

## Revolutionizing Pesantren In The Society 5.0 Era: The Synergy Of Digitalization, Ai, And Smart Education Management

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### Abstract

Pesantren, as a cornerstone of Islamic education, must adapt to the Society 5.0 era, where artificial intelligence (AI), digitalization, and smart education management redefine learning and institutional governance. This study examines the integration of AI and digitalization in pesantren, focusing on their impact on educational quality, operational efficiency, and long-term sustainability. Using a qualitative approach, the research explores existing digital transformation efforts, challenges faced by pesantren, and strategic frameworks for successful adaptation. The findings indicate that while digitalization enhances teaching methodologies, administrative management, and access to global knowledge, financial limitations, digital literacy gaps, and cultural resistance remain key obstacles. This study proposes a sustainable model for pesantren digital transformation, emphasizing AI-driven learning platforms, financial technology for waqf management, and digital literacy training for educators and students. These findings contribute to the discourse on Islamic education modernization, providing practical insights for policymakers, educators, and Islamic institutions to successfully navigate the Society 5.0 landscape.

**Keywords:** Pesantren 5.0, Society 5.0, AI in Education, Digitalization, Smart Education Management, Islamic Education

### Introduction

Pesantren are one of the oldest Islamic educational institutions in Indonesia, and they play an important role in forming the character, spirituality, and intellectuality of the Santri (Azra 2004; Zh 2021). Pesantren have an important role in the social and economic dynamics of society in addition to religious instruction (Dhofier 1982). Unlike contemporary educational institutions, the pesantren education system has a traditional approach with separate governance.

In the middle of the Industrial Revolution 5.0 and the growth of Society 5.0, digital technology and artificial intelligence (AI) present significant prospects to transform pesantren's learning and management methods (Sugiyono 2019). Several pesantren have begun to incorporate technologies such as Learning Management System (LMS), e-library, and AI-based administration, despite ongoing challenges such as insufficient infrastructure, poor digital literacy, and a lack of finance (Nizar 2011).

According to literature reviews, attention to technology integration in Islamic education is growing, although research on AI integration in the context of pesantren is still restricted (Santoso 2022), (Nugroho 2024). The majority of research focuses on the digitization of traditional schools, while the cultural and spiritual components of pesantren are frequently disregarded. The purpose of this study is to theoretically investigate the possibility of combining AI and digitalization in pesantren education management using a systematic literature review and comparative analysis technique. The primary goal is to identify obstacles, map strategies, and develop a Smart Pesantren Management (SPM) model that is tailored

to the local environment and Islamic values in the Society 5.0 era.

While the adoption of Artificial Intelligence (AI) offers numerous benefits in improving efficiency and personalising learning, it also presents complex ethical challenges. As noted by Ali et al., (2023), the implementation of AI within Islamic educational settings must consider the risks of academic misconduct, misuse of student data, and erosion of moral authority. Therefore, this study not only aims to propose a model of digital transformation, but also to reflect on the ethical boundaries and implications of AI integration within pesantren education. Furthermore, previous studies highlight that successful integration of AI in Islamic education requires a balance between innovation and ethics. As emphasised by (Qomariyah, n.d.-a; Humaera et al. 2023), the development of AI-based systems in pesantren must ensure the preservation of Islamic values and learner autonomy.

In addition, recent discourse suggests that curriculum transformation is also critical in ensuring that technological adoption aligns with the spiritual and pedagogical framework of pesantren. (Liriwati 2023) notes that AI integration in curriculum development must consider contextual needs and Islamic epistemology, several frameworks such as TPACK can inform future implementations by suggesting alignment between technology, pedagogy, and Islamic values, though this study does not explore it in depth (Bahtiar et al. 2023).

Although several prior studies have addressed digital transformation in general Islamic schools, there remains a gap in contextualised, values-based models specifically designed for pesantren. Most frameworks overlook the unique socio-cultural and spiritual foundations that differentiate pesantren from mainstream education institutions. Therefore, this study aims to fill that gap by proposing an integrative strategy rooted in smart education management, cultural ethics, and AI innovation tailored for pesantren in the Society 5.0 era.

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## **Methods**

This study examines pesantren's digital transition in the Society 5.0 age using a qualitative methodology and the Systematic Literature Review (SLR) method. This technique entails identifying, selecting, and synthesizing scientific literature from Scopus, Google Scholar, and DOAJ indexed journals published within the last five years that is relevant to the themes of digitalization of Islamic education, integration of artificial intelligence (AI), and pesantren education management.

This study is also supplemented by a comparative examination of pesantren's digitization strategy in Indonesia to similar practices in Malaysia and Turkey. The goal is to identify best practices, structural problems, and adaptation possibilities relevant to the local Indonesian environment. The study is conducted thematically using a content analysis technique to identify narrative patterns, critical concepts, and conceptual models that may be turned into a Smart Education Management framework for the pesantren context.

Furthermore, prior research underlines that the effective integration of AI in Islamic education must strike a balance between innovation and ethical responsibility. As (Qomariyah, n.d.) point out, the design and implementation of AI-based systems within pesantren should safeguard Islamic values and uphold

learners' autonomy. Accordingly, this study also aims to address the ethical and pedagogical implications of AI adoption within faith-based educational institutions.

### A. The Level of Technology and AI Adoption in Pesantren

The Technological Pedagogical Content Knowledge (TPACK) paradigm serves as the conceptual underpinning for this study's integration of digital innovation into pesantren education. The TPACK framework, created by (Mishra and Koehler 2006), emphasizes the significance of integrating three domains: technology, pedagogy, and content knowledge. In the pesantren setting, this strategy assists educators in integrating Islamic knowledge with suitable digital tools while keeping the integrity of traditional teaching techniques. According to (Bahtiar et al., 2023 and Rahman et al., n.d.), applying the TPACK paradigm for pesantren necessitates contextualizing digital technology in accordance with Islamic beliefs, hence promoting ethical usage and relevance to santri requirements. Moreover, this study is based on the Society 5.0 ideology, which envisions a human-centered society in which digital innovation promotes social well-being. Unlike the technologically driven Industry 4.0, Society 5.0 emphasizes the ethical and social aspects of digital revolution. According to (Liriwati 2024), pesantren prioritize the spiritual aim of Islamic education over technological growth.

The digital transformation of Indonesian pesantren is expanding, but unevenly. According to literature, several pesantren have embraced the Learning Management System (LMS) to enable distant learning, although adoption of Artificial Intelligence (AI)-based technologies such as automated administration systems and academic chatbots remains limited. Several studies have found that digitization is more readily adopted in the academic sector than in the internal management sector of pesantren.

According to recent study, just a tiny minority of pesantren make full use of digital integration. One of the most significant barriers is a lack of physical capacity, human resources, and regulatory assistance, particularly in rural and semi-rural regions. However, the tendency toward digitalization is growing, particularly among urban pesantren who have strategic collaborations with foreign institutions or education technology groups.

**Table 1. Summary of Technology Adoption in Pesantren Based on the Literature**

<b>Technology Adopted</b>	<b>Implementation Level</b>	<b>References</b>
<b>Cloud-based LMS</b>	Medium-High	(Alimuddin 2023a)
<b>Digital Payment System</b>	Medium	(Khotimah 2021; Umam and Hasanah, n.d.)
<b>Academic Chatbot and AI Admin</b>	Low	(Arifudin 2024; Aji Purnomo Sekolah Tinggi Agama Islam Al-Amanah Al-Gontory, n.d.)
<b>E-Library and Santri Information System</b>	Medium	(Syamsuddin 2022)

Despite increasing digitalisation, AI usage remains restricted to tests and pilot projects. Policies that encourage the integration of technology based on the values and local wisdom of pesantren are required to ensure that innovation does not end at the technological level.

## B. Challenges in Pesantren's Digital Transformation

Despite the growing incorporation of technology in pesant communities, the digitalization process confronts a number of structural and cultural hurdles. One of the most significant hurdles is the digital gap between urban and rural pesantren. Pesantren in distant places typically have poor internet connection, infrastructure, and HR training (Islam, Humaniora, and Hajri 2023)

Furthermore, there is ongoing internal resistance to the use of technology in religious activities and education management. Some caretakers or senior teachers believe that digitalization has the potential to undermine the traditional ideals of pesantren, which are founded in face-to-face relationships and direct exemplification (Arief and Assya'bani 2023). Limited operational finances are also a significant challenge. Implementing LMS, AI admin, or e-library systems necessitates significant investment in equipment, training, and long-term maintenance, which many non-advanced private pesantren cannot afford. External assistance, such as government, NGOs, or engagement with the corporate sector, is crucial for successful digital integration in pesantren (Ibnu Sholeh et al., n.d.).

**Table 2. The Main Challenge of Digitalisation of Pesantren Challenge Categories Explanations**

Challenge Categories	Explanations
<b>Infrastructure</b>	Limited internet access, hardware & software in rural areas
<b>Human Resources</b>	Lack of digital literacy of teachers & caregivers; no systematic training yet
<b>Cultural &amp; Theological</b>	Concerns about the loss of traditional values and scholarly authority
<b>Financial &amp; Funding</b>	Limited funds for technology investment and maintenance

*(Alimuddin, 2023; S et al., 2024a; Teguh Ciptadi, n.d.)*

To address this difficulty, a transformational strategy based on community and local wisdom is required, so that the digitalization process does not become a mere technocratic tool, but rather empowers and preserves the essence of pesantren.

## C. Smart Educational Management Strategy for Pesantren

To achieve effective digital integration, pesantren must design a Smart Education Management (SEM) Strategy based on values, technology, and current management practices. According to the results of the literature synthesis, this strategy is built on three major pillars: digital integration, capacity building, and data-driven leadership.

First, digital integration include the usage of learning management systems (LMS), e-administration, and application-based monitoring. Pesantren that effectively use this technique demonstrate a rise in communication efficiency, academic reporting, and government transparency (Ramadan and Astutik, n.d.).

Second, capacity building involves training teachers and other education staff. Technology training programs not only promote digital literacy, but also extend awareness of ethics, cybersecurity, and the necessity of digitalization based on Islamic principles (Jasri et al. 2024).

Third, data-driven leadership involves analyzing needs, academic accomplishments, and stakeholder feedback using digital platforms. This strategy supports pesantren's leadership position as centers of innovation in modern Islamic education (Jasri et al. 2024).

**Table 3. Pillars of the Pesantren Smart Education Management Strategy Strategic Pillars Field Implementation Reference**

Strategic Pillars	Field Implementation	Reference
<b>Digital Integration</b>	LMS, e-raport, integrated admin system	(Fattachil 'Izza, Dwi Nabila, and Zuhriyah 2025)
<b>Capacity Building</b>	AI-based teacher training, digital security, online pedagogy	(Ridwan Maulana Rifqi Muzakky, Rijaal Mahmuudy, and Andhita Risko Faristiana 2023)
<b>Data-Driven Leadership</b>	Achievement dashboard, data-driven evaluation	(Sarioguz and Miser 2024)

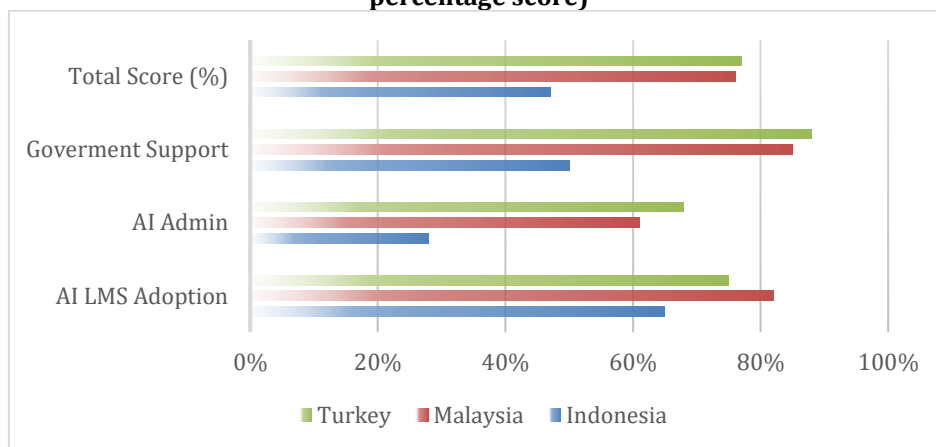
The implementation of this plan is projected to not only increase administrative efficiency, but also ensure the continuation of traditional values through digital advances that are tailored to the pesantren setting.

#### D. Comparison of Pesantren Digitalisation Strategies: Indonesia, Malaysia, and Turkey

In order to better understand best practices in digitalising Islamic education, a comparison of Indonesia, Malaysia, and Turkey reveals substantial variances in approach and institutional support. Turkey and Malaysia were the first to embrace a comprehensive approach to digitising Islamic value-based education, while Indonesia demonstrated significant but inconsistent attempts.

Malaysia's Smart Education Blueprint 2025 program, supported by the Ministry of Education and MITDA (Malaysian Islamic Technology Development Association), aims to digitize madrasahs and tahfiz centers nationwide (Ministry of Education Malaysia 2013). Turkey has been developing an e-Okul system and implementing AI Labs in Islamic-based schools since 2018 (Tüfekci, n.d.). In Indonesia, attempts originate from the pesantren business itself and supporting NGOs; nonetheless, funding and infrastructural limits are still a key barrier. (Muid, Arifin, and Karim 2024). The horizontal bar graph below helps to understand each country's readiness to digitalise Islamic education.

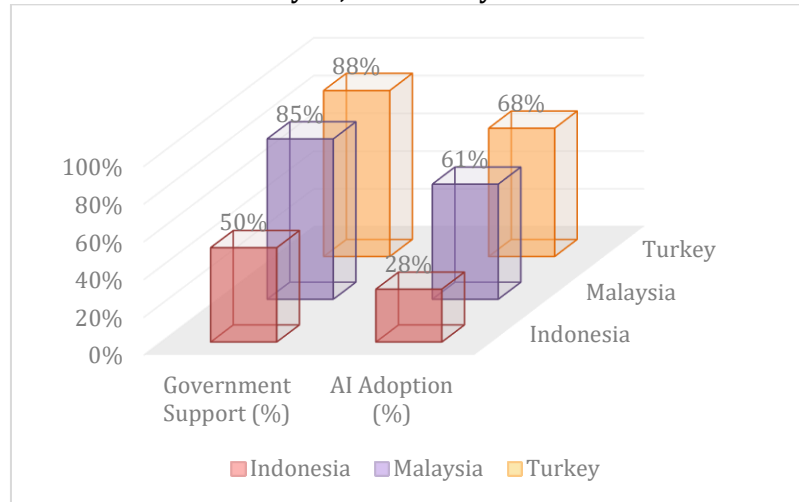
**Diagram 1. Readiness level of digitalisation of Islamic education (composite percentage score)**



(Source: Modelled by the authors from (Umar et al. 2025), (Ministry of Education Malaysia 2013)), and (Tüfekci, n.d.).)

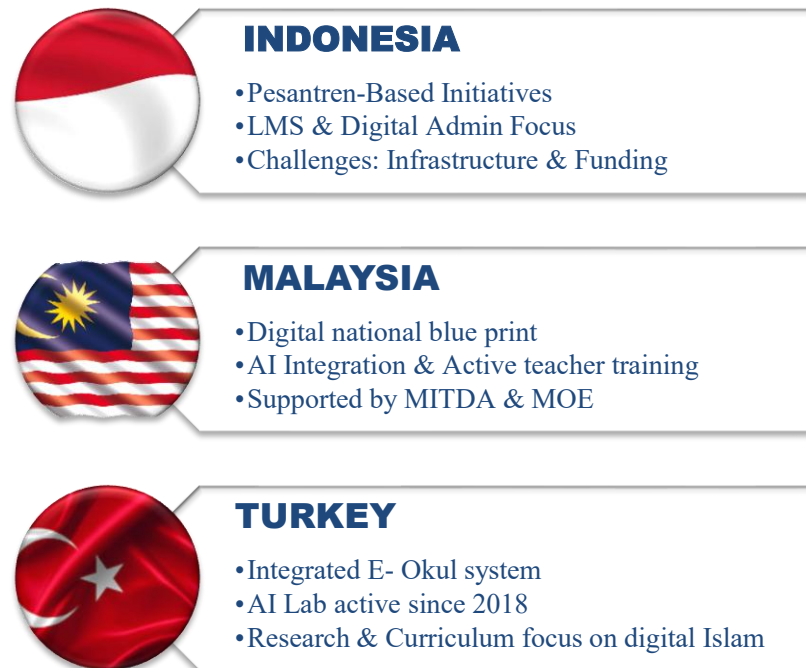
In addition to the overall digitalization readiness score, it is critical to examine the relationship between government assistance and AI use in the Islamic education system. The graph below shows a visual comparison of the three nations examined in this study.

**Figure 2. Comparison of Government Support and AI Adoption in Indonesia, Malaysia, and Turkey**



*(Source: Visualisation by the author based on (Tjondronegoro, n.d.), (Fauziddin et al. 2025), (ATABEK 2019)), and (Neo, n.d.)*

In addition to quantitative data in the form of percentages and bar graphs, descriptive visual representations are required to offer a succinct summary of each country's strategy to digitalising Islamic education. The infographic below compares Indonesia, Malaysia, and Turkey's strategies for incorporating technology into the Islamic education system based on pesantren and madrasah.



**Figure 3. Mini Infographic: Country Digitalisation Profiles**

*(Source: Compiled by the author based on synthesis of (Iskandar et al., n.d.)(S et al. 2024b),(Ministry of Education Malaysia 2013), (Bayir, Dilek, and Bugra 2023)and (Tüfekci, n.d.).)*

Based on this comparison, it is clear that Malaysia and Turkey have greater institutional capacity and infrastructure, resulting in a more systematic and secure digitalization process. Furthermore, Indonesia has a large potential for entrepreneurial agriculture through pesantren, but it still requires regulatory reform, investment, and sector collaboration to achieve comprehensive and contextual digital transformation.

### **E. Reflections and Implications: Discussion of Research Results**

According to the findings of this study, pesantren's digitalization in the Society 5.0 era is in a complicated transition phase. On the one hand, there is a growing awareness and effort within internal pesantren to implement technology such as LMS and Santri information systems. However, AI-based technology integration remains restricted due to technological, human resource, and regulatory barriers (Alimuddin, 2023).

International comparisons reveal that the success of Malaysia and Turkey is not only dictated by infrastructural preparation, but also by systematic official support and integration of Islamic education policies with the national digital roadmap (Ministry of Education Malaysia 2013; Ersoy and Karatas 2021). This highlights the need of institutionalizing rules and collaborative environments to support pesantren innovation in Indonesia, beyond just grassroots enthusiasm.

The Smart Education Management (SEM) method developed in this study demonstrates that technological measures alone cannot ensure the success of digital transformation (Sarioguz and Miser 2024). It demands collaboration between technology, Islamic principles, and innovative education governance. This paradigm is appropriate for the Indonesian environment, which has a strong cultural and religious pesantren.

These findings challenge the dominant techno-centric narratives in educational innovation, which often overlook the nuanced cultural, spiritual, and ethical dimensions within Islamic learning systems. The case of pesantren in Indonesia underscores that digitalisation must be locally contextualised and ethically grounded. Unlike existing digital transformation models designed for conventional education, the SEM framework proposed in this study places pesantren values and local traditions at the centre of innovation—offering a unique contribution to Islamic educational technology.

This study highlights the need for teachers to improve their digital skills, implement data-driven policies, and secure long-term financing. While this study synthesises multi-source literature and comparative strategies, it is limited by the lack of empirical validation through primary data. Future research is needed to empirically implement and evaluate the SEM framework in pesantren with diverse capacities.

Further study might be focused on testing the SEM model in various pesantren, as well as investigating AI-based Islamic digital platforms that align with local beliefs.

### **Conclusion**

This study demonstrates that the incorporation of digital technology and artificial intelligence (AI) into primary education is an unavoidable strategic move in the Society 5.0 age. Although AI adoption remains restricted, some pesantren have taken the initiative to build digital learning systems and technology-based management.

Comparisons with Malaysia and Turkey reveal that institutional support and national policies are critical to the achievement of Islamic-based digital transformation. The Smart Education Management (SEM) model created in this study has significant potential for implementation in Indonesia, emphasizing the synergy between technology, Islamic principles, and adaptive pesantren governance.

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