Journal of Infrastructure, Policy and Development 2025, 9(1), 10412.
https://doi.org/10.24294/jipd10412

Article

Towards Intelligent Universities Enhanced with Artificial Intelligence (AI)

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CITATION

Adel MAA, Abouelnour MM, Alhourani MI, Awad A. (2025). Towards intelligent universities enhanced with artificial intelligence (AI). Journal of Infrastructure, Policy and Development. 9(1): 10412. https://doi.org/10.24294/jipd10412

ARTICLE INFO

Received: 19 November 2024
Accepted: 3 December 2024
Available online: 13 January 2025

Abstract: This paper presents a comprehensive and integrated paradigm for intelligent universities using artificial intelligence (AI) to transform management systems and teaching, thus complementing sustainable development objectives. Through a systematic examination of top worldwide universities' AI applications, this study reveals key achievements, obstacles, and strategies for successfully implementing AI-driven intelligent universities. Every case study focuses on a particular AI-driven project, including the adaptive learning systems at MIT, the AI teaching assistant Jill Watson at Georgia Tech, and the AI-enabled quality control system at Cambridge University. Combining systematic review, meta-analysis, and case studies under a mixed-methods approach, the study provides a practical guide for implementing artificial intelligence to improve administrative and academic roles. Results show how artificial intelligence can solve institutional issues, automate quality assurance, and personalize learning. Recommendations advocate for gradual adoption strategies, ethical AI deployment, and capacity-building measures to enable sustainable digital transformation.

Keywords: artificial intelligence (AI); education quality; intelligent universities; machin learning; sustainable development

1. Introduction

The integration of artificial intelligence (AI) in higher education has witnessed rapid growth, especially in the third decade of the twenty-first century, with AI tools becoming increasingly pivotal. These tools enhance personalized learning, streamline administrative processes, and improve educational quality. AI's ability to forecast academic performance, adapt instructional methods, and provide timely feedback has positioned it as a transformative force in education, addressing modern academic and institutional challenges (Chu et al., 2022; Crompton and Burke, 2023; Kroshilin, 2022; Maltese, 2019; Payr, 2003; Teker at el., 2022).

As global competitiveness in education intensifies, universities must adopt innovative solutions like AI to remain relevant and sustainable. AI not only helps achieve personalized and efficient learning experiences but also aligns with sustainable development goals by improving resource utilization and institutional operations (Baig, 2024; Baca et al., 2024; Adel, 2022). This study aims to contribute a practical framework for integrating AI into universities, empowering them to address challenges and seize opportunities in education and management. The combined Digital Economy and Society Index (DESI) measures global digital performance and competitiveness. The DESI includes connectivity, internet-related human capital, internet services and online enterprises, digital technology integration, and digital

public services including e-government and e-health (Bucea-Manea-Țoniș et al., 2022).

Previous studies have explored AI's role in quality assurance, adaptive learning, and administrative efficiency. For instance, systems like MIT's adaptive learning frameworks and Georgia Tech's AI teaching assistants have demonstrated significant advancements in education. However, the majority of these studies remain theoretical or narrowly focused, leaving a gap in comprehensive, real-world applications and systematic frameworks.

Despite these advancements, a fully integrated intelligent university employing AI across all educational and administrative dimensions has yet to be achieved. Moreover, the lack of systematic studies addressing the challenges of AI adoption, such as resistance to change, ethical concerns, and high implementation costs, highlights the need for further exploration. This gap underscores the necessity of developing a holistic, flexible and scalable model for AI integration.

This study employs a mixed-methods approach , combining systematic reviews, meta-analysis, and case studies to examine global AI applications in higher education. By analyzing pioneering AI initiatives, such as personalized learning at MIT and quality assurance at Cambridge University, this research provides actionable strategies for implementing AI-driven intelligent universities. Its innovative focus on sustainability and ethical considerations ensures a balanced approach to digital transformation in education.

2. Literature review

Artificial intelligence is revolutionizing higher education by introducing innovative concepts to enhance quality, optimize administrative processes, and fulfill global sustainable development objectives. AI-operated universities are transforming administration, pedagogy, and education. Universities employ artificial intelligence to satisfy the need for personalized education, data-informed decision-making, and operational efficiency, while also confronting ethical dilemmas, resource constraints, and technology limitations (Alenezi et al., 2023; Crompton and Song, 2021; Mohamed, 2024; Mohamed et al., 2024). This section examines scholarly literature on worldwide success stories related to artificial intelligence in institutional sustainability, quality assurance, and personalized learning within universities. The evaluation of these contributions and opportunities for enhancement offers a comprehensive overview that enables organizations to utilize artificial intelligence technologies. AI's integration in higher education is proving to be a transformative force, driving improvements across quality assurance, personalized learning, and institutional sustainability.

Ivan et al. (2020) point to the need to modernize quality management processes since many universities in Indonesia struggle to meet professional academic accreditation standards due to manual processes and lack of accuracy. Thus, an internal AI quality assurance system is suggested to use digital data and algorithms to automatically improve, evaluate, and develop all aspects of higher education. This study underscores the potential of AI in addressing accuracy issues in quality management, making educational processes more efficient and reliable.

Nadu (2024) recommends strategies for improving education, reducing administrative burdens and, most importantly, improving learning for targeted

students, while attempting to address the challenges of this new trend regarding investing AI in higher education and quality assurance. The most significant of these challenges include limited data access, the need for comprehensive yet privacy-compliant data, resistance to change, particularly among senior faculty members, and the need for teaching staff and employees to be trained and sensitized to embrace development. The research paper recommends collaboration between teachers, administrators, policy makers and technicians to ensure the effective use of AI for the benefit of all students. The research demonstrates the importance of collaboration among stakeholders to maximize AI's benefits and overcome its implementation challenges.

In the research paper "Using Data Analysis and Artificial Intelligence to Achieving Quality Assurance in Higher Education Institutions", Mishra (2019) focuses on the role of AI data analysis in raising the quality of education and improving educational programs to increase student satisfaction and business growth of educational institutions. The research recommends large-scale surveys to be conducted, not only with university officials such as teachers, administrators and students, but also with samples from community members, and then utilizing AI to analyze these surveys in order to produce accurate results that would improve the quality of education. This study highlights the effectiveness of AI in generating actionable insights for improving student satisfaction and institutional growth.

A study by Buaton et al. (2022) proposes building a digital quality audit model that tracks the implementation of quality standards and academic accreditation at the tertiary level, noting that low quality in graduates' learning outcomes contradicts sustainable development and thus increases unemployment in Indonesia. This research emphasizes the role of AI in bridging the gap between educational standards and sustainable development goals.

Similarly, Zarlis et al. (2022) use Merdeka Learning Campus Merdeka Program in order to follow up on the implementation of quality standards. This study is keen on the integration of quality assurance, including the creation, implementation, evaluation, monitoring, and improvement of standards to help higher education institutions optimize the program's standards after the evaluation stage in which the standard is conducted, whether or not it has been achieved or deviated in the monitoring and improvement phase. Zarlis demonstrates how AI can ensure consistent monitoring and enhancement of quality assurance frameworks.

Chedrawi et al. (2019) attempt to validate the use of AI in the Three Experts System (ES), that is, software that relies on knowledge and limited human experience, to develop an academic accreditation process that improves results and quality with as little time, cost and error as possible. To achieve this, quality standards must be processed by Experts System (ES). Then, standards and systems must be developed in line with these three systems, and finally, a field study must be conducted to verify the results of this integration according to The Association to Advance Collegiate Schools of Business (AACSB). Chedrawi provides a practical example of how AI can revolutionize accreditation processes, ensuring efficiency and accuracy.

Somasundaram et al. (2020) indicate the importance of extrapolating all the student-specific study data available at university in order to predict future learning gaps, as well as to design appropriate plans for individual students to address their

weaknesses and shortcomings, so that each student can achieve academic excellence in going ahead with a specially designed plan, instead of the traditional approach including a common learning path for all students that does not take into account their specificities, differences, and weaknesses while seeking to design a study plan commensurate with their potential and vulnerabilities. This research shows how AI can tailor educational strategies to individual needs, fostering academic excellence.

Xiao et al. (2021) provide a more effective suggestion for students through using AI for personal unconventional training of students and for analyzing their knowledge before they enroll at university. The research proposes a way to extract modeling features from students' information, build an AI personal training model and predict the course of student development based on this model. This study illustrates the potential of AI in preparing students for higher education by providing them with tailored training before enrollment.

In a possibly most advanced study within the framework of Education 5.0, Rane et al. (2024) examine integrating AI into education by focusing on adaptive learning. The paper explores how AI systems dynamically adjust learning strategies based on real-time feedback of the learning process and learner progression, with the aim of improving the learning process by adapting content, frequency, and assessments to each student's abilities and style. The study examines the challenges and ethical considerations associated with the AI widespread adoption in education, in addition to assessing data privacy issues, bias in algorithms, and the influence of teacher-student relationships. The research highlights adaptive learning as a powerful tool to enhance student outcomes while addressing ethical and data privacy concerns.

Tobias et al. (2023) provide an effective model of an AI enabled quality management system to address gaps in audit processes caused by human errors and lack of technical knowledge concerning international quality standards and academic accreditation. This study illustrates how an AI enabled quality management system can match the audit results of accreditation compliance reports and internal quality audit reports with ISO 9001:2015. The researchers collected audit results data over the past five years. After processing the data, an LSTM deep neural network was created and trained by using MATLAB platform, and this AI model achieved an aggregated classification accuracy of 82.15% and predicted 70% of the audit results verified manually. Additional analysis demonstrates how AI can be optimized to produce useful and accurate audit reports for higher education institutions to develop and implement globally competitive education policies, programs, and standards. The study exemplifies how AI can elevate quality management to meet global education standards efficiently.

It is noted that the previous studies examine the AI uses in developing the quality of university education. In other words, they explore the AI contributions and its potential in raising the quality of higher education, including personal education that goes beyond the traditional method of education that adopts common curricula prescribed for all students without taking into account their needs and what suits each of them individually (Bera, 2019; Choi at el., 2021; Gould, 2019; Taneri, 2020). They also study adaptive education that updates teaching methods according to the immediate response to learning processes to reach more effective learning (Siirtola at el., 2019). However, these studies are theoretical; thus, the current study attempts to

go even further by focusing on the practical application of AI by looking at the latest experience in the field to introduce and build on it, so that this research could be an important resource for universities aspiring to move towards the concept of AI-enabled intelligent universities.

3. AI Contributions to Higher Education: Pioneer Experiences

3.1. Establishing the foundation for intelligent universities

It is time to develop successful models of intelligent universities as the advanced technological groundwork needed for such a digital transition is available. Universities, which have created intelligent cities and the Internet, are urgently required to continue their own mission to develop various aspects of human life (Jatoba et al., 2019). With this development, it is necessary to automate the quality management system in higher education as well as all related educational and administrative processes, in order to facilitate the measurement of achievement of learning outcomes and build on them to initiate the development process.

3.2. Successful applications of AI in higher education

This research seeks to examine successful experiences in using AI applications to enhance the quality of education and enrich the quality management system, in order to identify them as leading models to follow, build on and develop, to establish the concept of intelligent universities.

3.2.1. Academic analytics and early intervention

The "Signals" project at Purdue University uses academic analysis to improve student success. It gathers data on students' performance, such as test scores and class participation, and analyzes them to identify patterns that indicate potential difficulties. Alert signals (green, yellow, red) generate a level of hazard concerning academic performance. Based on these signals, appropriate academic or personal support is given to students. The project aims to improve students' knowledge and increase pass and graduation rates by using data-based tools to effectively monitor and guide students (Arnold, 2010; Arnold et al., 2012).

3.2.2. Virtual teaching assistants

Based on the need for invention principle, the use of AI applications in education development is in some cases a response to a need or solution to an emerging problem, as occurred in Georgia Tech's trial that faced the challenge of handling the massive amount of student queries in an AI course. To relieve the burden on human teaching staff, Professor Ashok Goel and his team developed a virtual teaching assistant called "Jill Watson", based on the IBM Watson technique. Jill Watson, which was launched on the electronic discussion board, was able to accurately answer 97% of common questions, allowing human teaching assistants to focus on more complex tasks and enhance personal interaction with students (Goel et al., 2018).

3.2.3. Chatbots for retention

To prevent dropouts among the new students, Georgia State University has launched the Pounce chatbot to help students adjust to college life and register for

courses. The project is still undergoing additional updates to provide students with academic support and remind them of assignments and tests. This Chatbot habot relies on AI to provide immediate answers to students' questions about school schedules, deadlines and university facilities. It made it easier for students to access necessary information, which helped reduce anxiety levels and increase confidence. As a result, enrollment rates increased, and dropout rates decreased significantly. Furthermore, Pounce has contributed to improving students' academic performance by providing timely support and guidance (Mdavis, 2022; Mohamed, 2024; Mohamed et al., 2024).

3.2.4. Predictive analytics for dropout prevention

Similarly, Nova Southeastern University tackles the problem of student dropout with "Aible" technology that identifies students most likely to drop out and thus provide support. Using AI and data analysis, the university is able to identify factors that increase the likelihood of students dropping out, and therefore provide support for them, including academic guidance and psychological and physical support. As a result, dropout rates fell by 17%. This experience reflects how technology can play a pivotal role in improving student outcomes and ensuring continuity of education (Aible, 2024).

3.2.5. Personalized learning systems

In another unique experiment, the Massachusetts Institute of Technology (MIT) provides student-specific learning experiments by utilizing AI to analyze learning patterns, through using the student data to determine the most effective educational methods for each individual student. The Institute has been able to improve academic performance and reduce failure rates by adapting content and teaching methods to the needs of individual students. The system is able to identify students' strengths and weaknesses, and therefore provides targeted support that enhances understanding of the courses and increases the chances of academic success (Project Overview 'Generative AI for Personalized Learning and Self-Development—MIT Media Lab, 2024).

3.3. Leveraging AI for quality management and social integration

AI extends beyond academics into quality assurance and social integration:

3.3.1. Quality management systems

The use of AI applications in a quality management system will advance the work of the academic institution in various fields through relying on the client (student) information. They are useful in anticipating the students' needs and can early detect the student satisfaction and be alerted to the potential for dropout and transfer to competing institutions (Jelonek et al., 2020).

3.3.2. Social matching for distance education

The Universities of Melbourne, New South Wales and Sydney have invented a technique called AI-based professional social matching that analyzes students' or alumni's personal data, including professional skills, experiences, interests, and career goals, to suggest the most suitable and compatible partners at university level or at postgraduate career level. The aim of this experiment was to break the social isolation of students using distance education, and to provide opportunities for scientific and

professional participation. (Cai et al., 2019; Wang et al., 2022).

3.4. Enhancing administrative efficiency with AI

AI has transformed administrative functions, such as recruitment and staff retention:

3.4.1. Streamlined recruitment

The experience of Mercy University (Strategic Artificial Intelligence Program, 2024) in preparing and adopting the CERTIFi program, enabling AI assist the human resources department in the recruitment process for the most qualified and worthy faculty and administrators according to the data of the applicants, can also be cited. This program saves a lot of time and effort in searching for the most qualified and worthy candidates, eliminate human biases, and ensure the greatest degree of transparency, by extrapolating the data of the applicants. This program can then identify the weaknesses of human resources workers and suggest training courses appropriate to their needs.

3.4.2. Staff retention

AI can also conduct employee satisfaction surveys to predict employee interest in continuing working or finding another job that would negatively affect the educational process, and to help move proactively to increase the retention of university staff (Jiang et al., 2018; Merlin et al., 2018).

3.5. Driving research excellence with AI

Cambridge University has developed the AI@Cam (2022) initiative to enhance research capabilities and expand their quantitative and qualitative capabilities to increase quality research outputs in a short period of time. The initiative focuses on interdisciplinary research, linking AI capabilities to fields such as physics, astronomy, and chemistry. Through this initiative, Cambridge University seeks to offer AI technologies useful to society and science, with an emphasis on innovation and moral responsibilities.

AI helps researchers perform robotic functions by guiding them to the most important research, thus cutting them a lot of time and effort (Bolanos et al., 2024). It also helps them to properly document the materials according to the publication procedures, as well as to find important and contemporary references. It can go further by automating data, classifying them, and identifying research gaps to overcome them (Rafik, 2023).

However, while artificial intelligence is effective and significant as a professional assistant to researchers, it cannot replace those researchers (Ridley, 2022). Such accessible preferences save a lot of time for researchers to devote themselves to more important matters like creativity and innovation.

3.6. Integrating AI across university facilities

For a holistic transformation, AI must be utilized across academic and administrative facilities. Examples include:

3.6.1. Security systems

With regard to the security and safety standard, AI can develop, upgrade and facilitate automatic use of this standard through the installation of automated surveillance cameras capable of recognizing faces (Li et al., 2024). Thus, distinguishing people who do not belong to this academic entity under surveillance is readily achieved, security and accuracy are increased, identifying sources of risk such as weapons and suspicious objects is automatically reinfoced (Arivalagan et al., 2024; Jacob et al., 2014), analyzing individual behavior such as unauthorized gatherings or thefts are made as well as identifying movements off duty and alerting security personnel are enhanced.

3.6.2. Sustainable energy solutions

As for a university intelligent environment, AI reinforces the use of renewable solar energy, which will be particularly favorable since the nature of the Arab environment, which has hot weather throughout the year, is consistent with that of investing in solar energy to maintain a healthy environment and meet the requirements of sustainable development. A good example for an intelligent environment is Stanford University, which by 2022, was able to meet 100% of its energy needs by using solar energy (Renewable Energy, 2024). Wind energy, as Harvard University has done since 2009 (Harvardgazette, 2009), can be relied upon to achieve sustainable environmental development and to reduce the carbon footprint, greenhouse emissions and long-term operational costs.

3.6.3. Adaptive testing and curriculum design

In terms of curriculum, a learning management system can be developed by using AI to analyze student performance to find weaknesses and strengths and then to develop curriculum accordingly, and the AI can tailor the educational content to individual student needs, preferences and past preferences (Sougleridi et al., 2024). In addition, AI can create adaptive tests for students which, based on algorithms, can determine how difficult questions are in real-time testing by relying on the student's response and ability to answer questions. Thus, adaptive tests can more accurately determine the extent of student knowledge and skills than standardized model tests can do, and they can help teachers identify where individual students need additional support (Kaswan et al., 2024).

3.7. Emerging frontiers: The metaverse

The Metaverse technology and its future impact on the development of interactive distance education cannot be ignored. This invention has revolutionized education, has increased interaction among students and has improved academic performance, especially as it suits disciplines such as rhetoric, biology, astronomy, and criminalistics. Some universities have pioneered its use. The University of California has created a virtual campus similar to the real one where students can interact to enhance learning process and increase learning pleasure (Goldberg, 2022). However, it is still expensive, so once it becomes more sophisticated and cheaper, it will be the most widely known and required future technology in the foreseeable term (kongpha et al., 2023).

4. Challenges of digital transition to AI-enhanced intelligent universities

Relying on AI requires avoiding any serious negative repercussions or side effects, such as privacy infringement, loss of jobs, prejudice, safety concerns, etc. (Chowdhury et al., 2023; George et al., 2013; Gong et al., 2022). This research reviews these challenges to ensure a reliable, considered, and loss-free digital transformation process that protects and further benefits all those involved in the educational process: students, teachers, administrators, communities, and even education investors. Like any technological advancement, AI involves both opportunities and challenges (Leoste et al., 2021), which requires empirical studies before being rolled out.

4.1. Opportunities and challenges of AI integration

AI can overcome challenges faced by higher education, including the enormous difficulty of collecting data important for building an educational development plan, such as the proportions of graduates with no failing courses,graduates securing employment within the first year after graduation, students retention rates, and the number of teaching staff compared to the numbers of students, as well as other data and statistics that need to be tracked annually to monitor weaknesses and find reasons of deficiency in any educational aspect, to effectively address them.

It becomes necessary to take into account statistics on labour market needs conducted by the competent authorities and to pursue the curricula development in a manner commensurate with the requirements of the labour market; that is, to guide students and provide them with educational outputs that fully reflect the academic needs of the labor market. However, this new digital approach would generate new challenges for the digital transformation itself, such as the high cost such a digital transformation would require (Abioye et al., 2021; Akinwalere et al., 2021; Crompton et al., 2021; Adel, 2024).

The current AI employing in higher education requires high funding, and this is one of the biggest challenges that cannot be ignored. Such step requires the formation of an AI team capable of implementing these programs to improve the quality of higher education, and this poses a challenge while setting the floor for a digital shift to an intelligent university model, but the costs will reduce later (Schiff, 2022), because AI will ease teaching staff and administrators from many routine burdens, such as student assessment, admission and enrollment processes, setting schedules, and designing lectures professionally, so that they devote themselves and direct their efforts towards creativity and development both in the educational process and its management, and there will be no need to reduce staff, but rather to redirect efforts and adapt to the new situation, to increase productivity, raise competencies, and focus more on academic research (Heilinger, 2023).

4.2. Administrative and academic efficiency

The implementation of AI is a relief for faculty members who do not publish research as they are busy in the teaching process, the quality requirements of year-round course files, academic supervising tasks, sometimes administrative matters such as committee work, etc. These activities take up the faculty's time and thus cannot

undertake research. Even more so is the complaint about the administrative burden teachers' face in the process of applying quality standards, which takes considerable time and effort at the expense of the educational process itself.

Quality procedures may distract teaching staff from the educational process, leading to unprofessionalism of standards implementation or affecting their accuracy, for many reasons, including (i) large numbers of students, which make the faculty unable to reconcile the requirements of the learning process with the quality and academic accreditation procedures represented in the need to prepare the course files required at the end of each semester for each course or class; (ii) the great detail of tracking the attainment of individual students' learning outcomes in short, midterm and final tests, assignments, presentations, research, and so forth (iii) and the more complex detail of asking faculty members to measure the achievement of learning outcomes thoroughly, which would be very burdensome for teachers.

4.3. Transformative impact of AI on education

The advent of AI will force radical shifts in education and its management. Suppose educational institutions wish to be more competitive in the quality of education. In that case, they are obliged to use AI to accelerate development in education and even in the management of the educational process (Klutka, 2018). The university administrators' tasks have changed after AI has become able to perform a large part of the management tasks related to administrative coordination and control; thus, the managers can focus on making decisions that are difficult for AI to intervene in, such as ethical considerations and reasoning, which require human expertise (Kolbjørnsrud, 2016).

These challenges can be overcome through professional development courses that are supposed to not only target the training of teaching staff and administrators and demonstrate the importance of new digital change and transformation to enhance quality and access to academic credentials but also to make these officials aware of the importance and necessity of keeping up with developments in higher education, focusing on those who are new and lack sufficient experience.

Many university academics and administrators believe the growing reliance on AI poses a risk of losing their jobs, and finding a new job will be a problem. Still, AI applications seek to accelerate development, make life easier, and help people accomplish their daily tasks more efficiently and with less time and effort (Wang, 2020).

4.4. Addressing human and ethical considerations

In addition, human and pedagogical guidance considers the emotional aspects of empathy and interaction between teachers and students. It considers ethical considerations of privacy in each environment and culture based on beliefs, races, customs, and religious affiliations. For example, in designing the content of lectures, AI can be directed to the need for content to be appropriate to the Arab environment, which is predominantly Islamic. Based on what is fed to AI, it produces content proportionate to its input, taking into account these peculiarities of the Arab environment, and AI outputs must be subject to human review and accreditation before

use.

With each development or change, unexpected problems arise. Therefore, it is necessary to share hands-on experience in the cautious transition and control the enthusiasm towards this new orientation. It is also a gradual, phased shift within a thoughtful year plan to include this digital shift to an intelligent university model that uses AI applications in its facilities in an integrated way that simplifies the learning process, increases its quality without complexity or misapplication, and avoids additional costs of some aspects of recruitment that are not yet feasible or tested.

4.5. Gradual implementation and future prospects

To achieve sustainable development, the university's infrastructure should be modernized by the latest developments in AI research. Still, it is preferable for emerging universities not to venture into new aspects of AI that have not been experienced before but to follow the early AI experiences of the leading universities until they reach advanced stages of using AI. Then, after having sufficient expertise, they can become pioneers in AI.

Studying at an intelligent university and obtaining an academic degree is desirable, with abundant prospects and opportunities in the same development-oriented labor market using AI applications. However, there is a slight fear that degrees issued from intelligent universities may be in doubt, and thus, graduates from traditional universities are preferred because traditional employers believe intelligent university graduates lack the skills of human interaction so crucial in the work environment (George, 2023),

It is the nature of humans to question every new novelty and prefer the familiar and usual, especially the old generations that hardly understand these radical shifts in the educational process. This doubt also arises from a lack of awareness about the new capabilities provided by AI and its applications. As humans are averse to what they are ignorant of, it is no wonder that graduates of intelligent universities face opposition from some traditional employers. It will take some time until the graduates of intelligent universities prove their excellence and superiority in various careers.

4.6. Urgency of AI adoption

Yet, graduates of traditional universities that do not adopt AI may face difficulty hiring large companies seeking elite graduates familiar with the latest technology. AI is no longer an option; it is an urgent necessity. Universities that delay in employing AI applications will risk excluding and challenging the quality of their traditional education, which is not in line with the latest developments and digital transitions. Accordingly, chances of obtaining domestic or international accreditation and ranking among world universities are affected, while universities using AI will be advantageous, reflecting a positive impression on accreditation that they consider modernity and open all avenues that promote their development.

5. Methodology

This study's methodology matches its novelty and starts with a comprehensive evaluation of historical studies to identify research gaps and trends in AI use to

improve education. Meta-Analysis then combines quantitative results from various research to reveal how AI technologies affect education quality. Finally, a narrative review examines qualitative studies to show how AI may encourage smarter institutions.

The research uses the most relevant academic research platforms and sites and selects current academic content from top international publications to assure quality and innovation. Thus, it uses live experience to create practical visions for academics, quality experts, policymakers, and others interested in improving higher education quality with AI.

This mixed-methods study examines university AI integration and its effects on institutional efficiency, sustainable development, and education quality. The qualitative and quantitative methodology ensures a complete analysis of AI's potential and challenges for higher education. Four components make up the approach:

Systematic Review: The research begins with a systematic review to evaluate the existing body of literature on AI applications in higher education.

Purpose: To identify trends, gaps, and best practices in leveraging AI for academic and administrative functions.

Process:

- A structured search of peer-reviewed journals, conference proceedings, and institutional reports was conducted using databases such as Scopus, Web of Science, and Google Scholar.
- Keywords such as "AI in educatio", "intelligent universities", and "AI and quality assurance" were used to filter relevant studies.
- Inclusion criteria focused on studies published in the last ten years, with significant emphasis on AI-driven initiatives in leading universities.
- A thematic analysis was performed to categorize findings into key areas such as personalized learning, quality assurance, and administrative efficiency.

Meta-Analysis: A meta-analytical approach was adopted to synthesize quantitative data from global case studies.

Purpose: To measure AI's impact on educational outcomes and institutional performance.

Process:

- Data was extracted from multiple empirical studies that provided statistical results on AI implementations in higher education.
- Metrics analyzed included improvements in student retention, learning outcomes, administrative efficiency, and cost reductions.
- The statistical analysis was conducted to compute effect sizes and assess the aggregated impact of AI technologies.
- Variance among studies was addressed using random-effects modeling to ensure robust and generalizable conclusions.

Case Studies: Detailed case studies were conducted to examine pioneering AI initiatives in prominent institutions such as MIT, Georgia Tech, and Cambridge University.

Purpose: To extract actionable insights and practical strategies from successful AI implementations.

Process:

- Each case study focused on a specific AI-driven initiative, such as MIT's adaptive learning systems, Georgia Tech's AI teaching assistant Jill Watson, and Cambridge University's AI-enabled quality management system.
- Data was collected through institutional reports, published case studies, and interviews with stakeholders where available.
- Thematic analysis was used to identify key success factors, challenges, and innovative practices.

Data Collection: Data collection involved synthesizing information from diverse sources to ensure comprehensive coverage of AI applications in higher education.

- Sources: Peer-reviewed articles, institutional reports, conference proceedings, and documented AI projects.
- Scope: The study examined initiatives across multiple academic contexts, including undergraduate and postgraduate education, administrative functions, and research environments.
- Analysis: Data was systematically analyzed to ensure the qualitative findings, enabling a nuanced understanding of AI's role in transforming universities into intelligent institutions.

Rationale for the Mixed-Methods Design: This methodological technique integrates the comprehensive nature of a systematic review and meta-analysis with the specific insights derived from case studies. It aims to underscore the measurable impacts of artificial intelligence technology on educational outcomes, provide evidence-based insights on global applications of artificial intelligence, and generate practical recommendations based on real-world implementations. The study seeks to offer practical insights for universities aiming to effectively integrate AI-driven intelligent systems through this robust and diverse methodology.

6. Findings and discussion

The results are presented in alignment with the study's research questions and objectives. They focus on analyzing global AI applications, addressing challenges in implementation, and assessing AI's impact on educational quality, student engagement, and institutional efficiency.

R.Q. 1: How is AI technologies utilized in higher education, and what impacts have they had on institutional and educational quality?

1) Personalized Learning and Academic Success:

- At MIT, AI-driven adaptive learning systems identified individual strengths and weaknesses, enabling personalized content delivery. This approach improved student performance and reduced failure rates.
- Purdue University's "Signals" project used predictive analytics to monitor student progress and provide targeted support. This led to higher graduation rates and better academic outcomes.

2) Advancements in Research:

- Cambridge University's AI@Cam initiative demonstrated how AI can optimize research processes by automating data analysis and identifying gaps.
- The interdisciplinary application of AI across fields such as physics and chemistry has expanded the scope and impact of research initiatives.

R.Q. 2: What challenges do universities face in adopting AI technologies, and how can these be mitigated?

1) Financial Constraints:

- High implementation costs remain a significant barrier, as seen in Georgia Tech's development of the "Jill Watson" teaching assistant. However, institutions noted long-term benefits, including reduced operational costs and improved efficiency.

2) Resistance to Change:

- Faculty and staff expressed concerns about AI replacing human roles. Programs like Mercy University's CERTIFi demonstrated how AI could complement rather than replace human efforts, focusing on enhancing recruitment and reducing workload.

3) Ethical and Privacy Concerns:

- Data security and algorithmic bias emerged as key issues. Institutions emphasized the importance of robust cybersecurity measures and transparent AI policies to address these challenges.

R.Q. 3: What key components should be included in a sustainable and adaptive framework for integrating AI into universities?

1) Sustainability Practices:

- Stanford University and Harvard University leveraged AI to integrate renewable energy solutions, achieving significant reductions in carbon emissions and operational costs.
- AI-enabled security systems enhanced campus safety through automated surveillance and risk detection.

2) Operational Efficiency:

- AI streamlined administrative processes, such as student enrollment, scheduling, and performance monitoring. Mercy University's recruitment system highlighted how AI could improve transparency and efficiency in human resource management.
- Phased Implementation:
- Successful institutions adopted AI through gradual integration, which reduced resistance and ensured effective resource allocation.

R.Q.4: How does AI influence student engagement, motivation, and retention in higher education?

1) Improving Retention Rates:

- Nova Southeastern University's "Aible" technology identified at-risk students and provided tailored support, resulting in a 17% reduction in dropout rates.
- Georgia State University's "Pounce" chatbot offered real-time assistance, reducing student anxiety and improving retention rates.

2) Enhancing Engagement:

- The University of California's use of Metaverse technology created interactive virtual campuses, increasing student participation and motivation, especially in fields like biology and rhetoric.

The findings demonstrate AI's transformative potential in higher education, as outlined below:

a) Enhancing Educational Quality: Adaptive learning systems and predictive analytics have significantly improved academic performance and institutional efficiency.
b) Addressing Challenges: Financial, ethical, and cultural barriers can be mitigated through phased implementation, targeted training, and robust policies.
c) Promoting Sustainability: AI applications have advanced renewable energy use and optimized resource allocation in universities.
d) Improving Engagement and Retention: AI tools like chatbots and virtual learning environments have increased student engagement and reduced dropout rates.

The findings highlight the transformative potential of AI in higher education, emphasizing several key areas of impact. First, adaptive learning systems and predictive analytics have notably enhanced educational quality by improving academic performance and institutional efficiency. Additionally, challenges such as financial, ethical, and cultural barriers can be addressed through phased implementation, targeted training, and robust policies. AI applications have also contributed to sustainability by advancing the use of renewable energy and optimizing resource allocation within universities. Furthermore, tools like chatbots and virtual learning environments have improved student engagement and reduced dropout rates, demonstrating AI's significant role in enhancing the overall educational experience.

These results highlight the necessity of a structured framework for integrating AI into universities, ensuring alignment with sustainability goals, and addressing the evolving needs of modern education.

Looking at the latest findings of leading universities in the AI use to raise the quality of education, the research concluded with a set of important findings that would lead to a qualitative shift in education development and management in higher education, which are listed as follows:

AI helps to automate the concept of personal and adaptive learning, saving faculty time and effort and helping them to identify the needs of each student, and thus to provide appropriate support, away from the traditional way in which it is difficult to discern the specific characteristics, tendencies and needs of each student.

AI can predict students' performance on the basis of past achievements and preferences, and thus suggest a remedial plan for those who are at risk of failing, which would increase success and retention rates, reduce student dropout rates and help the students learn about their own weaknesses and true levels, and this gives them the opportunity to make up for the shortfall by stepping up their efforts to pass the tests.

AI can reduce administrative burdens on faculty by automating various processes such as considering individual differences, evaluating students, setting school schedules, creating quality courses and measuring the level of achievement of learning outcomes, allowing teachers to focus more on development and innovation of education process and curriculum, designing content in innovative and interactive ways and facilitating academic publishing.

7. Conclusion

Given the human tendency to resist change, this research recommends organizing a series of training courses, workshops and seminars to train university officials and

students. These initiatives aim to raise awareness about the importance of adopting such a shift and to demonstrate its advantages in developing and raising the quality of education so that their conviction and willingness to adapt to it will help in its success and achieve the positive results expected of it, which cannot be achieved without concerted efforts and cooperation between the various actors, including teachers, educators, specialists and policy makers.

The research recommends that the model of intelligent universities enhanced with AI be achieved, because of its importance in raising the quality of education, reducing administrative burdens and long-term operational costs, preserving the environment by relying on green energy derived from sunlight and wind force and increasing the amount of security and safety by enhancing high-precision automatic monitoring.

The necessity of setting clear and controlling policies and updating them continuously due to the rapid revolutionary development in the field of AI applications in higher education, and warning of the caveats of using AI and subjecting it to experimentation before adopting it in its announced satisfactory version. Hence, the importance of benefiting from the successful experiences of leading universities and building on them and being cautious in any new AI applications until their feasibility is confirmed, taking into account ethical considerations, privacy and academic integrity.

This research paper calls for more study to explore the potential of AI in higher education. It would help harness AI's benefits and identify potential challenges to address.

Author contributions: Conceptualization, MAAA, MMA, MIA and AAA; methodology, MAAA; formal analysis, MAAA, AAA, MMA and MIA; writing—original draft preparation, MAAA; writing—review and editing, AAA; supervision, MAAA; funding acquisition: MAAA, MIA, AAA and MMA. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The authors would like to express their sincere gratitude to the esteemed reviewers and the dedicated journal editor for their valuable efforts in enhancing the quality and depth of this scientific research paper. Your constructive comments and insightful guidance have played a crucial role in refining this work into its current form. We greatly appreciate your time and dedication, especially the journal editor's support and attention to detail.

Conflict of interest: The authors declare no conflict of interest.

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