

Contribution of Islamic Boarding Schools in the Development and Research of Science and Technology: Literature Review on the Integration of Islamic and Scientific Knowledge in Islamic Boarding School Educational Institutions

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Abstract

Islamic boarding schools as traditional Islamic educational institutions have undergone significant transformation in responding to the challenges of the modern era, especially in the fields of science and technology. This study aims to explore the contribution of Islamic boarding schools to the development and research of science and technology through a library research approach. By reviewing academic literature, policy documents, and previous research results, this study maps the integration model between Islamic and scientific knowledge that has developed in Islamic boarding school environments. The results of the study indicate that Islamic boarding schools not only play a role as centers for the transmission of religious values, but have also begun to develop an interdisciplinary approach that combines Islamic spirituality with modern scientific thinking. This contribution is seen in the efforts to Islamize science, develop an integrative curriculum, and implement appropriate technology based on Islamic values in the lives of students. Islamic boarding schools such as the RMI-NU Technology Boarding School, the Darul Ihsan Science Boarding School, and the Daarut Tauhid Eco-Boarding School have become examples of real practices of this integration. However, this contribution still faces structural challenges such as limited human resources, minimal access to the latest technology, and lack of national policy support focused on Islamic boarding school research. Therefore, this study recommends strengthening the role of Islamic boarding schools as centers of interdisciplinary research through collaboration with universities, increasing teacher capacity, and reforming Islamic education policies. This study emphasizes that Islamic boarding schools have great potential to not only preserve the heritage of Islamic knowledge, but also become the driving force for technological innovation rooted in Islamic values.

Keywords: Islamic boarding schools, science and technology, literature study, integration of knowledge, Islamic education.

Introduction

The development of science and technology has influenced almost all sectors of life, including Islamic education (Zh et al., 2025). Islamic boarding school, as the oldest educational institution in Indonesia, has begun to adapt to the demands of the times by integrating religious and scientific teaching (Zh, 2021). This transformation is not only in educational practices, but also in the construction of a unique scientific paradigm: combining spirituality with rationality, and Islamic values with scientific methodology. This study examines how Islamic boarding school's contribution to technology research and development is examined from various academic literature and official documents.

Islamic boarding school is an Islamic educational institution that has played a strategic role in character formation and the transmission of Islamic knowledge in Indonesia since the 18th century. Historically, Islamic boarding school are known as institutions that focus on teaching classical religious sciences, such as fiqh, tafsir, and tasawuf, using yellow books as the main reference (Azra, 2013). However, along with the development of the times and the demands of globalization, Islamic boarding school are faced with the need to adapt to the development of modern science and technology.

This transformation is crucial considering that the progress of a nation in the Industrial Revolution 4.0 era is highly dependent on the capacity of human resources in mastering science and technology. In this context, the relevant question is: do Islamic boarding schools, as religious institutions, have the potential to contribute to the development and research of science and technology? The answer requires an in-depth study of the integration of Islamic science with modern science which is currently being developed in several Islamic boarding schools. Various literatures show that the integration of religious science and science is not a new idea in the Islamic treasury. In the classical Islamic scientific tradition, Muslim scientists such as Al-Farabi, Ibn Sina, and Al-Biruni have united religious and rational approaches in the development of science (Nasr, 1993). This concept was then renewed in contemporary thought through the Islamization of science movement popularized by Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi. Al-Attas (1980) emphasized the importance of “adab” in placing knowledge within a holistic monotheistic framework, which can essentially become an epistemological foundation for the integration of science and Islam in Islamic boarding school education. In the Indonesian context, several Islamic boarding schools have demonstrated progressive initiatives in integrating religious and scientific teaching, both through the development of an integrated curriculum and the establishment of simple research centers and science laboratories. The RMI-NU Islamic Boarding School of Technology, for example, developed an appropriate technology training program based on local needs, while the Darul Ihsan Islamic Boarding School of Science and the Daarut Tauhid Eco-Islamic boarding school implemented the principle of environmental sustainability based on Islamic teachings on *khilafah fil ardh* (Wahid, 2015; Haryono, 2021). These initiatives demonstrate that Islamic boarding schools have the latent capacity to become interdisciplinary learning centers that combine Islamic values with analytical and technological capabilities.

However, this integration is still partial and faces a number of obstacles. Studies by Zamzami (2022) and Wahid (2015) state that limited human resources who master science, minimal research facilities, and resistance from some Islamic boarding school circles to the modernization of science are still the main obstacles. In addition, the absence of a national policy that explicitly encourages science and technology research in Islamic boarding schools also hinders the development of this potential systematically.

Through a library research approach, this study aims to critically analyze the contribution of Islamic boarding schools to the development and research of science and technology with a focus on literature that discusses the integration of Islamic and scientific knowledge. This study is important to expand the discourse on Islamic education that is adaptive to the challenges of the times and encourages the formulation of policies that support Islamic boarding schools as centers of research and innovation based on Islamic values.

Problem Formulation

1. How does academic literature describe the contribution of Islamic boarding schools to the development of science and technology?
2. What is the form of the paradigm of science integration developed in Islamic boarding schools according to the literature study?
3. What are the recommendations to strengthen the role of Islamic boarding schools in interdisciplinary research?

Research Objectives

1. Review and analyze literature that discusses the relationship between Islamic boarding schools and the development of science and technology.
2. Identify models of science integration proposed or implemented in Islamic boarding schools.
3. Provide critical reviews and recommendations based on academic literature.

Methods

This study employs a qualitative approach using library research as its primary method. The data are collected from several sources, including academic books discussing Islamic boarding schools and the Islamization of science, scientific articles from both national and international journals, as well as official reports issued by government institutions and Islamic organizations such as RMI-NU, the Ministry of Religious Affairs, and UNESCO. The data analysis is carried out through a thematic literature review to identify the central issues, followed by content analysis to reveal dominant and alternative narratives within the discourse. To enhance the validity of the findings, literature triangulation is applied, ensuring that the arguments are both comprehensive and well-grounded.

Results and Discussion

A. How does academic literature describe the contribution of Islamic boarding schools to the development of science and technology?

1. The Concept of Integration of Science in Education

Academic literature consistently shows that Islamic boarding schools have a strong philosophical basis to contribute to the development of science and technology through the integration of religious and general sciences. This concept of integration is rooted in the paradigm of monotheism which views all knowledge as originating from Allah and has the aim of bringing humans closer to Him (Al-Attas, 1980; Nasr, 1993). In this framework, knowledge is not separated dichotomously between 'ulum ad-diniyyah (religious knowledge)

and 'ulum duniayah (worldly knowledge), but is viewed as an epistemological unity.

Islamic boarding schools as institutions based on Islamic values are believed to be able to pioneer the Islamization of science, namely efforts to make science and technology in line with Islamic values, without sacrificing rationality and scientific methods. This idea was developed by Syed Muhammad Naquib Al-Attas (1980), who emphasized the importance of adab in the use and development of knowledge.

Revitalization of Islamic Boarding Schools in the Current of Integration of Islamic Knowledge and Science

In the last few decades, Islamic boarding schools in Indonesia have experienced a significant paradigm shift, from traditional educational institutions to institutions that are adaptive to the development of the times. The revitalization of Islamic boarding schools in the current of integration of Islamic knowledge and science from various sources is as follows:

- a. **Curriculum Transformation: Integration of Islamic Knowledge and Science**
Traditional Islamic boarding schools in Indonesia have undergone significant transformation by integrating Islamic knowledge and science in their curriculum. The Tebuireng Science Boarding School in Jombang, for example, combines religious studies with science and technology, allowing students to understand the kauniyah verses in the Qur'an through a scientific approach. This reflects the efforts of Islamic boarding schools to eliminate the dichotomy between religious knowledge and worldly knowledge. *Unissula Journal+1 Hasanuddin University Journal+1*
- b. **Government Policy: Support for Modernization of Islamic Boarding Schools**
The Ministry of Religion of the Republic of Indonesia has recognized the strategic role of Islamic boarding schools in the development of science and technology. Through various programs, the government encourages Islamic boarding schools to adopt information and communication technology in the learning process, as well as develop a curriculum that integrates Islamic and scientific knowledge. This step aims to improve the quality of education in Islamic boarding schools and prepare students to face the challenges of the digital era.
- c. **Role of Islamic Organizations: RMI-PBNU Initiative**
Rabithah Ma'ahid Islamiyah Nahdlatul Ulama (RMI-PBNU) has taken the initiative to encourage Islamic boarding schools to adapt to technological developments. Through programs such as the Santri 4.0 Competition, RMI-PBNU seeks to improve digital literacy and technological skills of Islamic boarding schools, so that they can compete in the industrial era 4.0. This initiative demonstrates the commitment of Islamic organizations to strengthening the role of Islamic boarding schools in the fields of science and technology. *NU Online+3rmipbnu.id+3NU Online+3NU Online*
- d. **International Recognition: UNESCO and Islamic Boarding School Education**

UNESCO has recognized the excellence of the Islamic boarding school education system as an effective educational model in building the character and intellectuality of Islamic boarding schools. This recognition highlights the ability of Islamic boarding schools to integrate Islamic values with modern knowledge, including science and technology. This opens up opportunities for Islamic boarding schools to play a more active role in the global education arena. beritaedukasi.id+1NU Online+1Harian Sulsel

e. Challenges and Opportunities: Improving Capacity and Infrastructure

Despite progress, Islamic boarding schools still face challenges in terms of human resource capacity and technological infrastructure. Several Islamic boarding schools have developed curricula that integrate Islamic and scientific knowledge, but further efforts are still needed to improve the competence of teachers and supporting facilities. With the right support, Islamic boarding schools can become centers for holistic scientific development and contribute significantly to science and technology research. UIN Sunan Gunung Djati Library

B. What is the form of the paradigm of integration of knowledge developed in Islamic boarding schools according to the literature review

1. Paradigm of Integration of Knowledge: Conceptual Review

The paradigm of integration of knowledge in the context of Islamic boarding schools is a response to the dichotomy of knowledge between religious knowledge (*ulumuddin*) and worldly knowledge or modern science (*al-'ulum al-kauniyyah*). In the intellectual history of Islam, this dichotomy is not inherently known, because classical scholars such as Al-Farabi, Al-Ghazali, and Ibn Sina viewed all knowledge as part of the manifestation of revelation and reason, which originate from God Almighty (Nasr, 1993; Al-Attas, 1980).

Islamic boarding schools as traditional Islamic educational institutions have begun to adopt this spirit again in the form of an integrative paradigm, namely an approach that unites religious knowledge and science in one epistemological and axiological framework based on monotheism. In this paradigm, science is not positioned as a neutral science separate from values, but as part of *ilm nafi'* (useful science), which should bring humans to the benefit and strengthening of faith (Haryono, 2021).

Integration of Islamic Knowledge and Science in Islamic Boarding Schools: Holistic Curriculum Approach and Contemporary Relevance

In the global era marked by advances in science and technology, Islamic boarding schools as Islamic educational institutions are required not only to maintain the legacy of traditional knowledge, but also to adapt to the dynamics of the times. One form of this adaptation is through the development of an integrative curriculum that unites Islamic knowledge with science and general knowledge. Examples of the Integration of Islamic Knowledge and Science in Islamic Boarding Schools from various sources are as follows:

a. Modern Islamic boarding schools have developed a curriculum that integrates Islamic knowledge with science and technology. For example,

Islamic Boarding School Sains Tebuireng in Jombang combines religious studies with scientific disciplines, allowing students to understand the kauniyah verses in the Qur'an through a scientific approach. This reflects the school's effort to eliminate the dichotomy between religious knowledge and worldly knowledge (Hasanuddin University Journal).

- b. The Islamization of science approach further strengthens this integration by embedding Islamic values within the study and development of science. This perspective emphasizes that science does not contradict Islamic teachings but instead complements them. Islamic boarding schools therefore encourage students to explore science within the framework of Islamic values, resulting in a holistic and ethical understanding of knowledge (Academia; Hasanuddin University Journal; E-Jurnal).
- c. Another important approach is the integration-interconnection paradigm, which highlights the connection between religious knowledge and general knowledge. Rather than treating them as separate, this model positions both types of knowledge as interrelated and mutually enriching. With this integration, Islamic boarding schools can produce graduates who are equipped to face contemporary challenges while maintaining a strong Islamic foundation (Raden Intan Journal; Neliti; UIN Siber Syekh Nurjati Cirebon).
- d. Support from Islamic organizations and the government also plays a significant role in this development. Rabithah Ma'ahid Islamiyah Nahdlatul Ulama (RMI-PBNU) and the Ministry of Religious Affairs of Indonesia have initiated programs such as national seminars and curriculum development to promote integrative education. These initiatives aim to strengthen the role of Islamic boarding schools in advancing science and technology based on Islamic values. By developing a paradigm of science integration, Islamic boarding schools not only preserve Islamic traditions but also contribute to the creation of ethical science and technology rooted in Islamic principles.

2. Models of Science Integration in Islamic Boarding Schools

Based on literature studies, there are three main forms of science integration paradigms developed in Islamic boarding schools:

- a. The integrated curriculum model in Islamic boarding schools no longer separates religious knowledge from science but compiles them into one complementary educational structure. Subjects such as physics and biology are taught with a theological approach that emphasizes the order of nature as a sign of God's greatness (ayat kauniyah). An example of this implementation can be seen at Islamic Boarding School Sains Darul Ihsan in Yogyakarta, which applies such integration in its curriculum (Wahid, 2015).
- b. The Islamization of science model, on the other hand, emphasizes filtering and reframing modern sciences to align with Islamic values. This concept, developed from the thoughts of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi, is applied in several modern Islamic boarding schools

in the form of training and small-scale research based on the values of monotheism, justice, and social responsibility. Tebuireng Islamic Boarding School and Gontor Modern Islamic Boarding School have begun to implement this approach in student research activities (Zamzami, 2022).

- c. Meanwhile, the techno-social praxis model stresses the application of appropriate technologies developed by students based on Islamic values such as justice, sustainability, and independence. A concrete example can be found in the RMI-NU Jombang Technology Boarding School, which develops biogas, organic composters, and sharia-compliant hydroponic farming as part of its learning activities. In this paradigm, integration is not only theoretical but also has a direct impact on the environment and the surrounding community (Haryono, 2021; Wahid, 2015).

3. Philosophical Principles of Integration of Knowledge in Islamic Boarding Schools

The literature review also shows that Islamic boarding schools interpret the integration of knowledge not merely as a combination of curriculum content, but as a comprehensive paradigm encompassing epistemology, axiology, and methodology. Several fundamental principles underlie this paradigm. First, tawhid serves as the basis of epistemology, where all knowledge is regarded as part of Allah's revelation or the result of rational inquiry guided by divine values (Al-Attas, 1980). Second, there is an emphasis on balance between reason and revelation, meaning that no dichotomy exists between empirical and spiritual approaches; students are encouraged to use critical reasoning within the framework of faith (Nasr, 1993). Third, knowledge is perceived as a path to charity, where its purpose is not only to be understood theoretically but also to be practiced for the benefit of society (Zamzami, 2022).

Although ideal, the paradigm of knowledge integration in Islamic boarding schools is not free from challenges. Several studies highlight resistance from some Islamic boarding school communities toward modern science, which is sometimes viewed as a secular Western product. Moreover, limited human resources, inadequate research facilities, and the scarcity of scientific literature in Arabic or Indonesian remain obstacles that hinder the broader application of this paradigm (Kemenag, 2021; Haryono, 2021). However, these challenges also create new opportunities for collaboration between Islamic boarding schools and universities, ministries, and research institutions to formulate more contextual and sustainable approaches to integration.

C. What are the recommendations from the literature study to strengthen the role of Islamic boarding schools in interdisciplinary research?

Strengthening the integrative paradigm and literacy in Islamic boarding schools requires the internalization of the tauhidic paradigm into all dimensions of education, including research. This effort calls for curriculum revision and the

reorganization of teaching materials so that integration is not merely formalistic but epistemological in nature. One possible approach is the development of learning modules and training in research methodology that combine Islamic perspectives with science, supported by workshops for teachers and researchers on Islamic research methodology. The study of classical works discussing the philosophy of science, such as those by al-Ghazali, Ibn Khaldun, and Fakhruddin al-Razi, also provides a strong foundation for interdisciplinary research (Al-Attas, 1980; Nasr, 1993).

Collaboration between Islamic boarding schools and universities or research institutions represents another strategic pathway. Literature shows that such cooperation is one of the most effective means of fostering interdisciplinary research. Several pesantren that have partnered with universities have successfully established mini laboratories, technology entrepreneurship programs, and applied research training initiatives. To strengthen this collaboration, pesantren can expand research partnerships with faculties of science at Islamic and public universities, access research grants from the Ministry of Religious Affairs, the National Research and Innovation Agency (BRIN), or education-based NGOs, and create internship opportunities for students in technology-related research institutions (Kemendiknas, 2021).

The establishment of a pesantren-based research ecosystem is also vital. The social and cultural environment of pesantren strongly supports the development of a research tradition that is value-based, communal, and spiritual. However, this potential has not yet been systematically cultivated. To address this, pesantren can initiate centers for Islamic science studies or research and innovation institutes, allocate internal funds or community-based crowdfunding for small-scale student research projects, and encourage the publication of scientific works through pesantren journals or national journals such as *Al-Tarbiyah* or *Jurnal Sains Islami*.

Another critical step is the revitalization of the pesantren curriculum with a focus on applied sciences. A blended curriculum that combines sharia knowledge with practical fields such as food technology, renewable energy, and agriculture can be developed without reducing the authority of classical sciences. This integration can be realized through the incorporation of STEM content into *madrrasah diniyah* or *halaqah* activities, the production of textbooks that connect scientific concepts with sharia and ethical foundations, and the encouragement of final projects or assignments oriented toward social and ecological innovation (Zamzami, 2022).

Equally important is the strengthening of human resource capacity for interdisciplinary research. Studies reveal that the limited number of teachers and experts in science remains a major barrier in pesantren. Without adequate training in interdisciplinary methodology, research potential cannot be fully realized. To overcome this challenge, pesantren need to provide structured training in research methods for senior teachers and students, offer scholarships for pesantren graduates to pursue advanced studies in science and

technology, and invite practitioners from scientific fields who maintain a spiritual orientation and Islamic values (Haryono, 2021; Wahid, 2015).

The use of information and communication technology (ICT) is another crucial element in expanding the scope of pesantren research. ICT allows greater access to scientific resources and global networks of knowledge. For example, RMI-NU has collaborated with the Ministry of Communication and Information to provide satellite internet access to pesantren in support of education and research activities (NU Online). With stronger digital infrastructure, pesantren can engage more effectively in interdisciplinary research and contribute to technological development rooted in Islamic values. In addition, the establishment of interdisciplinary study centers within pesantren can serve as hubs for curriculum development, collaborative research, and academic activities that link various fields of knowledge.

By implementing these recommendations, Islamic boarding schools will be able to strengthen their role as institutions of interdisciplinary research and make meaningful contributions to the development of science and technology in ways that are ethical, contextual, and firmly grounded in Islamic principles.

Conclusion

The transformation of Islamic boarding schools in facing the challenges of the modern era shows significant progress in the integration of Islamic knowledge and science. Through a literature study approach, this study reveals that Islamic boarding schools have begun to play a role as educational institutions that not only instill religious values, but also develop scientific approaches that are relevant to technological developments. However, limited resources and policy support are obstacles that need to be overcome.

Islamic boarding schools have strategic potential in the development and research of science and technology through an integrated approach of Islamic knowledge and science. The three main forms of integration found are: integrative curriculum, Islamization of science, and application of technology based on Islamic values.

Islamic boarding schools not only play a role in religious education, but also have the potential to become interdisciplinary research centers that combine Islamic values with the progress of science and technology holistically.

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