

Utilization of Information Technology in Waste Management in Islamic Boarding Schools Baitul Qur'an as an Implementation of Continuing Education

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Abstract

This research focuses on the analysis of the application of information technology in the waste management system and its relationship with the implementation of sustainable education at the Baitul Qur'an Islamic Boarding School, Pringsewu, Lampung. The Background of the research is based on the increasing volume of waste in the Islamic boarding school environment and the low awareness of the residents of the Islamic boarding school regarding the importance of systematic and sustainable environmental management. As Islamic educational institutions, Islamic boarding schools have a moral, religious, and social responsibility to instill values of concern for nature, in accordance with Islamic teachings regarding trustworthiness, cleanliness, and preserving God's creation. The principles of Education for Sustainable Development (ESD) are an important foundation for forming consistent and sustainable ecological behavior. This research uses a descriptive qualitative approach with a case study design. The research results show that the use of information technology, such as digital waste banks, waste data collection applications, and cleanliness reporting systems, has a positive impact on the effectiveness of waste management in Islamic boarding schools. This technology simplifies the sorting, recording, and coordination processes between units. Furthermore, its implementation has increased students' ecological awareness, fostered clean living habits, and served as a contextual learning medium that integrates Islamic spiritual values with environmental management practices. Thus, technological innovation and values-based education have proven effective in creating an educational, efficient, and sustainable environmental management model in the Islamic boarding school environment.

Keywords: information technology, waste management, sustainable education, Islamic boarding schools, Islamic values

Introduction

The waste problem is a serious challenge faced by various educational institutions, including Islamic boarding schools (pesantren) as Islamic educational institutions that have a communal living system (El Madaniya, 2024). The daily activities of students, ranging from teaching and learning activities, daily consumption, to religious activities, produce quite a high volume of waste. If not handled systematically, the accumulation of waste can cause pollution, harm health, and reduce the comfort of the learning environment. In the context of Islamic boarding schools, this problem is very important because cleanliness is part of the fundamental teachings of Islam (Rafi Jawara et al., 2025), as the Prophet Muhammad said: "*Cleanliness is part of faith*" (HR. Muslim). Therefore, waste management in Islamic boarding schools is not just a physical effort to protect the environment, but also part of the implementation of spiritual values that teach responsibility and trust towards the natural creation of Allah SWT (Adinda Rizqi Nur Azizah & Fibrianis Puspita Anhar, 2025).

However, amidst increasing global awareness of environmental conservation, Islamic educational institutions still face various challenges in implementing the concept of *Education*

for Sustainable Development. (ESD) (Mufid et al., 2024). Many Islamic boarding schools do not yet have a planned and sustainable waste management system, while the integration between the educational curriculum and environmentally friendly practices has not been optimal. In fact, Islamic boarding schools have strategic potential as institutions that shape environmentally conscious character based on religious values. In line with the development of the digital era, information technology is present as an innovative solution to address the challenges of environmental management in educational institutions. Technology can be utilized to strengthen monitoring systems, cleanliness reporting, and environmental education through digital applications, smart trash bin sensors, and online learning platforms that support the habituation of ecological behavior among students (Buchanan et al., 2018).

Baitul Qur'an Islamic Boarding School serves as a concrete example of this innovation. Through the use of information technology, the Islamic boarding school strives to create an efficient, educational, and sustainable waste management system (Sujono Sujono et al., 2024). Administrators and students can actively participate in waste sorting, collection, and recycling activities with the support of a coordinated digital system (K.S.Abishek et al., 2025). This effort not only fosters a culture of cleanliness within the Islamic boarding school but also strengthens the values of sustainable education in line with Islamic teachings. Therefore, this study focuses on analyzing the use of information technology in waste management at Baitul Qur'an Islamic Boarding School and examining its contribution to the implementation of sustainable education in shaping the character of environmentally conscious students.

Recent research shows that the application of information technology in environmental management has been an effective strategy in increasing public awareness and participation in issues of cleanliness and sustainability (Hendra et al., 2024) A study conducted by (Setya & Novansyah, 2025) confirmed that the use of community-based digital applications can increase public participation in household waste sorting and processing activities. Similar findings were presented by (Diansyah et al., 2023) who showed that an information technology-based monitoring system can strengthen the transparency and effectiveness of environmental management policies in educational institutions because it can monitor the waste management process in real time.

(Liputo, 2025) *eco-school* programs emphasized the importance of collaboration between students, teachers, and school administrators in creating an environmentally friendly culture. This principle can be adapted in Islamic boarding schools through synergy between students and administrators to build ecological awareness based on Islamic values. (Alfiyah et al., 2024) added that the concept of sustainability in Islam encompasses not only ecological dimensions, but also moral and spiritual ones, where humans have a responsibility as caliphs to protect the earth from damage. Furthermore, Maryuni (2024) demonstrated the effectiveness of using digital waste banks in Islamic educational institutions as a contextual learning tool that not only increases waste management efficiency but also instills economic values and environmental responsibility in students. (Hafid et al., 2025) confirmed that an IT-based approach can shape sustainable ecological behavior in students by combining cognitive, affective, and psychomotor aspects in educational activities. Based on these various studies, it is seen that the use of information technology has great potential to create an effective, participatory, and educational waste management system in Islamic educational environments (Lingkungan et al., 2023)

In its theoretical framework, information technology (IT) is understood as a set of tools and systems used to collect, manage, store, and disseminate data to support decision-making (Permana & Ariana, 2022). In the context of environmental management, IT plays a crucial role in monitoring cleanliness conditions in real time, facilitating reporting, and optimizing sorting and recycling processes. Various innovations such as *smart bins*, *digital waste banks*, and *e-reporting* applications enable educational institutions, including Islamic boarding schools, to manage the environment more efficiently and transparently (Shinta Riana Putri & Erlin Kurniati, 2025)

In addition to its technological aspects, the concept of educational environment-based waste management is based on the 3R principle (*Reduce, Reuse, Recycle*), which emphasizes reducing waste production, reusing usable items, and recycling valuable materials (Putranto, 2023). In Islamic boarding schools, this principle can be realized through various activities such as waste sorting in dormitories, processing organic waste into compost, or creative recycling training for students. These activities not only create a clean environment but also provide educational value in shaping socially responsible behavior and love for the environment. Thus, waste management in Islamic boarding schools can be interpreted as an integral part of ecological character education oriented towards sustainability.

The concept of *Education for Sustainable Development (ESD)* as formulated by UNESCO (2017) emphasizes the importance of education that instills values, skills, and attitudes to build a sustainable future. From an Islamic perspective, this principle aligns with the teachings of monotheism which emphasize the balance between humans and nature (Widiastuty & Anwar, 2025) as stated by Allah SWT in QS. Al-A'raf [7]: 56, (Nurfauzi, 2022). The values of cleanliness, responsibility, and trustworthiness taught by Islam are the basis for students to maintain environmental sustainability (Fifi Risana et al., 2024). Islamic boarding schools, as the oldest Islamic educational institutions in Indonesia, have a strategic role in internalizing these values through the curriculum and extracurricular activities. By integrating ESD principles and Islamic teachings, Islamic boarding schools can transform into *eco-boarding schools* that not only produce a faithful and knowledgeable generation, but also one with environmental insight and a focus on the sustainability of life.

Methods

This research uses a descriptive qualitative approach with a case study type (Assyakurrohim et al., 2022), which aims to understand in depth the phenomenon of the application of information technology in waste management in Islamic boarding schools. This approach was chosen because it is able to describe conditions that occur in a real, factual, and contextual manner, and provides space for researchers to explore the meanings and social practices that develop in the field (Wulan et al., 2025). By using this method, researchers can describe the relationship between the application of technological systems and the formation of environmentally conscious behavior naturally according to the situation in Islamic boarding schools.

The research location was Baitul Qur'an Islamic Boarding School, located in Pringsewu Regency, Lampung Province. This Islamic boarding school was chosen because it has initiated the implementation of a digital-based waste management system and is committed to environmental education. These conditions make it a representative location to assess the

effectiveness of technological innovation in supporting the implementation of sustainable education in Islamic educational institutions.

The subjects in this study consisted of Asatidz (Islamic leaders), Islamic boarding school administrators, students, and parties directly involved in waste management using IT-based systems. The research object focused on the effectiveness of the technology implementation, the environmental education process carried out, and its impact on increasing the students' ecological awareness. Data collection techniques were carried out through three main methods. First, participatory observation, which was used to directly observe waste management activities and the use of digital media in Islamic boarding schools. Second, in-depth interviews with administrators, Asatidz (Islamic leaders), and students to gain an understanding of the experiences, perceptions, and challenges in utilizing information technology. Third, documentation in the form of photos, archived activity reports, social media, and digital reporting systems used by Islamic boarding schools that were relevant to the research theme. The combination of these three methods enabled data triangulation that strengthened the validity of the findings.

Data analysis was conducted using the interactive model of Miles , Huberman, and Saldana (2014) which includes three main stages: data condensation, data presentation, and drawing conclusions (Restu & Triyono, 2025). To ensure the validity and reliability of the data, this study used source and method triangulation techniques. Source triangulation was carried out by comparing information from various parties, such as Asatidz, Islamic boarding school administrators, students, and official institutional documents, while method triangulation was carried out by combining the results of observations, interviews, and documentation. This approach provides a more objective, comprehensive, and in-depth picture (Grisma Yuli Arta, 2024). Thus, the results of this study are expected to be able to contribute to the development of an effective information technology-based waste management model and are in line with the principles of sustainable education in Islamic boarding schools.

Discussion

Initial Conditions of Waste Management at Baitul Qur'an Islamic Boarding School

Before the implementation of information technology, the waste management system at the Baitul Qur'an Islamic Boarding School was still conventional and poorly structured. Management was carried out manually by students and administrators, relying on simple waste disposal bins that did not separate organic and inorganic waste (Zulfa et al., 2022). This pattern caused the volume of waste to continue to increase along with the increasing number of students and the relatively busy daily activities, such as the public kitchen, dormitory, and office activities of the boarding school. The lack of education about waste sorting meant that most boarding school residents lacked a strong ecological awareness, so that waste often piled up in the area behind the boarding school or was burned without further processing.

Furthermore, limited facilities and infrastructure are a major obstacle in maintaining the cleanliness of the Islamic boarding school environment. The lack of facilities such as separate trash bins, recycling areas, and cleanliness monitoring systems results in inefficient waste management. This phenomenon illustrates that before technology-based interventions were implemented, waste management at the Baitul Qur'an Islamic Boarding School was still at a traditional stage and required a more integrated system update. This is in line with Allah's

command in QS. Al-Baqarah [2]: 222, which indicates the importance of cleanliness as part of the sanctity and spiritual responsibility of Muslims (Yono et al., 2025).

Forms of Information Technology Utilization

The implementation of information technology at the Baitul Qur'an Islamic Boarding School is an innovative step in transforming its waste management system. The school has begun introducing a simple app-based digital system that allows online cleanliness reporting (Fattachil 'Izza et al., 2025). Through this app, students can report the condition of their trash bins, track collection schedules, and evaluate the cleaning team's performance. Furthermore, the school has developed online educational media such as instructional videos and infographics on waste management, recycling, and the reuse of used goods.

Some Islamic boarding schools have even initiated digital waste banks, where students can exchange inorganic waste for digital points that can be used to purchase necessities at the Islamic boarding school cooperative. Data management strategies are implemented by storing collection and sorting information in a cloud-based system, making it easier for administrators to conduct periodic evaluations and reports (Aulia et al., 2025). The roles of students, Asatidz, and administrators are crucial in this system, as they are the main agents of behavioral change. With a clear division of roles, students as field implementers, Asatidz, and administrators as controllers of the Islamic boarding school system have succeeded in creating a transparent, participatory, and measurable waste management ecosystem.

The application of information technology reflects the principle of "caliphate for the sake of Allah" (Palupi et al., 2025), as stated in QS. Al-Baqarah [2]: 30, that humans are assigned as caliphs on earth to protect and preserve nature. In this context, the use of technology becomes an instrument to carry out this mandate in a modern and efficient manner (Abdul Kadir et al., 2023).

The Impact of Information Technology Implementation on the Effectiveness of Waste Management

The research results show that the implementation of an information technology-based system has significantly impacted the effectiveness of waste management at the Baitul Qur'an Islamic Boarding School. In terms of efficiency, the waste sorting and collection process has become more organized because the collection schedule and data can be digitally monitored. The use of trash bin sensors that send notifications when full also helps the cleaning team act quickly.

In addition to increased efficiency, there has been a positive impact on environmental awareness among students (Tsauri, 2024). Through digital education and an app-based reporting system, student participation has increased dramatically. They are not only technology users but also active participants in maintaining environmental cleanliness. This awareness has developed into daily habits, such as sorting waste in their rooms, composting organic waste, and reducing the use of single-use plastics.

The application of technology also encourages the emergence of new innovations, such as the creation of *eco-bricks* from plastic waste and the development of a simple *smart bin* made by students majoring in applied science (Kamalova et al., 2025). These innovations prove that information technology is not only an administrative tool, but also a catalyst for creativity and project-based learning that supports sustainable education. As emphasized in QS. Ar-Rum [30]:

41, this verse is a reflection for humans to use knowledge and technology to repair damage, not worsen it (Simon, 1973).

Integration with the Concept of Continuing Education

The IT-based waste management program at the Baitul Qur'an Islamic Boarding School is not only practical but also educational, fostering the character of environmentally conscious students. Through this activity, the values of responsibility, discipline, and trustworthiness are instilled in students. The learning process extends beyond the classroom and is also implemented through environmental projects, digital cleanliness competitions, and *green education-based extracurricular activities*.

Waste management activities are integrated with the Islamic boarding school curriculum through the subjects of environmental fiqh, tahsin, and community social practices (Ulya, 2025). Each cleaning activity is linked to Islamic teachings, for example the principles of *thaharah* (cleanliness) and *amanah* (responsibility), which emphasize that maintaining environmental cleanliness is part of worship (Ristianah & Munir, 2025). This integration supports the goals of *Education for Sustainable Development (ESD)*, namely preparing a generation capable of critical thinking, ecological behavior, and implementing sustainable values in life (Ekawati et al., 2025). In a spiritual context, this is in line with the saying of the Prophet Muhammad: "*Cleanliness is part of faith*" (HR. Muslim). This hadith emphasizes that cleanliness, including in the context of waste management, is a manifestation of a Muslim's faith and morality.

Analysis and Discussion of Findings

Analytically, the research findings at Baitul Qur'an Islamic Boarding School align with UNESCO's *Education for Sustainable Development (ESD) theory*, where technology serves as a tool for building critical awareness and sustainable action. The application of IT in Islamic boarding school waste management strengthens the synergy between educational, social, and environmental aspects. These findings also align with previous research, such as a study by Inayah & Suprpto (2017) that found that a digital waste bank system in Islamic boarding schools increased student participation by up to 70%.

However, there are still challenges that need to be addressed, such as limited internet connections, the digital literacy skills of some students, and the need for ongoing training for Islamic boarding school administrators and asatidz so that the system can run optimally (Saepurrohman, 2025). Opportunities for future development include integrating the waste management system with a digital *dashboard* connected to village officials or local environmental services, so that Islamic boarding schools can become pilot models for sustainable digital *eco-Islamic boarding schools*. Thus, the application of information technology not only increases the effectiveness of waste management but also becomes a means of transforming the character education, independence, and spirituality of students (Suhartini Martiningsih, 2023). This confirms that Islamic boarding schools are capable of becoming pioneers in the application of green technology based on Islamic values, as the principle of monotheism that guides humans to care for the earth as a mandate from Allah SWT.

Conclusion

This study confirms that the application of information technology in waste management at the Baitul Qur'an Islamic Boarding School has had a significant positive impact on increasing the effectiveness and efficiency of environmental cleanliness activities. The use of digital systems such as a cleanliness reporting application, an online education platform, and a technology-based waste bank has simplified the process of sorting, collecting, and recycling waste. Through these applications, the Islamic boarding school administrators are able to manage data more systematically and transparently, while the students demonstrate greater involvement in maintaining the cleanliness of the Islamic boarding school environment. Thus, technological innovation functions not only as a managerial tool but also as a means of fostering strong ecological awareness among the Islamic boarding school community.

In addition, the results of this study show that the integration of information technology in waste management also contributes to strengthening the concept of sustainable education (*Education for Sustainable Development/ESD*), in the Islamic boarding school environment. Waste management activities linked to learning provide students with direct experience in instilling Islamic values such as cleanliness, responsibility, and trustworthiness. These values align with the principle of *rahmatan lil 'alamin* (*blessing for all the universe*), where education is directed toward developing individuals who care about environmental sustainability. Therefore, the implementation of IT at the Baitul Qur'an Islamic Boarding School can be considered successful in creating a clean, productive learning environment oriented toward Islamic values of sustainability.

Based on the research findings, several strategic recommendations can be used as a reference for developing similar policies in the future. First, it is crucial to improve the digital and environmental literacy capacity of Islamic boarding school students (*santri*), administrators, and religious teachers (*astidz*). Targeted training on the use of digital systems, data management, and an understanding of recycling principles will strengthen the sustainability of information technology implementation in waste management. Second, it is recommended to develop a more integrated and adaptive IT system, for example by adding sensor-based monitoring features, automated reporting, and a cleanliness evaluation *dashboard* to make the monitoring and decision-making process more effective.

Furthermore, collaboration between Islamic boarding schools, government agencies, universities, and environmental organizations is needed to support innovation and the development of more adequate technological facilities. Third, the IT-based waste management model implemented at Baitul Qur'an Islamic Boarding School can be used as a reference and adapted by other Islamic boarding schools according to the needs and local context of each institution. The widespread implementation of this model will encourage the formation of a network of *eco-Islamic boarding schools* that contribute to realizing an environmentally friendly and sustainable Islamic education system that reflects Islamic values of cleanliness and social responsibility towards nature.

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Conflict of interest

The author declares that there is no conflict of interest in the research, writing, or publication of this article. The entire research and manuscript preparation process was conducted independently without any influence from any party that could have influenced the results and interpretation of the research.

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