

Islam, Science, and Technology: Muhammadiyah's Progressive Islamic Perspective on Digital Transformation

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ABSTRACT

Rapid advances in artificial intelligence, data-driven platforms, and digital learning have transformed education by expanding access and efficiency while raising ethical concerns regarding algorithmic bias, privacy, academic integrity, misinformation, and digital inequality. This study examines how Islamic epistemology and Muhammadiyah's paradigm of Progressive Islam (Islam Berkemajuan) provide an ethical and institutional framework for addressing these challenges. An integrative library review with a qualitative conceptual-synthesis approach was employed. Sources were drawn from peer-reviewed national and international publications, authoritative works on Islamic thought, official Muhammadiyah documents, and international policy reports on artificial intelligence published primarily between 2020 and 2025, while seminal references were retained where conceptually relevant. Data were analyzed through deductive and inductive thematic coding focusing on Tawhid, knowledge and human responsibility, mashlahah, technological ethics, institutional implementation, and humanistic digital civilization. The findings indicate that Islamic epistemology supports scientific advancement while emphasizing moral accountability. Progressive Islam operationalizes these principles through educational reform, institutional governance, and community engagement. The study proposes a six-stage conceptual framework integrating Tawhid, Islamic epistemology, scientific inquiry, technological ethics, Muhammadiyah governance, and social welfare. This framework offers practical guidance for AI governance, curriculum development, digital literacy, ethical oversight, and community-oriented innovation in Muhammadiyah higher education, although further empirical validation across institutional contexts remains necessary.

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INTRODUCTION

Artificial intelligence (AI), data analytics, automated decision-making, and digital learning platforms are reshaping education, communication, research, and social interaction. These technologies can increase access, personalize learning, and support institutional efficiency, yet they also generate ethical risks involving privacy, opacity, algorithmic discrimination, academic integrity, misinformation, cultural bias, and unequal access (Crompton & Burke, 2023; Jobin et al., 2019; Zawacki-Richter et al., 2019). UNESCO's Recommendation on the Ethics of Artificial Intelligence places human dignity, fairness, transparency, accountability, sustainability, and human oversight at the center of responsible AI governance (UNESCO, 2021). Its guidance for generative AI in education further emphasizes data protection, pedagogical validation, institutional readiness, and the preservation of human agency (Miao & Holmes, 2023).

In educational settings, generative AI can support explanation, feedback, brainstorming, writing, and accessibility, but it can also produce inaccurate information, weaken independent reasoning, facilitate misconduct, and reproduce bias contained in training data (Barrett & Pack, 2023; Kasneci et al., 2023; Tlili et al., 2023). Students and lecturers often recognize both the benefits and risks of these technologies, which indicates that effective integration requires policy clarity, assessment redesign, digital literacy, and ethical safeguards rather than mere technical adoption (Chan & Hu, 2023; Chan, 2023; Nguyen et al., 2023).

Recent reviews show that AI research in higher education has grown rapidly, but concerns remain regarding limited educator involvement, fragmented ethical frameworks, and inadequate attention to institutional governance (Bond et al., 2024; Zawacki-Richter et al., 2019). Curriculum-wide AI literacy has therefore been proposed as a means of combining technical competence, critical thinking, interdisciplinary understanding, and ethical responsibility (Southworth et al., 2023). The central issue is no longer whether educational institutions will encounter AI, but how they will govern it in accordance with their intellectual, moral, and social commitments.

Islamic intellectual traditions position knowledge as both a human capacity and a moral trust. The Qur'anic command to read in Surah al-'Alaq (96:1-5) links learning with recognition of the Creator, while the concepts of khalifah, amanah, justice, and mashlahah locate human creativity within responsibility for other people and the natural world (Al-Ghazali, 2005; Shihab, 2022). This perspective does not reduce science to religious preaching. Rather, it rejects the assumption that technological capacity alone determines what ought to be developed or how innovation should be used (Nata, 2020).

The development of digital religion scholarship also demonstrates that technology changes religious identity, authority, community, and practice

rather than functioning as a neutral communication channel (Campbell & Evolvi, 2020). Consequently, AI-generated religious content, automated recommendation systems, and platform-based authority require critical evaluation because they can influence interpretation, trust, and access to religious knowledge.

Existing discussions on Islam and technology often follow one of three patterns: celebration of the classical Muslim contribution to science, general theological statements about the compatibility of Islam and modernity, or broad warnings about the moral effects of digital media. These approaches are useful but frequently stop before explaining how religious values can be translated into institutional rules for AI, data governance, curriculum, research, and public engagement. Studies of Muhammadiyah likewise emphasize educational modernization and social reform, yet the organization's Progressive Islam paradigm has not been sufficiently formulated as an operational framework for contemporary technological governance (Nashir, 2022; Pimpinan Pusat Muhammadiyah, 2015).

This article addresses that gap by reconstructing Progressive Islam as an ethical-practical framework for digital transformation. Its novelty lies in connecting Islamic epistemological principles with institutional mechanisms that can be implemented by Muhammadiyah higher education institutions. The study asks three questions: (1) How does Islamic epistemology conceptualize the relationship between religion, science, and technology? (2) How can Progressive Islam guide responses to contemporary AI and digital-ethics challenges? (3) What institutional measures can Muhammadiyah higher education adopt to build a humanistic digital civilization? Accordingly, the study aims to develop an integrated conceptual model and derive practical implications for curriculum, governance, research, and community engagement.

METHODS

This study used an integrative library review with a qualitative conceptual-synthesis design. This design was selected because the study sought to connect normative Islamic sources, Muhammadiyah's institutional thought, contemporary scholarship, and international AI-governance guidance rather than estimate an intervention effect or claim exhaustive systematic-review coverage (Creswell & Creswell, 2018; Zed, 2008).

The literature search was conducted from January to June 2026 through Google Scholar, Scopus, Sinta, and official Muhammadiyah repositories. Search terms were combined in Indonesian and English, including "Islam Berkemajuan," "Progressive Islam," "Muhammadiyah education," "Islamic epistemology," "Islam and science," "artificial intelligence ethics," "generative AI in education," "data ethics," and "digital religion." Contemporary peer-reviewed studies published mainly from 2020 to 2025 were prioritized. Classical Islamic works, foundational methodological references, and official

organizational documents outside that period were retained when they were necessary for conceptual interpretation.

Inclusion criteria comprised: (1) direct relevance to Islamic epistemology, Muhammadiyah, digital education, AI ethics, or institutional governance; (2) peer-reviewed journal articles, authoritative academic books, official organizational documents, or international policy guidance; (3) full-text availability; and (4) publication in Indonesian or English. Exclusion criteria comprised popular opinion without scholarly support, duplicated material, texts with only incidental relevance, and sources whose bibliographic identity could not be verified. Screening continued until thematic saturation, and the final analytical corpus consisted of the sources explicitly cited in this article.

Analysis followed the interactive logic of data condensation, data display, and conclusion drawing (Miles et al., 2014). First, relevant passages were extracted and coded. Deductive codes were derived from Tawhid, amanah, justice, mashlahah, human dignity, and Progressive Islam; inductive codes emerged from the literature, including algorithmic bias, data privacy, academic integrity, digital inequality, institutional readiness, and human oversight. Second, codes were organized into a conceptual matrix comparing normative principles, contemporary risks, and institutional responses. Third, relationships among categories were synthesized into propositions and the six-stage framework presented in Figure 1.

Credibility was strengthened through source triangulation across religious texts, scholarly studies, organizational documents, and international policy guidance. Interpretive claims were distinguished from reported findings, while broad institutional claims were phrased cautiously unless supported by documentary or empirical evidence. The main limitation of this method is that it produces conceptual rather than institution-wide empirical conclusions.

RESULT AND DISCUSSION

Science as Inquiry under Moral Accountability

Islamic epistemology supports scientific inquiry while refusing the assumption that technical feasibility is sufficient ethical justification. Tawhid integrates knowledge with responsibility: knowledge is pursued through reason and observation, but its use is assessed through justice, amanah, and consequences for human and ecological well-being (Al-Ghazali, 2005; Nata, 2020). The distinction between *farḍ ‘ayn* and *farḍ kifāyah* can be contextualized in the digital era. Personal digital literacy, honesty, and responsible communication relate to individual moral obligation, while cybersecurity, trustworthy AI, health technology, and public-interest data systems may constitute collective obligations because their absence exposes society to harm.

This contextualization avoids romanticizing the classical Muslim scientific tradition. The significance of earlier Muslim scholarship lies not merely in historical pride but in the institutional conditions that enabled translation, debate, observation, and cumulative knowledge. Contemporary revival

therefore requires research ecosystems, methodological rigor, intellectual openness, and ethical governance. It cannot be reduced to repeating historical achievements or attributing later scientific decline to a single cause (Nata, 2020).

This perspective also expands the meaning of scientific responsibility beyond individual researchers. Universities, funding bodies, technology providers, and professional communities share responsibility for the social consequences of innovation. A Tawhid-based epistemology thus supports institutional mechanisms such as research ethics review, data-governance standards, responsible procurement, and public-interest assessment. These mechanisms help ensure that the pursuit of knowledge remains connected to accountability, ecological sustainability, and the protection of human dignity rather than being driven solely by technical novelty or market competition (Jobin et al., 2019; UNESCO, 2021).

The moral accountability attached to scientific inquiry also requires institutions to distinguish between innovation that merely increases efficiency and innovation that advances human welfare. In higher education, automated systems may support admissions, assessment, student advising, and research administration, but these benefits must be weighed against risks of exclusion, opaque decision-making, and excessive dependence on commercial platforms. Islamic principles of justice and amanah therefore require transparent criteria, meaningful human oversight, and procedures through which affected individuals can question or appeal automated decisions (Floridi & Cows, 2019; Nguyen et al., 2023).

Progressive Islam as an Ethical-Practical Framework

Progressive Islam provides a bridge between normative principles and institutional action. Its orientation toward renewal, education, social service, and public benefit enables Muhammadiyah to treat digital transformation as more than the adoption of devices or platforms (Nashir, 2022; Pimpinan Pusat Muhammadiyah, 2015). The key question becomes whether technological change strengthens learning, justice, inclusion, and service to society.

Within this framework, Tawhid supplies the integrative worldview; Islamic epistemology legitimizes inquiry and critical reasoning; mashlahah evaluates social benefit and harm; and Progressive Islam translates these principles into organizational reform. Technology is therefore religiously and socially valuable not because it is modern, but because its design and use preserve dignity, reduce harm, widen beneficial access, and remain accountable to the public.

The framework also emphasizes social transformation rather than institutional modernization for its own sake. Technology should strengthen Muhammadiyah's educational, health, humanitarian, and community-service missions by widening access and improving the quality of public benefit. Digital innovation can support distance learning, community health information, disaster response, Islamic social finance, and services for underserved groups. Nevertheless, these applications should be evaluated according to whether they

reduce inequality and empower communities, not merely whether they enhance organizational visibility or operational speed.

As an ethical-practical framework, Progressive Islam also requires continuous *ijtihad* in response to technological change. Digital transformation produces new questions that cannot be answered adequately through simple acceptance or rejection of technology. Muhammadiyah institutions therefore need interdisciplinary dialogue among scholars of Islamic studies, computer science, education, law, sociology, and public policy. Such collaboration allows normative values to be translated into technically informed standards for data use, artificial intelligence, intellectual property, and digital inclusion (Nashir, 2022; Pimpinan Pusat Muhammadiyah, 2015).

AI Ethics through Tawhid, Justice, Amanah, and Mashlahah

Algorithmic bias can reproduce discrimination when training data reflect historical inequalities or dominant cultural assumptions. Justice therefore requires institutions to examine who benefits, who is excluded, and whether automated decisions can be challenged. Data privacy is connected to *amanah* because personal information is entrusted to institutions and may not be exploited without legitimate purpose, security, and meaningful consent. These concerns are consistent with global AI-ethics research emphasizing fairness, privacy, transparency, and accountability (Floridi & Cowls, 2019; Jobin et al., 2019; Nguyen et al., 2023).

Generative AI also affects academic integrity. Prohibition alone is inadequate because students already encounter these tools. Muhammadiyah higher education institutions need transparent distinctions among permitted assistance, required disclosure, unacceptable substitution of authorship, and legitimate pedagogical experimentation. Assessment should place greater emphasis on reasoning processes, oral defense, iterative drafts, source verification, and contextual application (Barrett & Pack, 2023; Chan, 2023; Kasneci et al., 2023).

Misinformation and the changing structure of religious authority constitute another challenge. AI-generated religious answers may appear confident despite lacking context, methodological competence, or accountable authority. Digital literacy should therefore include verification of sources, recognition of uncertainty, and understanding of the limits of automated religious guidance (Campbell & Evolvi, 2020; Nam & Bai, 2023). Unequal access must also be addressed; otherwise, AI may widen educational differences between institutions, regions, and socioeconomic groups (Bond et al., 2024; UNESCO, 2021).

Environmental responsibility should also be included in Islamic AI ethics. Large-scale digital infrastructures consume energy, require resource-intensive hardware, and generate electronic waste. The principle of *mashlahah* cannot be limited to immediate educational benefits while ignoring long-term ecological costs. Muhammadiyah higher education institutions should therefore consider energy efficiency, equipment life cycles, responsible disposal, and the

proportionality of AI use. This broadens ethical evaluation from user behavior to the material and environmental consequences of digital systems (UNESCO, 2021).

Muhammadiyah Higher Education: Institutional Implementation

The proposed framework requires implementation at five interrelated levels. At the value level, institutional statements should connect AI use with dignity, justice, amanah, knowledge, and public welfare. At the policy level, universities need rules governing privacy, acceptable AI use, disclosure, intellectual property, cybersecurity, procurement, and accountability. At the curriculum level, AI literacy should be integrated across disciplines, including technical understanding, ethical reasoning, source verification, and social impact (Chan, 2023; Southworth et al., 2023). At the technology level, institutions should evaluate platform security, accessibility, local-language needs, and dependence on external providers. At the evaluation level, implementation should be reviewed through measurable indicators and stakeholder participation.

Practical measures include establishing an interdisciplinary AI and digital-ethics committee; publishing student and lecturer guidance; incorporating AI literacy into general university courses; redesigning assessment; providing professional development; conducting ethical impact assessment for high-risk systems; strengthening data-protection procedures; and supporting community-oriented innovation (Miao & Holmes, 2023; UNESCO, 2021). Research laboratories should not be separated from social responsibility. Projects can prioritize educational access, disaster preparedness, public health, environmental monitoring, Islamic social finance, and services for marginalized communities.

Institutional governance should also clarify responsibility. Senior leadership can establish policy direction, academic senates can regulate scholarly integrity, information-technology units can manage security, ethics committees can review high-risk applications, and faculties can translate general policy into teaching practices. Student participation is essential because policies developed without learner perspectives may be unrealistic or overly restrictive. Participatory governance can increase legitimacy, improve compliance, and help institutions identify emerging practices that formal regulations have not yet anticipated (Chan & Hu, 2023; Miao & Holmes, 2023).

Curriculum implementation should be differentiated across academic disciplines. Students in computer science may require deeper competence in model design, data quality, and algorithmic auditing, while students in education, law, health, and Islamic studies need the ability to evaluate reliability, disclose AI assistance, protect sensitive data, and recognize the limits of automated recommendations. A university-wide AI literacy framework can provide common ethical foundations while allowing each program to develop discipline-specific outcomes and assessment practices (Chan, 2023; Southworth et al., 2023).

Institutional Challenges and Critical Limits

A critical account must recognize that Muhammadiyah institutions differ in infrastructure, funding, staff competence, research capacity, and local context. A policy designed for a large urban university may not be directly applicable to a smaller institution. Dependence on foreign platforms may create privacy, cultural, linguistic, and financial risks. Commercial pressure can also turn digital transformation into branding without improving learning (Bond et al., 2024; Crompton & Burke, 2023).

Another challenge is the gap between normative language and implementation. Invoking Islamic values does not automatically produce fair algorithms, secure databases, or valid assessment. Ethical claims need procedures, responsible offices, documentation, training, audits, and mechanisms for appeal. Progressive Islam becomes operational only when values are translated into institutional design and when implementation is open to evaluation and correction.

The cultural context of Muhammadiyah institutions must also be considered. Ethical guidelines imported from global organizations provide important standards, but they may not fully address local language, religious authority, institutional diversity, and community expectations. Contextualization should not weaken universal commitments to fairness, privacy, and accountability; instead, it should connect them with Islamic concepts and local educational realities. This process requires dialogue with lecturers, students, religious scholars, technical experts, and surrounding communities.

A further limitation concerns the speed of technological change. Policies may become outdated quickly as new generative models, multimodal systems, and automated research tools enter academic practice. Institutions therefore need adaptive governance based on periodic review rather than one-time regulation. Pilot implementation, feedback mechanisms, and scheduled policy revision allow universities to respond to evidence without creating uncertainty or abandoning ethical principles (Bond et al., 2024; Crompton & Burke, 2023).

Proposed Institutional Indicators

The humanistic character of digital transformation can be evaluated through observable indicators. These include the existence of an AI-use policy; percentage of lecturers and students receiving AI-literacy training; availability of disclosure rules for AI-assisted work; documented privacy and cybersecurity procedures; accessibility standards; ethical review for high-risk systems; mechanisms for reporting harm; community-benefit orientation of technology projects; and periodic evaluation involving students, lecturers, technical staff, leaders, and external stakeholders (Chan, 2023; Miao & Holmes, 2023; UNESCO, 2021). These indicators convert an abstract commitment to humanistic digital civilization into a governance agenda.

At the institutional-impact level, universities should monitor whether digital transformation broadens access, improves service quality, reduces

administrative burden, and produces community benefit without increasing inequality or harm. Relevant evidence can include accessibility audits, cybersecurity incidents, energy use, participation by marginalized groups, and outcomes of community-oriented technology projects. Periodic public reporting would strengthen accountability and allow Muhammadiyah institutions to demonstrate that Progressive Islam is embodied in measurable practice rather than only in normative statements.

At the learning level, evaluation can examine whether students can verify AI-generated information, disclose assistance appropriately, identify bias, protect personal data, and justify ethical decisions. Portfolios, oral examinations, source-verification assignments, and reflective reports may provide more valid evidence than simple awareness surveys. These indicators align assessment with the reasoning and accountability expected in humanistic digital education (Kasneci et al., 2023; Southworth et al., 2023).

At the policy level, indicators should assess not only whether a document exists but also whether it is understood and implemented. Evidence may include the proportion of faculties with local AI guidance, the frequency of policy orientation, the availability of consultation channels, and the number of reported cases resolved through transparent procedures. This distinction prevents institutions from treating policy publication as equivalent to effective governance.

CONCLUSIONS

This study concludes that Islamic epistemology offers neither a rejection of modern science nor an uncritical religious endorsement of technology. It places scientific inquiry within moral accountability through Tawhid, justice, amanah, and mashlahah. Progressive Islam extends these principles into an institutional orientation characterized by renewal, educational reform, social service, and public benefit. The resulting conceptual framework links Tawhid, Islamic epistemology, scientific inquiry, technological ethics, Muhammadiyah institutional action, and humanistic digital civilization.

For Muhammadiyah higher education, the framework implies concrete reforms in AI governance, data protection, curriculum, academic integrity, professional development, research ethics, and community-oriented innovation. Humanistic digital transformation should be evaluated through dignity, fairness, transparency, accountability, accessibility, security, sustainability, and social welfare. The study's principal contribution is the conversion of broad religious values into an ethical-practical institutional model.

The study is limited by its conceptual library-review design and does not measure implementation across Muhammadiyah institutions. Future research should conduct comparative case studies, policy audits, interviews, and surveys in Muhammadiyah schools and universities to test the framework, identify institutional variation, and develop validated indicators of ethical digital transformation.

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