

Technology-Friendly Pesantren: Advancing Learning Effectiveness in the Contemporary Era

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ABSTRACT

This study investigates the incorporation of digital technology within Islamic boarding schools (pesantren) and its effect on educational quality in the contemporary era, employing a Systematic Literature Review (SLR) of 30 peer-reviewed academic publications sourced from accredited journals, supplemented by content analysis. The review was guided by three research questions addressing the forms of technology integration in pesantren, the barriers impeding such integration, and the institutional strategies adopted in response. The findings reveal that technology enriches the educational experience in pesantren through diverse innovations, including e-learning platforms, the digitization of classical Islamic texts (kitab kuning), contemporary administrative management systems, and broadened Islamic outreach (da'wah), while also enabling productive partnerships with external institutions to strengthen infrastructural capacity. Of the 30 analyzed studies, the majority reported improvements in learning accessibility and administrative efficiency following technology adoption, though persistent obstacles nonetheless remain, among them insufficient technological resources, limited digital competency among educators and students, and apprehensions regarding the adverse influence of technology on students' moral development. In response, pesantren have adopted multifaceted strategies encompassing digital literacy programs, external institutional collaboration, the formulation of internal governance regulations, and a balanced, moderated approach to technology adoption that upholds Islamic principles. This study synthesizes evidence from the reviewed literature to provide practical guidance for policymakers and educators seeking to optimize technology use in pesantren, thereby empowering students to succeed in a globalized world while preserving their religious and cultural identity.

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INTRODUCTION

As a foundational Islamic educational institution in Indonesia, pesantren occupies a central role in cultivating generations of Muslims characterized by noble moral values (Faruq et al., 2022). Beyond serving as centers for religious instruction, pesantren function as social institutions that contribute substantially to character formation within the broader community (Apriliana & Junaedi, 2021; Mujahid, 2021). Existing scholarship underscores the imperative for pesantren to adapt to the accelerating pressures of modernization and globalization, which necessarily involves incorporating technology into educational practices (Halimah et al., 2024). To remain effective, pesantren must develop adaptive strategies that foster creativity, critical thinking, communication, and collaboration, in alignment with the demands of the Society 5.0 era (Roidah Lina & Qiyadah Robbaniyah, 2024). This trajectory is consistent with the broader pedagogical orientation of pesantren education, which seeks to ground learning in Islamic values while remaining responsive to the challenges of contemporary life (Ma'arif, 2018).

The contemporary era is defined by rapid technological advancement that fundamentally reshapes knowledge acquisition and information access (Marpelina et al., 2024). Within this context, the incorporation of technology in pesantren education holds considerable potential to enhance the efficiency and effectiveness of teaching and learning processes (Fauzi et al., 2018). Sound management of educational quality within pesantren is essential for institutional competitiveness in the modern landscape (Aini, 2021). Furthermore, pesantren play a meaningful role in empowering students (santri) through character education attuned to the demands of globalization (Pratiwi et al., 2022), affirming their capacity to evolve into more progressive and adaptive educational institutions.

However, the integration of technology in pesantren is not without its complications. Deficiencies in infrastructure and human resource capacity frequently impede the adoption of digital tools. The centrality of a morally grounded curriculum must not be undermined by the pressures of modernization (Rizal et al., 2018). Equally, the design of Islamic educational curricula must remain anchored in divine values and Islamic epistemological sources to ensure continued relevance and fidelity to the objectives of Islamic teaching (Cholid Abdurrohman, 2022).

The deployment of technology in pesantren must therefore be approached with deliberate caution, accounting for the potential for misuse, particularly in relation to internet access. Well-considered institutional policies are indispensable in governing technology use. Despite the inherent tensions involved in applying Islamic values within a modern technological context, pesantren can sustain their relevance through strategic approaches to character development (Bambang Triyono & Elis Mediawati, 2023). The primary focus of this study is to understand the extent to which technology can be integrated without diminishing the traditional values that constitute the identity of pesantren. By examining the experiences of institutions that have successfully adopted technology, this research aims to generate strategic recommendations applicable at a broader institutional scale.

Despite the growing body of scholarship addressing technology in Islamic education, a notable gap persists in the literature regarding comprehensive systematic syntheses that consolidate empirical and conceptual evidence across diverse pesantren contexts in Indonesia. Most prior studies have examined technology integration at individual institutions or from a single disciplinary perspective, without providing thematic mapping that simultaneously addresses adoption patterns, barriers encountered, and institutional responses. This study addresses that gap. The present review is guided by the following research questions: RQ1: What forms of technology have been integrated into the learning systems of pesantren in Indonesia? RQ2: What barriers and challenges hinder the effective integration of technology in pesantren education? RQ3: What institutional strategies have pesantren adopted to address those challenges and optimize technology for educational benefit?

METHOD

This study employs the Systematic Literature Review (SLR) methodology, augmented by content analysis, to systematically examine textual data from scholarly articles addressing technology

integration in pesantren and its implications for learning effectiveness in the modern era. The data corpus comprises peer-reviewed academic publications sourced from accredited databases.

Literature Search

The identification of relevant literature followed a structured series of steps, commencing with the formulation of the research problem around technology use in pesantren and its educational effects (Hinderks et al., 2020). This was succeeded by a comprehensive database search for pertinent articles, followed by a filtering and selection process guided by thematic relevance. Data were subsequently categorized and coded to facilitate systematic analysis, and the resulting information was evaluated for accuracy and scholarly relevance (Pati & Lorusso, 2018; Weißer et al., 2020). The process concluded with the synthesis of findings and the derivation of conclusions aligned with the research objectives.

Inclusion and Exclusion Criteria

The literature search was initiated through the identification of relevant search terms, including “technology in pesantren,” “digital learning,” “pesantren education,” and “technology in Islamic education.” Searches were conducted across major academic databases, namely Web of Science, Scopus, and Google Scholar, using the Publish or Perish tool. The review was restricted to publications from 2020 to 2025. Inclusion criteria encompassed peer-reviewed journal articles, publications within the specified timeframe, studies directly concerned with technology use in pesantren, and articles written in English or Indonesian. Articles failing to satisfy these criteria were excluded from the review. Full texts of candidate articles were retrieved, and those not meeting the inclusion thresholds were eliminated from further analysis. The article selection process adhered to the PRISMA 2020 framework (Page et al., 2021), ultimately yielding a corpus of 30 articles for in-depth analysis.

It is important to note that several sources predating the 2020 to 2025 inclusion window appear in the Introduction and Discussion sections of this article as contextual background references. These works, including Fauzi et al. (2018), Kumar Basak et al. (2018), Ma'arif (2018), Rizal et al. (2018), Muklason et al. (2019), Setyawan (2019), Rahmawati and Astuti (2019), and Ja'far (2019), were not included as part of the analyzed corpus of 30 articles. They serve solely as theoretical and contextual foundations for the background and interpretive sections of this article. This distinction is made explicit to ensure methodological transparency and consistency with the declared inclusion criteria.

Quality Assessment

To ensure the methodological rigor of the included corpus, each candidate article was subjected to a systematic quality appraisal procedure prior to final selection. Quality assessment was conducted using an adapted checklist informed by the Critical Appraisal Skills Programme (CASP) framework, evaluating each article according to the following criteria: clarity of research objectives, appropriateness of research design, adequacy of data sources, coherence of analytical procedures, and relevance to the study's research questions. Articles that did not meet the minimum quality threshold were excluded from the final corpus. The screening and selection process was conducted independently by two reviewers. Inter-rater reliability was assessed using Cohen's Kappa statistic, yielding a coefficient of $\kappa = 0.82$, indicating strong agreement between reviewers. Any discrepancies between reviewers were resolved through discussion and consensus.

RESULTS

Technology Integration in the Learning System of Islamic Boarding Schools

Analysis of the 30 reviewed articles revealed four predominant thematic clusters pertaining to technology integration in Indonesian pesantren: (1) e-learning and digital platform adoption, (2) digitization of classical Islamic texts (kitab kuning), (3) technology-supported administrative management, and (4) social media utilization for institutional communication and Islamic outreach (da'wah). Collectively, the reviewed studies demonstrate that technology integration has become a central concern across diverse pesantren contexts, from urban modern pesantren to rural traditional

institutions. A summary of all analyzed articles, including author(s), year of publication, methodology, key findings, and institutional context, is presented in Table 1 below.

Multiple studies within the corpus indicate that in the contemporary era, pesantren confront substantial pressures arising from accelerating technological change, shifting generational mindsets, and intensifying competition in the educational sector. The present generation, highly proficient in digital technology, demands learning approaches that are both relevant and innovative (Milidar, 2024). Consequently, integrating technology into the pesantren learning system has become a practical necessity (Wijaya et al., 2024). Technology serves to support pedagogical processes, improve managerial efficiency, and extend the institutional reach of pesantren's religious mission (dakwah), all while preserving Islamic values as the foundational framework (Muid et al., 2024).

A technology-friendly pesantren is one capable of adaptively utilizing digital tools across educational, administrative, and outreach functions (Susyanto, 2022). Through the strategic deployment of digital devices, learning applications, and online platforms, such institutions can effectively serve the needs of the digital generation without compromising their traditional orientations. This integration enables pesantren to remain pertinent amid contemporary challenges while reinforcing their role as educational institutions capable of producing technology-literate Muslims who are morally grounded and globally competitive.

This institutional transformation is essential to ensuring the continued relevance of pesantren, equipping them to deliver education responsive to modern needs while maintaining their core values. By engaging productively with technological developments, pesantren can demonstrate how traditional institutions may evolve without surrendering their cultural and religious essence (Soleh, 2024). Through balanced technology integration, pesantren are positioned to lead in shaping a generation that possesses both spiritual guidance and modern competencies.

Table 1. Summary of Analyzed Articles (N = 30)

No.	Author(s)	Year	Method	Key Findings	Institution
1	Ghafur	2021	Quantitative	ICT supports e-learning in Islamic universities	University
2	Safitri	2020	Descriptive	Santri potential in digital literacy in Industry 4.0	Pesantren
3	Murdianto	2021	Qualitative	Adaptation strategies of pesantren in digital age	Pesantren
4	Bali & Holilah	2021	Quantitative	Caregivers' role in online learning effectiveness	Pesantren
5	Dwi Pritama & Hidayat	2020	Development	Web-based information system for pesantren management	Pesantren
6	Halimi et al.	2022	Library Research	Digitization of kitab kuning expands accessibility	Pesantren
7	Ibda et al.	2023	Descriptive	Maktabah Syumilah NU 1.0 supports digital learning & moderation	Pesantren
8	Ar-Ridho et al.	2023	Content Analysis	Islamic da'wah strategies on Instagram reach broad audiences	Digital Media
9	Halimah et al.	2024	Qualitative	Technology transforms religious learning culture	Pesantren
10	Muid et al.	2024	Lit. Review	Technology presents opportunities and challenges	Pesantren

No.	Author(s)	Year	Method	Key Findings	Institution
11	Nisa et al.	2024	Qualitative	Digital transformation: solutions and threats for Islamic education	Pesantren
12	Maulana	2024	Lit. Review	Digital media enhances Islamic studies and character development	Pesantren
13	Muslikatun & Siswanto	2024	Case Study	Social media builds institutional image and communication	Pesantren
14	Syobah et al.	2024	Qualitative	Da'wah strategy transformed in digitalization era	Pesantren
15	Setiawan	2024	Conceptual	Digital literacy and entrepreneurship empower students	Pesantren
16	Badrun	2024	Qualitative	Madrasah-based management strengthens Islamic boarding schools	Pesantren
17	Huda	2024	Conceptual	Religious moderation reinforced through core pesantren values	Pesantren
18	Hakim	2023	Historical	Pesantren as core identity of Islamic cultural education	Pesantren
19	Soleh	2024	Lit. Review	Administrative transformation in modern pesantren	Pesantren
20	Sedayu	2024	Qualitative	Islamic-values-based learning organization strategy	Pesantren
21	Saini	2024	Lit. Review	Pesantren balance tradition and digital transformation	Pesantren
22	Susyanto	2022	Lit. Review	Islamic educational management in the digital era	Pesantren
23	Sari Hernawati et al.	2024	Conceptual	Islamic curriculum adjusted to AI-based technology	School/Pesantren
24	Nurhayati et al.	2024	Descriptive	Digital-based learning media training for teachers	School
25	Sholehuddin et al.	2023	Qualitative	Family education and children's spiritual intelligence in digital age	Family/Pesantren
26	Ayyash et al.	2024	Survey	Cybersecurity education for responsible digital engagement	General
27	Anugraheni et al.	2025	Policy Analysis	Digital literacy policy prepares pesantren for Society 5.0	Pesantren

No.	Author(s)	Year	Method	Key Findings	Institution
28	Zainuddin et al.	2020	Experimental	Gamified e-quizzes improve student engagement	General
29	Wijaya et al.	2024	Case Study	Digital technology in Islamic boarding schools, Samarinda	Pesantren
30	Milidar	2024	Conceptual	Interactive PAI learning for millennial generation	School

Note: Lit. Review = Literature Review. All 30 articles constitute the analyzed corpus of this Systematic Literature Review.

Implementation of Technology in Learning Processes

1. E-Learning in Pesantren

The adoption of e-learning in pesantren makes it possible for the learning process to occur through online modalities utilizing diverse digital devices (Ghafur, 2021). Learning modules, traditionally disseminated in printed textbook format, can now be delivered digitally, enabling students to access educational content at any time and from any location (Kumar Basak et al., 2018). Through interactive videos and online assessments, instructional content can be presented in more engaging and stimulating formats, thereby increasing student motivation and participation (Zainuddin et al., 2020). Educational videos enable repeated viewing of lectures, demonstrations of religious practices, and academic discussions, while digital assessments afford opportunities for immediate and formative comprehension evaluation.

The principal advantage of e-learning lies in its flexibility. Students are no longer constrained by fixed schedules or physical locations, affording opportunities for self-directed learning beyond formal teaching hours. This promotes learner autonomy and individualized pacing. Additionally, technology-mediated instruction equips educators to present richer and more varied content, incorporating multimedia resources that enhance both learning effectiveness and student engagement.

2. Digitization of Kitab Kuning

A defining characteristic of pesantren education is its reliance on kitab kuning, classical Islamic texts typically authored in Arabic that serve as primary pedagogical references. The digitization of kitab kuning through mobile applications has substantially expanded student access to these canonical texts (Ibda et al., 2023). Digital kitab kuning applications typically incorporate search functionality, enabling students to locate specific terms or passages with ease, thereby facilitating reference retrieval and the resolution of instructional queries. Commentary and annotation features embedded within these applications further provide deeper contextual understanding for students encountering difficulty with the source material.

The digitization of kitab kuning represents a significant advancement in student accessibility and comprehension (Halimi et al., 2022). Previously, access to physical kitab kuning was constrained by limited availability and geographic restrictions. Digital applications resolve these limitations by enabling access via mobile devices or tablets, supporting more flexible and efficient learning. Interactive features such as audio, annotations, and simplified explanatory notes assist students in navigating complex religious texts, accelerating comprehension and deepening engagement with classical Islamic scholarship.

3. Technology for Pesantren Administrative Management

Technology has emerged as a critical asset in supporting the administrative functions of pesantren (Dwi Pritama & Hidayat, 2020). Among the most significant innovations is the adoption of educational information systems designed to manage student data. These applications allow pesantren to store and retrieve student information more efficiently and securely, encompassing personal data, academic

records, and attendance logs (Dwi Pritama & Hidayat, 2020). Automated reporting functions and integration with digital services further streamline administrative operations, enabling administrators to redirect attention toward educational development and student welfare.

Operational efficiency is further enhanced through the digitalization of attendance monitoring, scheduling, and academic evaluation (Bali & Holilah, 2021). Digital attendance systems facilitate real-time recording of student presence, immediately accessible to administrators and parents alike. Digital scheduling tools enable more systematic organization of instructional hours, extracurricular activities, and lectures. Technology-based assessment tools allow administrators to evaluate student academic performance objectively through automated data analysis, supporting timely intervention when necessary.

The adoption of these technologies yields meaningful improvements in both the speed and quality of pesantren management. Administrative tasks previously demanding substantial manual effort are accomplished with greater speed and accuracy. With reduced administrative burdens, pesantren administrators are better positioned to devote attention to spiritual mentorship and curriculum improvement. Furthermore, the quality of institutional decision-making is enhanced through access to well-organized, readily available data.

4. *Utilization of Social Media for Da'wah and Communication*

Social media has become an indispensable instrument for facilitating internal communication within pesantren (Muslikatun & Siswanto, 2024). Platforms such as WhatsApp and Telegram are widely employed to connect students, administrators, and staff for the dissemination of daily updates, activity schedules, and important announcements. The immediacy and accessibility of social media contribute to more efficient and effective institutional communication. Through the use of dedicated groups or channels, pesantren can ensure that information reaches all relevant parties without impediment.

Beyond internal communication, social media serves as an effective vehicle for Islamic outreach (da'wah) (Ar-Ridho et al., 2023). Platforms including YouTube, Instagram, and TikTok enable pesantren to disseminate da'wah content such as religious lectures, Islamic educational series, and short-form videos crafted for broad appeal. When executed with appropriate creativity, digital da'wah can reach extensive audiences, particularly among younger demographics with high levels of social media engagement. Content can be tailored to contemporary communication styles without compromising the substance of Islamic values.

Social media engagement also serves to enhance the public image of pesantren in contemporary society. By presenting positive activities, including educational programs, social initiatives, and student accomplishments, pesantren project themselves as dynamic institutions relevant to current developments. This strengthens public confidence in pesantren, attracts prospective students, and contributes to the preservation of Islamic educational traditions in the digital era.

5. *Collaboration with External Institutions*

Institutional collaboration with external partners has become a vital strategy for pesantren seeking to improve educational quality and administrative capacity (Halimah et al., 2024). Partnerships with higher education institutions afford students access to supplementary academic programs, scholarships, and exchange opportunities. Collaboration with technology companies facilitates access to digital devices, educational software, and technical training. Partnerships with religious organizations strengthen da'wah networks and support student spiritual development programs.

Through such collaborative arrangements, pesantren can offer students training in digital competencies relevant to contemporary professional demands, such as graphic design and digital marketing. These skills hold practical value in the workforce and also equip students with tools for creative and effective da'wah on digital platforms. The cumulative benefits of such collaborations substantially enhance student competitiveness in the modern world (Putri et al., 2024). Students emerge

equipped not only with deep religious knowledge but also with practical skills applicable across diverse professional contexts.

DISCUSSION

Pesantren Strategies in Facing the Digital Era

The synthesis of findings from the 30 reviewed articles both corroborates and extends prior scholarship on technology integration in Islamic educational institutions. The identification of e-learning, kitab kuning digitization, administrative technology, and social media as primary domains of technology adoption aligns with earlier conceptual frameworks proposed by Fauzi et al. (2018) and Muklason et al. (2019), while the present review offers a more comprehensive and empirically current thematic mapping. In contrast to individual case studies that tend to focus on a single technology or institution, the patterns emerging from this review demonstrate that technology adoption in pesantren is a multidimensional phenomenon that simultaneously encompasses pedagogical, administrative, communicational, and outreach dimensions.

The strategies identified in the reviewed literature, namely digital literacy training, external institutional collaboration, internal governance development, and a moderated approach to technology, reflect an institutional pragmatism consistent with the adaptive capacity described by Ma'arif (2018) and more recent empirical accounts (Halimah et al., 2024; Nisa et al., 2024). This study's findings further align with Saini's (2024) observation that pesantren have begun navigating a productive tension between tradition and transformation, adopting technology not as a replacement for Islamic values but as an instrument in their service. However, unlike single-institution studies that report uniformly positive outcomes, the cross-study synthesis in the present review reveals persistent structural barriers, most notably inadequate infrastructure and insufficient educator capacity, that limit the transferability of best-practice models.

From a theoretical standpoint, the findings support a contextually adapted technology acceptance model for Islamic educational settings, in which the perceived utility of technology is mediated by its alignment with Islamic pedagogical values. This suggests that frameworks such as the Technology Acceptance Model (TAM) require cultural and religious contextualizing when applied to pesantren environments. Practically, the review underscores the urgency of government policy engagement and multi-stakeholder collaboration in supporting pesantren technology infrastructure, particularly in rural and underserved regions.

Limitations of the Study

This review is subject to several limitations that warrant acknowledgment. First, the corpus was restricted to publications written in English or Indonesian, which may have excluded relevant scholarship in Arabic or other languages, particularly given the international scope of Islamic education. Second, reliance on three academic databases (Web of Science, Scopus, and Google Scholar) may not have captured all pertinent published research, including grey literature, institutional reports, and conference proceedings. Third, the absence of primary data collection means that the review's findings are inherently dependent on the quality and representativeness of the included publications. Fourth, given the rapid pace of technological development, findings pertaining to specific platforms or applications may require updating in the near term. Future empirical research addressing these limitations would substantially advance the field.

1. Digital Literacy Training for Teachers and Students in Pesantren

Digital literacy training represents one of the most strategically significant solutions available to pesantren in preparing educators and students for the demands of the digital era (Anugraheni et al., 2025). Digital literacy in this context extends beyond basic familiarity with technological devices to encompass the capacity to use such devices productively and in accordance with Islamic values. Structured training programs are therefore essential to ensure that technology is not merely adopted but is employed optimally in support of learning and institutional management.

Training programs may be initiated with foundational instruction in the operation of devices such as computers, laptops, and tablets, as well as relevant software applications (Sholehuddin et al., 2023). Educators and students are guided in accessing online resources and utilizing applications that support educational purposes, including classroom management tools, digital libraries, and interactive presentation software. Beyond technical proficiency, training must incorporate digital security awareness, encompassing personal data protection, recognition of cyber threats such as phishing and malware, and strategies for safe and responsible technology use (Ayyash et al., 2024).

Importantly, training must be grounded in Islamic ethical principles. Pesantren can provide guidance on using the internet and digital tools for constructive purposes, such as studying religious sciences, accessing digital Islamic texts, and participating in relevant scholarly forums (Halimah et al., 2024). Through comprehensive digital literacy training, pesantren can empower educators and students to leverage technology in ways that genuinely strengthen the educational process (Nurhayati et al., 2024), while maintaining the balance between modern digital engagement and the Islamic traditions that define the institution's identity.

2. Collaborating with External Parties to Strengthen Pesantren Infrastructure

Collaboration with external stakeholders represents a foundational strategy for pesantren seeking to enhance their technological infrastructure and educational capabilities. Engagement with government entities, technology companies, and non-governmental organizations (NGOs) enables pesantren to access resources beyond their internal capacities. Government initiatives may extend internet connectivity to remote regions through national digital inclusion programs, directly addressing the geographic barriers that constrain technology integration in education. The significance of government policy in supporting pesantren within the national educational framework has been well documented in the literature (A'la & Rahman, 2022).

Partnerships with technology companies offer further opportunities through corporate social responsibility programs oriented toward educational development, including the provision of hardware, software, and targeted training programs (Setyawan, 2019). NGOs fulfill a pivotal role within this collaborative ecosystem, frequently offering programs focused on community-based education, including the establishment of computer laboratories and digital libraries within pesantren (Anjarsari et al., 2023). Technical support and training provided by NGOs help ensure that implemented technologies are utilized effectively and in alignment with the specific needs of each institution (Rahmawati & Astuti, 2019).

3. Developing Internal Regulations for Technology Use in Pesantren

The formulation of internal governance policies constitutes a strategic imperative for pesantren seeking to ensure that technology is used productively and in a manner consistent with Islamic values (Maulana, 2024). Without appropriate regulatory frameworks, technology carries the potential to undermine students' moral development and academic focus. A foundational element of such regulations is the restriction of access to content ethically incompatible with Islamic educational values, shielding students from exposure to harmful material associated with violence, gambling, or activities irrelevant to educational purposes. This content governance simultaneously promotes digital literacy and reinforces character development through sustained engagement with morally appropriate material (Sari Hernawati et al., 2024).

Students must be cultivated in the etiquette of digital engagement, encompassing courteous communication in online environments, respect for the privacy of others, and the use of technology as an instrument for deepening religious knowledge. Internal regulations must be effectively communicated across all institutional constituencies, accompanied by a systematic evaluation mechanism and consistent enforcement measures. With clear and consistently applied policies, technology can function as an instrument that strengthens the Islamic educational mission without eroding traditional pesantren values.

4. *A Moderated Approach to Technology in Pesantren*

A moderated approach to technology seeks to harness digital tools wisely, advancing educational and managerial quality in pesantren without compromising the Islamic foundations upon which these institutions rest. This orientation frames technology not merely as a vehicle for modernization but as a means of reinforcing the pesantren's central role as an institution of Islamic-principled education (Saini, 2024). A core principle of moderated technology use is the prioritization of educational benefit. Technology should be directed toward supporting instructional processes (Zulfitria et al., 2020), whether through digital learning applications, the provision of electronic versions of classical Islamic texts, or the use of interactive media to enrich religious instruction.

In the administrative domain, moderated technology use can yield meaningful gains in operational efficiency through the implementation of academic information systems for student data management, activity scheduling, and administrative coordination. However, moderation in technology necessarily entails robust oversight and regulatory control. Pesantren must ensure that digital engagement does not transgress Islamic principles (Sedayu, 2024), including through restrictions on access to non-educational content and the governance of device use patterns. By situating technology within an Islamic values framework, pesantren can remain institutions deeply rooted in tradition while being responsive to contemporary demands.

CONCLUSION

This study addressed three research questions: what forms of technology have been integrated in pesantren (RQ1), what barriers hinder effective integration (RQ2), and what strategies pesantren have adopted in response (RQ3). Pesantren possess substantial opportunities to harness digital technology in advancing educational quality and strengthening their competitiveness in the modern era. However, the successful integration of technology depends on the institutional capacity of pesantren to address existing challenges through coherent and well-directed strategies. When managed appropriately, technology can serve as an instrument for reinforcing student character, moral development, and intellectual growth, while sustaining the distinctive tradition of pesantren as centers of Islamic learning. This study contributes meaningfully to the understanding of how pesantren can leverage technology to improve educational quality without compromising the religious values that define their institutional identity. Furthermore, the study highlights the importance of wise institutional governance in navigating technological challenges and underscores the necessity of maintaining equilibrium between technological advancement and the Islamic principles that characterize pesantren education.

With respect to the study's limitations, the findings are drawn exclusively from published peer-reviewed sources in English and Indonesian, which may not fully represent the breadth of pesantren experiences across the Indonesian archipelago. As acknowledged in the preceding Discussion, the absence of primary data and the restriction to three databases further constrain the generalizability of the conclusions. Notwithstanding these limitations, this review provides a systematic and empirically grounded synthesis that advances scholarly and practical understanding of technology integration in pesantren education.

Future research priorities in this domain should include empirical mixed-methods investigations collecting primary data from students, educators, and institutional leaders to generate qualitative insights on implementation challenges, pedagogical adaptation, and community perceptions, alongside quantitative measurement of learning outcomes and digital competency levels. Sustained attention to the long-term effects of technology on student character formation, religious orientation, and moral development is also essential. Comparative studies examining different categories of pesantren, including salaf, khalaf, urban, rural, and those at varying levels of technological readiness, would provide contextual insights valuable to policymakers and educators. Research investigating the intersection of Islamic values and digital ethics in pesantren technology use is equally important for developing culturally grounded frameworks that ensure technology adoption genuinely enhances, rather than undermines, the educational, spiritual, and social mission of pesantren programs.

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