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Toward an AI-driven Islamic eco-campus model: bridging digital transformation and sustainability in Higher Education

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Abstract
In today's digital era, the use of Artificial Intelligence (AI) has become a tool to assist human work, including in achieving sustainability performance in higher education. This study aims to describe the implementation, strategies, supporting factors, and inhibiting factors of AI use in supporting sustainability performance in higher education. This qualitative study took the case of a State Islamic University (UIN) A, which was ranked among the top 10 in the UI GreenMetric awards. Data were obtained through interviews, observations, and documentation. Semi-structured interviews were conducted with 10 informants, both online and offline, in mid-2025. Observations were obtained during campus visits. Documentation was obtained from the campus website, UI GreenMetric, and documents obtained from the green campus management. The research results show that UIN A has used AI to support its sustainability performance, especially in energy, transportation, infrastructure, waste management, and education. Commitment from the leadership, solid team support, and financial support are important supporting factors in the success of sustainability performance on campus. Although there are still obstacles such as limited human resource competency in AI, data security, and limited integration of AI and existing systems on campus. This research provides a theoretical contribution in the development of the triple bottom line theory which is integrated with Islamic values, thus becoming the quadrant bottom line theory. The results of this study can also provide empirical evidence of campus support for sustainability issues. However, there are still many improvements and enhancements that need to be made by green campus management to provide maximum support for the Sustainability Development Goals (SDGs).

Keywords:
Artificial Intelligence; Islamic Higher Education; Smart Campus; Sustainable Performance; UI GreenMetric

A. INTRODUCTION

Since the adoption of the global Sustainability Development Goals (SDGs), all parties have strived to contribute to their achievement. Universities, as centers of research, innovation, and science, are also responsible for achieving the SDGs (de Cámara et al., 2021). One of the efforts undertaken by universities is achieving campus sustainability performance. Numerous factors support sustainability performance, one of which is Artificial Intelligence (AI). Recently, there has been a significant development in digital technology, particularly AI, in higher education (Adjekum et al., 2024). Previous research also found that AI supports green campus governance, including waste management, water, energy, transportation, and resources (Onwusinkwue et al., 2024).

This research focuses on the implementation and strategy of AI at universities participating in the UI GreenMetric event. UI GreenMetric is the first award event for sustainable campuses initiated by the University of Indonesia (UI). Sustainability performance measurement according to UI GreenMetric includes the implementation of sustainability activities in six areas:

infrastructure, water, waste, energy, transportation, education, and community service (UI GreenMetric, 2024). UI GreenMetric participants have increased significantly from year to year, with 1,477 universities from 95 countries participating in this event in 2024 (UI GreenMetric, 2024). Universities around the world have begun to realize the need to take part in supporting the SDGs by improving their sustainability performance (Eslava-Zapata et al., 2024).

One factor that can support improved sustainability performance is the use of AI as a tool for digitalization. Previous research in the context of higher education has found AI's support for sustainability performance in areas such as energy efficiency, sustainable governance, and improving the quality of research and community service (Mauro, 2024). Other research has also found that AI is successful in managing water and energy usage, adaptive learning systems, and is able to improve the performance of lecturers and students (Wen et al., 2024). The implementation of AI in higher education still faces many challenges, including: a lack of human resource readiness, ethical data governance, and energy infrastructure (Strzelecki et al., 2024). While previous research has linked AI to learning, few have examined AI's support for achieving sustainable performance. Research on the role of AI in sustainability has been conducted primarily in developed countries Francisco & Linnér, 2023). However, there has been limited research within the context of higher education institutions participating in the UI GreenMetric competition (Wang, 2024). Previous research has primarily used quantitative methods, but few have used exploratory, qualitative methods in a more in-depth social context. Furthermore, research integrating sustainability with Islamic values is still rare.

This study aims to describe and analyze the implementation, strategies, supporting factors, and inhibiting factors of AI's role in supporting sustainability performance at UIN A. UIN A is a participant in the UI GreenMetric sustainable campus award event, using qualitative methods. This approach was chosen to explore and provide a deeper understanding. This research theoretically supports the development of the triple bottom line theory in the context of Islamic higher education. Meanwhile, on a practical level, this research can serve as a basis for campus administrators in developing green transformation strategies and sustainable digitalization.

B. METHODS

This research uses a qualitative method with a case study technique that focuses on just one site. The object of this research is UIN A (pseudonym), one of the Islamic State Universities in Indonesia that successfully received a top ten ranking award at the UI GreenMetric event. UIN A has been included in the UI GreenMetric World University Rankings several times, with consistently improving achievements year after year. Most recently, the university was ranked among the top 10 most sustainable universities in Indonesia in 2024. The university's vision is to become "a leading, superior, and competitive state Islamic university in the development of science, technology, and the arts with an environmental perspective and religious moderation." This vision demonstrates the integration of Islamic values and sustainability.

The research data consisted of interviews, observations, and documentation. Semi-structured interviews were conducted with 10 informants consisting of UI GreenMetric managers, the head of general affairs, lecturers, and students at UIN A. Interviews were conducted online and offline for approximately 20 minutes each. Data on AI implementation and strategies in supporting sustainability performance were also obtained through observations of sustainability facilities at UIN A. This was also supported by documentation obtained from the UIN A website, UI GreenMetric, and documents obtained upon arrival. Data analysis was conducted using an interactive model from Miles et al. (2014). Data validity using source triangulation and method triangulation. Informed consent was obtained before the interviews were conducted. The data collected will be used solely for academic purposes.

C. RESULT & DISCUSSION

Based on the three research questions presented in the introduction, the results and discussion of this research can be explained as follows.

Table 1. Research Result

AI Implementation	The Strategic Role of AI	Supporting and Inhibiting Factors
Campus Digitalization and Academic Data Management Energy Efficiency and Green Infrastructure Waste Management and Digital Waste Smart Mobility and Transportation Strengthening Digital Culture and AI Literacy	AI in Energy Efficiency and the Environment AI in Academic Management and Research AI in Smart Transportation and Low Emissions AI in Governance and Public Services	Supporters: university leadership's commitment to digitalization and a green campus, collaboration between the IT unit and the GreenMetric Team, funding support from the Smart Islamic Campus project and Islamic values that encourage efficiency, cleanliness and environmental responsibility. Barriers: limited human resources with competency in the field of AI, data center infrastructure that still needs to be strengthened, ethical concerns regarding data privacy and security, and limitations in integration between AI systems across various campus units.

Source: Author's own

Implementation of AI Technology to Support Sustainability Performance

UIN A has participated in UI GreenMetric since 2018. Based on the 2024 report, the university was ranked 9th nationally and 71th globally for green universities (UI GreenMetric, 2024). UIN A's sustainability performance is supported by six main pillars. First, the development of campus environmental governance. Second, energy and climate management. Third, water management. Fourth, waste management. Fifth, an environmentally friendly transportation system. Finally, SDG-oriented education, research, and publications. Through the vision of "Green Campus and Smart Islamic University," the campus integrates the principles of sustainability, digitalization, and Islamic spirituality into university governance. Some of the AI implementations that have been carried out to support sustainability performance are as follows:

a. Campus Digitalization and Academic Data Management. UIN A has implemented various AI-based and automation systems to improve campus management efficiency. One informant stated that the university has developed an AI-based academic dashboard that can automatically analyze the performance of lecturers, students, and scientific publications. This system not only increases research productivity but also helps the university improve its score on the Education and Research indicator on UI GreenMetric.
b. Energy Efficiency and Green Infrastructure. In terms of energy, the university has begun implementing automatic sensors for lighting and air conditioning (AC) in several main buildings. This system uses a simple AI-based algorithm to detect human presence and automatically adjust temperature and lighting. Observations show a reduction in electricity consumption. UIN A also built solar panels, using a digital dashboard to report renewable energy production.
c. Digital Waste Management. UIN A uses a smart waste management program to manage daily waste volumes. This system limits the amount of waste, serving as a reminder to campus residents to avoid excessive waste generation. Additionally, there are campaigns promoting the use of plastic bottles and reducing paper in campus services.
d. Smart Transportation. UIN A is collaborating with a local startup to develop an AI-based mobile app for shuttle bus and bicycle use, as well as an environmentally friendly pedestrian system. Transportation mobility analysis on campus is managed using AI, with the hope of monitoring carbon emission reductions and transportation efficiency.
e. Strengthening Digital Culture and AI Literacy. AI can also provide digital literacy in teaching and learning activities on campus. UIN A conducts AI literacy training and workshops, particularly in teaching and research. There is an AI-based green campus program that integrates sustainability data into research and community service.

Based on the results of interviews, observations, and documentation conducted, there is strong support for strengthening the theory that AI can improve sustainability performance, especially in the management of transportation, waste, teaching, research, energy, and green infrastructure (Ahmad et al., 2022). UIN A provides support for sustainability issues not only because of the campus' obligation to support the SDGs, but also to carry out a transformation based on Islamic values, namely rahmatan lil 'alamin (Al-Qur'an, QS. Al-A'raf: 56). Conceptually, these results align with the Triple Bottom Line model (Loc et al., 2020), in which AI plays a role in improving the balance between environmental (planet), social (people), and economic (profit) aspects. However, in the context of UIN A, spiritual values (faith) are the fourth dimension that distinguishes the Islamic-based sustainability approach (Leechman et al., 2019).

The Strategic role of AI in Improving Sustainability Indicators

Research results show that AI has been implemented in several strategic sectors, namely:

a. AI in Energy Efficiency and the Environment. Through collaboration between the IT team and the Green Campus Team, the university developed an IoT sensor-based energy monitoring system combined with machine learning. This system enables automatic detection of inefficient electricity usage in campus buildings . Energy usage data is stored and processed using predictive algorithms to estimate daily electricity needs. According to the Green Metric team leader (2025):

"AI helps us detect rooms with high electricity consumption and provide automatic recommendations for efficiency."

Furthermore, UIN also uses an AI-based Waste Management system, which processes data on waste volumes on campus. Through image recognition, the system can identify waste types (organic, inorganic, and e-waste), simplifying the sorting process.

b. AI in Academic Management and Research. In the areas of academic governance and research, UIN A utilizes AI in the form of SIAKAD (academic system) and e-learning. These systems assist lecturers and students in managing teaching and learning activities and tracking their own performance.

c. AI in Smart Transportation and Low Emissions. In the area of transportation and carbon emission reduction, UIN A manages parking using vehicle sensors. There's also an app for renting bicycles and electric bicycles for easy access around campus.

d. AI in Governance and Public Services. The use of AI in the field of governance and public service is used to manage administration, student and academic services.

The three pillars of the triple bottom line: people, planet, and profit, are also supported by this research. These three pillars need to be synergized to support sustainable performance (Stone, 2023). In the environmental sector, AI is used to support the management of waste, water, energy, transportation, and campus resources (Katsamakas et al., 2019). AI is also used to support the improvement of the academic quality of lecturers and students, as well as digital services to support the social dimension of the three pillars of sustainable performance (Francisco & Linnér, 2023). Meanwhile, from the economic dimension, AI can be used to make decisions and save administrative costs, particularly in energy and waste reduction (Cath, 2018). The use of AI can also measure improvements in sustainable performance using the UI GreenMetric measure (Batki & Phudinawala, 2024).

Supporting and Inhibiting Factors for the Implementation of AI in Supporting Sustainability Performance

Sustainable performance is supported by several important factors, including: leadership commitment, financial support, and the green campus team. In addition to supporting factors, there are also factors that hinder the implementation of AI to support sustainable performance, including: limited human resources with competency in the field of AI, data center infrastructure that still needs to be strengthened, ethical concerns regarding data privacy and security, and limitations in integration between AI systems across various campus units. The successful implementation of AI in supporting sustainability performance, particularly in the context of

higher education, is not only supported by the commitment of leaders and academics, but also by Islamic values (Soodan et al., 2024). This fact provides empirical evidence that sustainability based on religious values is one way to create ethical innovation oriented towards the common good.

The development of the theory is a theoretical contribution in this research. The triple bottom line theory, consisting of three dimensions (Hammer & Pivo, 2016), is further developed by adding another dimension, faith, to form the quadrum bottom line. This fourth dimension is derived from essential Islamic values and serves as a guideline for Islamic higher education institutions in their actions and behavior. Empirical evidence of AI as a catalyst for sustainability performance is also generated in this study, which can accelerate the transformation of green campuses (Feng et al., 2024). The concept of an AI-based Islamic eco-campus integrates ecological responsibility and digital transformation that are in line with Islamic values (Bukhari et al., 2020).

In addition to theoretical contributions, this research also provides practical recommendations for various parties. For the green campus team, cross-sector collaboration, especially with the IT department, is needed regarding digitalization and the use of AI. University leaders need to strengthen green digitalization policies by using environmentally friendly AI infrastructure. Developing AI literacy for lecturers and students needs to be carried out by prioritizing humanitarian values and sustainability. For the Ministry of Religious Affairs and Higher Education, the results of this research can serve as a basis for strengthening AI-based sustainable higher education institutions. This research proposes the development of the previous theory, namely the triple bottom line theory which is integrated with Islamic values which then becomes the quadrant bottom line theory. Based on the research results above, it is possible to develop the existing triple bottom line theory as shown in the image below:

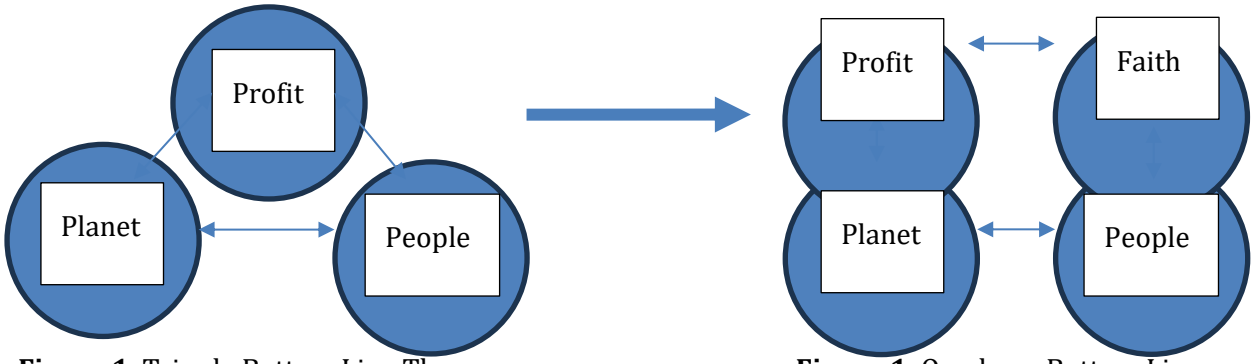

Figure 1. Tripple Bottom Line Theory.

Figure 1. Quadrum Bottom Line

D. CONCLUSION

The research results show that AI implementation to support campus sustainability performance is carried out through data digitization, energy and infrastructure, waste management, transportation, strengthening digital culture and AI literacy. The strategies implemented include using AI in energy efficiency, the environment, academic management, transportation and carbon emission reduction, governance, and public services. Supporting factors include: university leadership's commitment to digitalization and a green campus, collaboration between the IT unit and the GreenMetric Team, funding support from the Smart Islamic Campus project and Islamic values that encourage efficiency, cleanliness and environmental responsibility. Meanwhile, inhibiting factors include: limited human resources with competency in the field of AI, data center infrastructure that still needs to be strengthened, ethical concerns regarding data privacy and security, and limitations in the integration of AI systems across various campus units. AI is not only a tool for automation, but also encourages the achievement of a smart and equitable green campus. AI is not free from ethical issues; in fact, ethics are constantly being questioned in its use. Therefore, Islamic values can be used to prevent or mitigate ethical issues arising from AI use. Humans must be wise in using AI to avoid violating Islamic ethics and values.

Limitations always exist in any research that need to be refined in future studies. This study was limited to qualitative methods exploring the implementation, strategies, supporting factors, and inhibiting factors of AI use in supporting sustainability performance. The research also focused on a single sustainable campus site participating in the UI GreenMetric awards. A multiple case study technique could be used in future research to compare the results of two Islamic and Islamic campuses in terms of AI use and sustainability performance. Quantitative or mixed methods methods could also be used to test specific theories. The use of Islamic law could also be applied to examine issues of sustainability, ethics, and AI law in the context of education.

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