however, this mandate is rarely realized. PAI is frequently delivered through a normative-textual model that privileges doctrinal transmission and ritual correctness while leaving untouched the professional and scientific worlds its students inhabit. The result is a pedagogical disconnect, in which instruction is administratively obligatory yet professionally irrelevant to the students who sit through it.

This disconnect is symptomatic of a deeper structural condition in which the dichotomy of knowledge that has long divided 'religious' from 'secular' sciences in Muslim educational institutions. Such dualism produces what may be termed an *academic silo*, in which disciplines coexist physically within the same campus yet remain epistemologically sealed from one another. Overcoming this dichotomy is therefore a precondition for any meaningful integration of PAI with engineering — far more than an incidental pedagogical adjustment (Fernadi, 2025).

The STEAM Approach in Islamic Education from STEM to Re-STEAM

The STEAM paradigm extends the established STEM model (Science, Technology, Engineering, and Mathematics) by adding "Arts" as an integrating element that introduces creativity, human values, and aesthetic-ethical judgment into otherwise technical reasoning. In the Islamic educational context, the "A" has been productively reinterpreted as an axiological gateway through which religious values enter scientific learning, rather than as a merely decorative addition.

Recent Indonesian scholarship demonstrates the feasibility of this integration. Adiyono and colleagues advance a "Re-STEAM" interdisciplinary model (explicitly incorporating Religion) to revitalize PAI instruction by connecting it with science and technology (Adiyono et al., 2024), while Nur Hadi shows how the deliberate infusion of Islamic values into STEAM learning can cultivate students who are both intellectually capable and spiritually whole (Hadi, 2025). These contributions establish an important precedent. Their scope, however, has remained largely confined to primary, secondary, and madrasah settings and to the pure sciences; the heavy-engineering disciplines of the public university, with their distinctive technical demands and professional-accreditation pressures, remain largely unaddressed.

While the Re-STEAM model offers a productive precedent, this study works within the established STEAM framework rather than adopting Re-STEAM as its operative paradigm. The

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reason is methodological. Adding "Religion" as a discrete sixth letter risks reinstating the very dualism this study seeks to overcome, positioning religion as a supplement *added to* STEM rather than as a perspective *internal to* the entire framework. The present study's move is different, in that rather than appending a religious component, it reinterprets the existing "Arts" element as the axiological gateway through which the *maqāshid* enter engineering reasoning structurally. This approach treats religious ethics as architecturally integrated rather than externally attached.

Contemporary *Maqāshid al-Sharīʿa* from al-Shātibī to Jasser Auda

The theory of *maqāshid al-sharīʿa*, the higher objectives of Islamic law, provides the ethical architecture of this study. Its classical formulation reaches maturity in the work of al-Shātibī, who organized the objectives of the law into a hierarchy of necessities (*al-darūriyyāt*), needs (*al-hājiyyāt*), and embellishments (*al-tahsīniyyāt*), and identified five universal essentials (*al-kulliyyāt al-khams*): the preservation of religion (*hifdz al-dīn*), life (*hifdz al-nafs*), intellect (*hifdz al-ʿaql*), progeny (*hifdz al-nasl*), and wealth (*hifdz al-māl*) (Al-Shāṭibī, 2003).

While al-Shātibī's framework remains foundational, its classical articulation was largely protective and individual in orientation. Contemporary scholarship has sought to render it more dynamic and developmental. The most influential of these efforts is Jasser Auda's systems approach, which reconceives the *sharīʿa* as an open, purposive system that moves well beyond a fixed catalogue of rulings characterized by six interlocking features, namely cognition, wholeness, openness, interrelated hierarchy, multidimensionality, and purposefulness (Auda, 2008). This systems perspective is particularly suited to the present study, for it permits the *maqāshid* to function as living criteria that can be brought into dialogue with non-traditional domains, including the technical standards of engineering. Recent applications confirm this versatility, deploying Auda's framework as an evaluative lens for fields as varied as the digitalization of Islamic education (Sanusi, 2025).

The Academic Justification for *Hifdz al-Bīʾah* as a Contemporary *Maqshad*

A central conceptual move in this study is the treatment of environmental preservation (*hifdz al-bīʾah*) as a *Maqshad* in its own right rather than a mere derivative of the classical five. This position requires explicit justification, since it is not part of al-Shātibī's original enumeration. The classical jurists did not list environmental protection separately because, in their historical context, ecological stability was assumed and its preservation was considered subsumed under *hifdz al-māl* and *hifdz al-nafs* (Khuluq & Asmuni, 2024). The contemporary ecological crisis has dissolved that assumption. Building on the proposals of scholars such as Yūsuf al-Qaradāwī (who argued for environmental care as an objective integral to the *sharīʿa*) and ʿAbd al-Majīd al-Najjār, more recent analysis positions *hifdz al-bīʾah* as a foundational condition that underwrites the realization of all five classical essentials, well beyond functioning as a mere external addition, since there can be no preservation of life, progeny, or wealth on an uninhabitable earth (Al-Najjār, 2008; Al-Qaraḍāwī, 2001). Understood this way, *hifdz al-bīʾah* is both a distinct objective and an enabling substrate for the entire *maqāshid* system, an interpretation directly consonant with Auda's principles of wholeness and interrelated hierarchy (Auda, 2008).

Three convergent lines of argument support treating *hifdz al-bīʾah* as an independent *maqshad* and not simply a derivative of the classical five. The first is ontological, in that the environment is a constitutive condition of the very possibility of life and wealth, not merely an instrument for their protection, a point al-Qaradāwī argues explicitly in *Riʿāyat al-Bīʾah fī Sharīʿat al-Islām* (Al-Qaraḍāwī, 2001). The second is systemic: within Auda's open-systems framework, a *maqshad* that was always latent in the structure of the *sharīʿa* can become explicitly articulated when historical conditions make it visible, precisely what the contemporary ecological crisis has done. *Hifdz al-bīʾah* is therefore best understood as an emergent node whose independence is warranted by the system's own logic of openness and interrelated hierarchy, rather than from its status as an addition external to the classical enumeration. The third line of argument is drawn from Indonesian Islamic scholarship, that is KH. Ali Yafie's formulation of *al-darūriyyāt al-sittah* (six essential necessities), which explicitly elevates *hifdz al-bīʾah* to the status of an independent pillar normatively equivalent to the

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classical five, a position that has gained significant traction in contemporary Indonesian Islamic jurisprudence and environmental fiqh.

The practical consequences of this independence for curriculum design are direct. A curriculum that derives environmental obligation entirely from *hifdz al-nafs* frames ecological responsibility as a function of human survival, leaving open the anthropocentric cost-benefit reasoning that has historically licensed environmentally destructive engineering. A curriculum grounded in *hifdz al-bīʾah* as an independent *maqshad* treats ecological integrity as an obligation that holds independently of its instrumental value to human welfare, a normatively stronger and pedagogically more consequential framing for students whose professional work directly shapes the built and natural environment. This distinction maps precisely onto the difference between IABEE Criterion 6 (the engineer and society) and Criterion 7 (environment and sustainability), since the former concerns harm to persons while the latter concerns harm to systems beyond persons. Assigning an independent *maqshad* to each criterion prevents the collapse of Criterion 7 into a subset of Criterion 6, a collapse that would reproduce the very knowledge dichotomy this study sets out to dissolve.

Outcome-Based Education and Engineering Accreditation Standards

The operational bridge between Islamic ethical objectives and engineering practice in this study is the framework of Outcome-Based Education (OBE) and its institutionalization through international accreditation. OBE organizes curricula around demonstrable graduate competencies rather than content coverage, a design principle operationalized through what Biggs and Tang term 'constructive alignment,' in which intended learning outcomes, teaching activities, and assessment tasks are mutually aligned to produce coherent, evidence-based learning (Biggs & Tang, 2011). At the global level, the Washington Accord (administered by the International Engineering Alliance) defines a set of graduate attributes that signatory accreditation bodies are expected to certify, extending well beyond technical problem-solving to encompass professional ethics, environmental sustainability, and responsibility to society (International Engineering Alliance, 2021).

For Indonesia, these attributes are administered by the Indonesian Accreditation Board for Engineering Education (IABEE), an autonomous body of the Institution of Engineers Indonesia whose criteria are harmonized with the Washington Accord and substantially equivalent to those of comparable bodies such as the Japan Accreditation Board for Engineering Education (JABEE). A close reading of the IABEE learning-outcome criteria reveals that the framework does not simply tolerate ethical and environmental concerns but mandates them as assessable graduate competencies. Among its outcome criteria, IABEE explicitly requires that graduates demonstrate competence in "The Engineer and Society" (Criterion 6), "Environment and Sustainability" (Criterion 7), and "Ethics" (Criterion 8), alongside the more conventional attributes of engineering knowledge, design, and problem analysis.

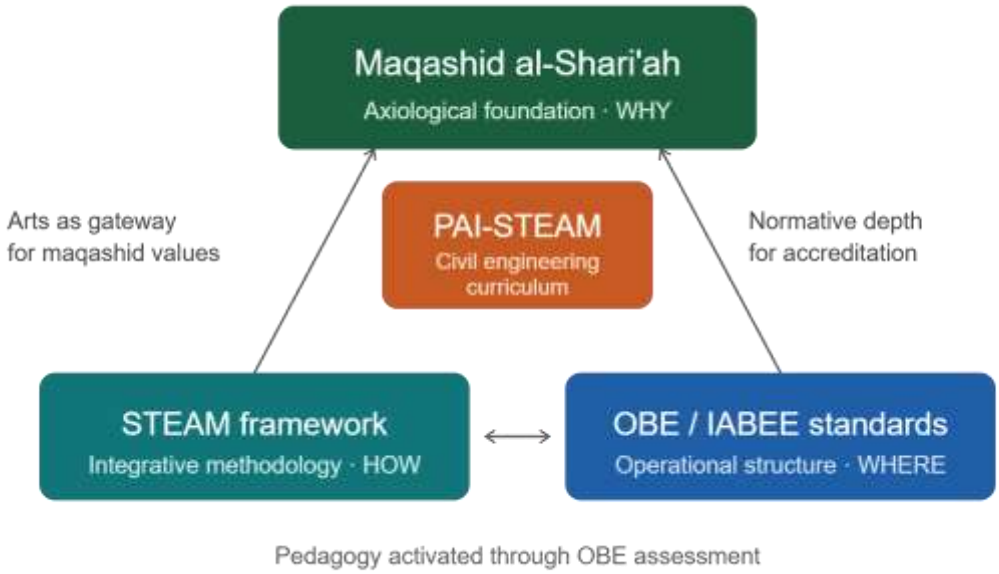
This observation is central to the argument of the present study. The ethical, social, and environmental graduate attributes mandated by these bodies are not foreign impositions upon Islamic values; on the contrary, they constitute precisely the institutional space in which the *maqāshid* can be operationalized as measurable learning outcomes. The integration of OBE into Islamic Religious Education has begun to receive scholarly attention (Manggali et al., 2024), as have efforts to embed Islamic principles within engineering education more broadly (Ismail et al., 2025). Recent work in Malaysia has similarly shown how new accreditation standards can operationalize sustainability and ESG-aligned values through Outcome-Based Education (Mat Isa et al., 2026). Where the accreditation framework specifies *that* an engineer must act ethically and sustainably, it leaves open the question of *why* and *on what normative basis*, a space that the *maqāshid al-sharīʿa* are uniquely positioned to fill. Criterion 7 finds a natural axiological anchor in *hifdz al-bīʾah*, Criterion 8 in the ethics of *amāna* and *hifdz al-māl*, and Criterion 6 in the social responsibility entailed by *hifdz al-nafs*. Early efforts to Islamize engineering instruction (such as embedding the concept of *tawhīd* within the technical vocabulary of a control-systems course) demonstrate that such integration is pedagogically conceivable (Radzol & Hamzah, 2023), even if it has not yet been systematized for the demands of civil engineering. This study takes up precisely that unaddressed task.

Conceptual Framework

Drawing these strands together, this study proposes a triadic conceptual framework in which three elements converge on a single point of application. *Maqāshid al-sharīʿa*, read through Auda's systems approach, supplies the axiological foundation answering the *why* of ethical engineering, providing the normative ground that accreditation frameworks mandate but do not supply. The STEAM paradigm, with its "Arts" component reinterpreted as an axiological gateway, supplies the integrative methodology, the *how* of uniting religious values with technical disciplines without reinstating the knowledge dichotomy. And the OBE/IABEE accreditation architecture supplies the operational structure: the *where* through which these values become assessable graduate competencies recognized by the global engineering community.

The three elements are mutually enabling. The *maqāshid* need the accreditation framework to become institutionally legible; the accreditation framework needs the *maqāshid* to supply the normative depth its ethical criteria presuppose; and STEAM provides the pedagogical medium through which both are translated into learning. The synthesis of these three, applied specifically to civil engineering in Indonesian public universities, constitutes the analytical model that the remainder of this article develops and tests conceptually. Figure 1 illustrates the structure of this triadic relationship. Double-headed arrows indicate mutual enablement. The *maqāshid* supply normative depth that accreditation criteria presuppose; OBE/IABEE provides the institutional structure through which *maqāshid* values become assessable competencies; and the STEAM framework, via its reinterpreted "Arts" component, serves as the pedagogical gateway through which both converge in engineering learning.

Figure 1. Triadic conceptual framework of PAI-STEAM civil engineering curriculum integration



Source: researcher documentation, 2026

Method

This study employs a qualitative design in the form of library research, in which the library functions as the primary site of the research itself, beyond serving as a repository of supporting references. The data consist entirely of texts (theological, juridical, and technical-regulatory) rather than field observations or human subjects. Within this design, the study

adopts a philosophical-hermeneutic approach, which is appropriate for inquiry aimed at interpreting, reconstructing, and synthesizing meaning across bodies of knowledge that have conventionally been kept apart, rather than at measuring a phenomenon. The approach is fitting because the central problem is conceptual and epistemological, asking not how often something occurs but how two distinct normative systems (the higher objectives of Islamic law and the competency standards of engineering) can be brought into coherent, mutually intelligible relation.

The study is therefore explicitly interpretive and constructive rather than descriptive. Its aim is to formulate a defensible conceptual model rather than to report an existing state of affairs. This positions the research as a work of *transdisciplinary* synthesis, since it deliberately crosses the boundary between the religious sciences and the applied engineering sciences in search of an integrative framework that neither discipline could generate in isolation.

Consistent with library research, the data are drawn from documentary sources organized into two clusters. The first cluster comprises Islamic theological-philosophical sources. Its primary references are the classical articulation of the *maqāshid* in al-Shātibī's *al-Muwāfaqāt* and its contemporary systems reconstruction in Jasser Auda's work; its secondary references include recent peer-reviewed scholarship on the contemporary application of the *maqāshid*, including the dedicated literature on *hifdz al-bī'ah*.

The second cluster comprises engineering-standard and educational-policy sources. These include the graduate-attribute framework of the Washington Accord, the accreditation criteria of IABEE and JABEE, and scholarship on Outcome-Based Education and engineering ethics. Treating these two clusters as data of equal standing, rather than subordinating the technical documents to the theological ones or vice versa, is itself a methodological commitment that reflects the study's anti-dichotomous premise.

Data were collected through documentation techniques proceeding in two movements. The first is *heuristic*, the systematic identification and gathering of authoritative primary and secondary sources from each cluster, with priority given to canonical primary texts, peer-reviewed journal articles indexed in reputable databases, and official standard-setting documents. The second is *textual criticism*: the critical reading of each source to verify the authenticity of its attribution, the precision of its concepts, and, importantly for a transdisciplinary study, the ontological compatibility of concepts drawn from different domains, so that a *maqshad* and an engineering criterion are related only where their underlying meanings genuinely correspond rather than merely sharing surface vocabulary.

The analysis proceeded in four stages. In the first stage, *heuristics*, the relevant corpus was assembled and catalogued. In the second stage, *concept verification*, each key concept was examined in its original context to fix its meaning before cross-domain comparison was attempted; fixation required corroboration across at least two independent primary or high-authority secondary sources before a concept was treated as settled for the purposes of the study. In the third stage, *transdisciplinary content analysis*, the verified concepts were subjected to thematic coding and comparison. The pillars of the *maqāshid* were subjected to thematic coding governed by three explicit mapping criteria: (a) semantic correspondence: whether the normative meaning of a *maqshad* and the competency language of an IABEE criterion converge at the level of obligation rather than merely sharing surface vocabulary; (b) functional correspondence: whether the domain of professional practice addressed by each genuinely overlaps; and (c) directional correspondence: whether both point to the same professional conduct as required. A correspondence was recorded only when all three criteria were satisfied; borderline cases were resolved by returning to primary sources and consulting the secondary literature on each domain independently. In the fourth stage, *creative synthesis*, correspondence patterns were integrated into a coherent model subject to two integration warrants: internal consistency (no proposed correspondence may contradict another within the same model) and external convergence (each mapping must be defensible from both Islamic-jurisprudential and engineering-accreditation perspectives independently, without privileging one domain's vocabulary over the other). The Complementarity Matrix and IPBL-

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OBE model presented in the Results section are the direct, auditable outputs of this fourth stage.

Because the study is interpretive, its rigor rests on trustworthiness rather than on statistical validity. Three measures were applied. First, *source triangulation* was used to corroborate claims across the three independent bodies of evidence (classical juridical texts, contemporary peer-reviewed scholarship, and official accreditation documents), so that the proposed correspondences do not rest on a single type of source. Second, *conceptual confirmability* was pursued by grounding every interpretive step in explicitly cited textual evidence, allowing the reasoning to be audited and retraced by other scholars. Third, the analysis observed the principle of *ontological compatibility* as a guard against forced or superficial concordism, ensuring that the integration of religious and technical concepts is defensible at the level of meaning and not merely rhetorical (Lincoln & Guba, 1985).

Result and Discussion

This section presents the three principal results of the study's transdisciplinary synthesis. The first result is an integrative epistemological framework that dissolves the knowledge dichotomy and positions STEAM as the structural methodology for bringing Islamic ethics into engineering reasoning. The second result is the operationalization of the five *maqāshid* pillars into assessable engineering-ethics domains, consolidated in a Complementarity Matrix that maps each *maqshad* onto the corresponding IABEE accreditation criterion. The third result is an implementable curriculum model (the Integrated Project-Based Learning aligned with Outcome-Based Education, IPBL-OBE) anchored in the Green Eco-Mosque capstone project, together with an analysis of its accreditation implications and institutional challenges. Each result responds directly to one of the study's three research questions.

Ontological Reconstruction Bridging PAI and Civil Engineering

The first and most fundamental result of this study is the reconstruction of the epistemological premise on which PAI-engineering integration can stand. As established earlier, the failure of conventional PAI in engineering faculties runs deeper than poor delivery alone; it is rooted in an inherited dichotomy that treats religious and natural-scientific knowledge as ontologically separate domains. Any durable integration must therefore begin by dissolving that separation at the level of epistemology rather than merely adjusting it at the level of teaching technique.

This study adopts the integrative-interconnective paradigm articulated in Indonesian Islamic higher education, which situates knowledge within three mutually informing horizons: the horizon of revealed text (*hadlārat al-naas*), the horizon of empirical science (*hadlārat al-ʿilm*), and the horizon of philosophical-ethical reflection (*hadlārat al-falsafa*) (Abdullah, 2012). Read through this paradigm, the technical laws governing civil engineering (soil mechanics, hydrology, the strength of materials) are not religiously neutral facts standing outside the domain of faith. They are, in Islamic cosmology, instances of *sunnat Allāh*, the consistent, discoverable regularities God has embedded in creation. The civil engineer who calculates a load-bearing capacity is, on this reading, reading the *āyāt kawniyya* (the cosmic signs) with the same seriousness that the exegete brings to the *āyāt qurʾāniyya*. The dichotomy collapses because both are repositioned as complementary readings of a single, coherent created order, without the disciplines themselves being conflated. This epistemological move extends M. Amin Abdullah's integration-interconnection paradigm beyond its original application to Islamic studies programs, demonstrating that the same three horizons (revealed text, empirical science, and philosophical reflection) can structure the self-understanding of a heavy engineering discipline with equal coherence (Abdullah, 2020).

If the integrative paradigm supplies the ontological ground, the STEAM framework supplies the methodological vehicle. The decisive move is the reinterpretation of the 'A' (the Arts) as the axiological gateway through which ethical and spiritual values enter the engineering reasoning process, in place of its conventional role as a decorative supplement to

technical content. In the model proposed here, "Arts" denotes the domain of value, judgment, and meaning: the *amāna* (trust) that frames professional responsibility, the aesthetic-ethical sensibility that distinguishes a humane built environment from a merely functional one, and the reflective humanism that asks whether a structure ought to be built, and how, rather than merely whether it can be. Positioned this way, the STEAM framework allows the *maqāshid al-sharīʿa* to enter the engineering curriculum organically through its existing "A" component, rather than being appended as an external religious module. Integration thus becomes structural rather than additive.

The choice of "Arts" as this gateway is not arbitrary; it follows from a fundamental distinction between the epistemic character of each STEAM component. Science, Technology, Engineering, and Mathematics are, by their internal logic, *descriptive* and *prescriptive* disciplines, telling us *what is* and *what works*. They operate within a domain of functional rationality in which a correct answer can, in principle, be established through calculation, experiment, or formal proof. "Arts," by contrast, is constitutively *evaluative*, asking not whether a structure can be built but whether it *should* be built, and *how*, and *for whom*, and *at what cost to the commons*. It is the only STEAM component whose internal logic already demands a normative framework that accounts for value, beauty, human dignity, and responsibility. The *maqāshid al-sharīʿa* supply precisely such a framework. To introduce them through "Arts" is therefore not an external insertion but a response to a question that "Arts" already poses: *on what axiological basis should technical decisions be made?* The other four STEAM components provide the instruments; "Arts," reinterpreted through the *maqāshid*, provides the orientation that determines how those instruments ought to be used.

Operationalizing *Maqāshid al-Sharīʿa* as an Ethics of Infrastructure Engineering

The preceding epistemological reconstruction establishes the *why* of integration; the following operationalization establishes its *what*. Read through Auda's systems approach (in which the objectives function as interrelated, purposive criteria rather than isolated prohibitions), each pillar of the *maqāshid* yields a specific, assessable domain of engineering ethics. The five sub-sections below develop each correspondence in turn.

The preservation of life translates most directly into the engineer's non-negotiable duty of structural safety. Within this frame, the accurate calculation of seismic loads, the honest specification of material quality, and rigorous adherence to disaster-resilient design standards cease to be merely technical obligations and become expressions of a religious imperative to protect human life. The recurrent collapses discussed in the Introduction (where substandard materials and unpermitted construction cost dozens of lives) are, in this light, violations of *hifdz al-nafs*, as much as engineering failures. The pillar supplies the *why* that transforms code compliance from bureaucratic box-ticking into an act of conscience. Where Radzol and Hamzah demonstrate the feasibility of Islamizing a single technical course through the concept of *tawhīd*, the present operationalization is systematically broader, in that rather than embedding one Islamic concept into one course, it maps the full *maqāshid* architecture onto an entire accreditation framework, producing a curriculum logic applicable across multiple courses and competency domains (Radzol & Hamzah, 2023).

The preservation of the environment grounds an ethics of ecological responsibility in construction. Given that the buildings and construction sector accounts for roughly 37 percent of global energy-related carbon emissions and nearly half of global material extraction (United Nations Environment Programme, 2022), the engineer's choices about materials, energy, and waste carry direct ecological weight. *Hifdz al-bīʾah* furnishes the normative basis for green-infrastructure practice: the prioritization of environmentally responsible materials, the minimization of construction waste, and the integration of environmental-impact considerations from the design stage onward. This is consonant with the established juridical position (articulated by al-Qaradāwī and elaborated in contemporary *maqāshid* scholarship) that environmental care is integral to, rather than incidental to, the objectives of the *sharīʿa* (Al-Qaraḍāwī, 2001; Khuluq & Asmuni, 2024) and operationalized in recent sector-specific applications such as sustainable water management (Hamdi et al., 2025).

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The preservation of wealth translates into an ethics of financial integrity and accountability in project management. The Islamic prohibitions against fraudulent measure (*tatfīf*) and the misappropriation of entrusted funds (*ghulūl*) speak directly to the corruption that, as shown earlier, pervades the construction sector and degrades the physical quality of infrastructure. Operationalized, *hifdz al-māl* demands transparent cost estimation, honest reporting of volumes and specifications, and the faithful stewardship of public and client resources. Here the *maqshad* supplies a direct ethical counterweight to precisely the manipulation that respondents identified as endemic to construction projects (Prastica, 2024). In response, scholarship on Islamic leadership in construction management foregrounds *amāna* and accountability as antidotes to such practices (Kamaruding et al., 2026). This vulnerability is well documented in the international construction-management literature, which identifies systemic causal factors of corruption across project life cycles (Owusu et al., 2019).

The preservation of intellect underwrites a duty of scientific rigor and continuous innovation. This obligation does not sanction a retreat into tradition; instead, *hifdz al-ʿaql* obligates the engineer to cultivate and apply the most advanced and reliable knowledge available, from Building Information Modeling (BIM) to geographic information systems (GIS), as a form of intellectual stewardship. Understanding and applying the regularities of *sunnat Allāh* through disciplined inquiry is itself an act of faithfulness, and the deliberate use of inferior methods where better ones exist becomes an ethical failing rather than a neutral choice.

Finally, the preservation of religion functions not as a sixth, parallel concern but as the integrating axiology that orients the other four. It reframes the whole of engineering practice as a form of *ʿibāda* (worship enacted through competent, honest, and socially beneficial work) and recasts the engineer as a *khalīfa*, a trustee charged with developing the earth without corrupting it. Under this pillar, the professional code of ethics is no longer an external regulatory instrument but a concrete manifestation of faith translated into practice.

A Complementarity Matrix of PAI-STEAM Aligned with IABEE Standards

The preceding operationalization can be consolidated into a complementarity matrix that maps each *maqshad* onto its corresponding engineering-accreditation criterion and its locus within the STEAM framework. The matrix demonstrates that the integration proposed here consists of natural correspondences already latent in the accreditation architecture, rather than a forced overlay (Table 1).

Table 1. Complementarity Matrix of *Maqāshid al-Sharīʿa*, IABEE Learning-Outcome Criteria, and the STEAM Framework

***Maqshad* (objective)**	**Engineering ethical domain**	**Corresponding IABEE criterion**	**STEAM locus**	**Integrated content focus**
Hifdz al-nafs	Structural safety	Criterion 6: The Engineer and Society	Engineering / Science	Seismic-load analysis, material quality, disaster-resilient design as the duty to protect life
Hifdz al-bīʾah	Ecological responsibility	Criterion 7: Environment and Sustainability	Science / Arts	Green materials, waste minimization, environmental-impact assessment as *fiqh al-bīʾah*
Hifdz al-māl	Financial accountability	Criterion 8: Ethics	Mathematics / Arts	Transparent cost estimation; rejection of *tatfīf* and *ghulūl* in

				project management
Hifdz al-ʿaql	Scientific innovation	Criteria 1–5: Engineering knowledge, analysis, design, investigation, modern-tool usage	Technology / Mathematics	BIM, GIS, and advanced methods as intellectual stewardship of *sunnat Allāh*
Hifdz al-dīn	Professional axiology	Criterion 8: Ethics; Criterion 9: Individual and Team Work	Arts (integrating)	Engineering as *ʿibāda* and *khilāfa*; the ethics code as enacted faith

Source: Primary data processed, 2026

The matrix makes the study's core claim concrete, in that the ethical and environmental graduate attributes that IABEE already mandates provide ready receptors for the *maqāshid*. What the accreditation framework specifies as required competencies, the *maqāshid* supply with normative depth and motivational force. The matrix advances beyond the existing literature in one specific respect, as prior studies on OBE in Islamic education (Manggali et al., 2024) have addressed the *procedural* integration of OBE into PAI course design, but have not established a principled *correspondence* between specific Islamic ethical objectives and specific accreditation criteria. The Complementarity Matrix supplies that missing relationship, mapping normative Islamic content onto institutionally mandated graduate attributes in an auditable way.

An Integrated Project-Based PAI-STEAM Curriculum Model (IPBL-OBE)

The Complementarity Matrix establishes what should be integrated and where it belongs within the accreditation architecture. What it cannot do, by itself, is generate learning. A matrix is a design reference rather than a pedagogical event in itself; it specifies correspondence without creating the conditions under which students actually develop the integrated competencies it maps. Translating correspondence into competence requires an instructional model in which ethical and technical reasoning are exercised together, on a real problem, in a way that is both assessable and authentic. The Integrated Project-Based Learning model aligned with Outcome-Based Education (IPBL-OBE) is designed to provide exactly this, a pedagogical structure that activates the correspondences the matrix identifies and makes them measurable as graduate outcomes. Project-based learning, understood as a broad approach in which students investigate authentic problems and produce meaningful artifacts, has been shown to sustain both motivation and deep thinking in ways that conventional instruction cannot (Blumenfeld et al., 1991), with empirical evidence within engineering education specifically confirming that technology-integrated project-based approaches strengthen self-regulated learning and engagement among engineering students (Bui et al., 2022). The model rests on three components.

The model's structural enabler is the cross-listing of an integrated course co-taught by PAI lecturers and civil-engineering faculty. Instead of running religious and technical instruction on separate tracks, team teaching places both bodies of expertise in the same room around the same problem, so that ethical reasoning and technical reasoning are modeled as inseparable. This arrangement requires institutional support (shared course codes, joint workload recognition, and coordinated learning outcomes), but it is the precondition for genuine rather than nominal integration.

At the heart of the model lies an authentic capstone project: the design of a Green Eco-Mosque, which functions as an integrative vehicle where all five STEAM components and all five *maqāshid* converge in a single task. Students engage Science and Technology in analyzing structural and environmental systems, Engineering in the design itself, Mathematics in load and cost calculations, and Arts in the ethical-aesthetic and devotional dimensions of a worship space conceived as ecologically responsible. The single project simultaneously exercises *hifdz*

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al-nafs (a safe structure), *hifdz al-bīʾah* (an ecologically sound building), *hifdz al-māl* (an honest budget), *hifdz al-ʿaql* (rigorous modern methods), and *hifdz al-dīn* (a space for worship designed as an act of stewardship). The mosque's selection rests on more than religious symbolism; it is the one building type in which devotional purpose and engineering substance are intrinsically united. This is not merely hypothetical. The Raja Haji Fisabilillah Mosque in Cyberjaya (Malaysia's first GBI Platinum-certified mosque) demonstrates how a worship space can embody environmental ethics through a design philosophy explicitly grounded in tawhīd, illustrating the broader potential of mosques as catalysts for environmental stewardship.

Consistent with OBE, learning is evaluated through authentic, rubric-based assessment of the project rather than through conventional examinations. The rubric distributes weight across three domains (technical competence, ethical reasoning, and integrative reflection), so that a student cannot earn a high mark for an elegant structure that ignores its environmental cost or its budgetary honesty. Each rubric level is described in observable performance terms, allowing the ethical attributes mandated by IABEE Criteria 6–8 to be assessed as concretely as the technical ones. The assessment design thus closes the loop, as the *maqāshid*, having entered through content and pedagogy, become measurable graduate outcomes.

Accreditation Implications and Implementation Challenges

A significant practical implication of the model is that it strengthens, rather than competes with, a program's accreditation case. Because the Green Eco-Mosque project generates authentic student work addressing safety, sustainability, ethics, and teamwork, the resulting portfolio constitutes direct evidence for IABEE Criteria 6, 7, 8, and 9, criteria that engineering programs frequently find difficult to evidence through conventional technical coursework alone. PAI, reconceived in this way, ceases to be an accreditation-neutral formality and becomes an accreditation asset.

The model nonetheless faces real structural obstacles. The first is a human-resource gap, in that few PAI lecturers possess engineering literacy, and few engineering faculty are versed in *maqāshid* reasoning, making genuine team teaching initially difficult. This can be mitigated through joint faculty-development programs and the gradual cultivation of a community of transdisciplinary instructors. The second is bureaucratic rigidity: existing academic information systems, credit structures, and course-coding conventions often cannot easily accommodate a cross-listed, co-taught, project-based course. Mitigation here requires institutional policy support (formal recognition of team-taught credits and administrative flexibility for integrated courses), without which the model risks remaining a conceptual aspiration. Acknowledging these constraints is essential to the model's credibility; the proposal is offered as a defensible and implementable direction that demands deliberate institutional commitment, with no pretense of being a frictionless solution.

Conclusion

This study set out to address a persistent disconnect between Islamic Religious Education and the technical formation of civil engineers in Indonesian public universities. Three conclusions follow, corresponding to the three research questions. First, durable PAI-STEAM integration requires dissolving the inherited dichotomy of knowledge at the level of epistemology, situating engineering knowledge within the integrative-interconnective horizons of revealed text, empirical science, and philosophical reflection; the reinterpreted "Arts" component then functions as the structural gateway through which ethical and spiritual values enter engineering reasoning organically. Second, each pillar of *maqāshid al-sharīʿa* maps onto an assessable domain of engineering practice, supplying the normative ground for graduate attributes that the IABEE accreditation framework already mandates, a complementarity consolidated in the study's central contribution, the Complementarity Matrix. Third, the Integrated Project-Based Learning model aligned with Outcome-Based Education (IPBL-OBE), anchored in the Green Eco-Mosque capstone and authentic rubric-based assessment, offers a workable pathway for translating these correspondences into measurable graduate outcomes.

Theoretically, the study contributes an integrative framework that brings *maqāshid al-sharīʿa*, the Re-STEAM paradigm, and global engineering-accreditation standards into a single

coherent model, a synthesis not previously articulated for a heavy-engineering discipline such as civil engineering. This theoretical contribution matters because existing scholarship on Islamic values in STEAM has so far remained confined to primary and madrasah-level education, leaving higher-level technical disciplines largely untouched by any comparable framework. Practically, the study also equips curriculum developers in public universities with two instruments that can be put to immediate use. The Complementarity Matrix serves as a design reference, allowing programs to identify precisely where *maqāshid* principles correspond to specific accreditation criteria rather than treating Islamic content as a generic add-on. The IPBL-OBE model, in turn, serves as an implementation template, showing how that correspondence can be translated into a concrete, assessable classroom experience anchored in a single authentic capstone project.

These conclusions should be read alongside the study's limitations. As a conceptual-philosophical inquiry, the model remains theoretically argued but empirically untested, and its design is calibrated to the Indonesian public-university and IABEE/JABEE context, requiring adaptation elsewhere. Future research should therefore pursue action research or quasi-experimental studies testing the model's classroom effectiveness, development of concrete teaching modules and validated rubrics, and comparative studies across universities to assess institutional feasibility.

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