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EDUCATION

ARTIFICIAL INTELLIGENCE AND SUSTAINABILITY IN HIGHER EDUCATION IN RELATIONSHIP WITH UN SDGS AND VISION 2030

(SDG 4 (Quality Education), SDG 9 (Innovation), SDG 13 (Climate Action) and Social Pillar (Vision 2030)

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ABSTRACT

Background: Artificial Intelligence (AI) is increasingly transforming the higher education landscape globally. In Kenya, its potential aligns closely with development priorities set out in the United Nations Sustainable Development Goals (SDGs) and Kenya Vision 2030, particularly in promoting quality education, fostering innovation, and addressing climate change.

Purpose: The core objective of carrying out this systematic review of literature was to respond to the very critical question on the nexus between artificial intelligence and the sustainability in higher education in relationship with UN SDGs and Vision 2030.

Methods: The study adopts a qualitative, literature-based approach, synthesizing peer-reviewed articles, policy reports, and grey literature to analyze the dual impact of AI on educational sustainability.

Result: AI offers significant benefits in enhancing personalized learning, improving academic efficiency, supporting climate-related research, and driving institutional innovation. However, it also raises critical concerns, including digital inequality, ethical risks, academic dependency**,** and a notable environmental footprint through high energy and water consumption. The short-term advantages may obscure longer-term risks if not adequately addressed.

Conclusion and recommendation: To ensure that AI contributes positively to educational and national development outcomes, its adoption must be guided by evidence-based policy, contextual sensitivity, strong regulatory frameworks, and inclusive stakeholder engagement. Institutions must weigh both the short- and long-term implications of AI use and align technology deployment with Kenya's socio-economic goals and global sustainability commitments. Ultimately, the success of AI in higher education will depend not only on technological capabilities but also on ethical governance, equitable access, and sustainable implementation practices that safeguard both educational quality and environmental responsibility.

Key words*: Artificial Intelligence***,** *Higher Education, Sustainability, SDGs, Vision 2030*

1.0 BACKGROUND

Artificial intelligence is a specialty within computer science that is concerned with creating systems that can replicate human intelligence and problem-solving abilities. They do this by taking in a myriad of data, processing it, and learning from their past in order to streamline and improve in the future. A normal computer program would need human interference in order to fix bugs and improve processes (Tableau, 2025). Artificial Intelligence (AI) has a history stretching back to ancient times with concepts of thinking machines, but its modern development began in the mid-20th century with the advent of computers. Early research focused on mimicking human-like reasoning and problem-solving, with the Dartmouth Workshop in 1956 considered a foundational event. Over time, AI has evolved through various approaches, including rule-based systems and neural networks, leading to the diverse applications we see today (GPT, 2024).

The artificial intelligence (AI) landscape witnessed a pivotal moment in late 2022 with the release of OpenAI's ChatGPT. Dubbed the "ChatGPT revolution," this event marked a watershed in AI adoption, mainstreaming conversational AI into daily life and catalyzing interest in the technology from sectors worldwide. While ChatGPT's impact is undeniable, it is essential to recognize both the fundamental shifts it triggered in AI and the areas where AI remains consistent with previous trends. Before ChatGPT, AI was largely confined to niche applications in industries like healthcare, finance, and tech. ChatGPT democratized access to AI by placing conversational capabilities in the hands of millions. From writing essays to generating code, the AI's ability to perform various tasks made it relevant to individuals outside of traditional AI consumers, sparking a new wave of adoption.

Information technologies, particularly artificial intelligence (AI), are revolutionizing modern education. AI algorithms and educational robots are now integral to learning management and training systems, providing support for a wide array of teaching and learning activities ((Costa et al., 2017). Numerous applications of AI in education (AIED) have emerged. For example, Khan Academy offers Khanmigo, an AI tutor harnessing GPT-4 capabilities, delivering personalized learning support and intelligent feedback across various subjects, including mathematics, programming, and language learning. Similarly, Duolingo, a language learning platform, uses sophisticated AI systems to improve learner experiences (Bicknell, Brust, & Settles, 202. iFlyTek offers intelligent assessment systems tailored for various grading scenarios, including the national college entrance examination in China (iFlyTek, 2024). AI-powered learning management systems (LMS), such as Absorb LMS and Docebo, deliver multiple AI capabilities to support teaching and learning activities, such as intelligent content creation, administrative task automation, and personalized learning (Leh, 2022). In the realm of educational robots, Soft Bank Robotics Nao and Pepper robots are developed to serve as language-teaching social robots (Belpaeme & Tanaka, 2022).

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.The 17 SDGs are integrated—they

recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.Countries have committed to prioritize progress for those who're furthest behind. The SDGs are designed to end poverty, hunger, AIDS, and discrimination against women and girls.The creativity, knowhow, technology and financial resources from all of society is necessary to achieve the SDGs in every context. Sustainable Development Goal 4 (SDG 4) aims to ensure inclusive, equitable, and quality education for all by 2030. This includes free primary and secondary education, equal access to vocational training and higher education, and the elimination of gender and income disparities in education. Education is recognized as a key driver of sustainable development. SDG 9 emphasizes the importance of infrastructure, industrial development, and innovation as key drivers of economic growth and sustainable development. With urban populations expanding, the need for efficient transportation systems, renewable energy, and advanced technologies is increasing. SDG 13 focuses on urgent action to combat climate change and its impacts. Every country is experiencing the severe effects of climate change, with greenhouse gas emissions now over 50% higher than in 1990. Global warming is causing lasting changes to the climate system, threatening potentially irreversible damage (UN, 2015).

Kenya Vision 2030 is the long-term development blueprint for the country and is motivated by a collective aspiration for a better society by the year 2030. The aim of Kenya Vision 2030 is to create “a globally competitive and prosperous country with a high quality of life by 2030”. It aims to transform Kenya into “a newly-industrializing, middle income country providing a high quality of life to all its citizens in a clean and secure environment”. The Vision is a product of a highly participatory, consultative and inclusive stakeholders’ (international and local experts, ordinary Kenyans and stakeholders from all parts of the country) process carried out between October 2006 and May 2007. Between July and August 2007, the contents of the Vision 2030 were again subjected to open consultations in all provinces in Kenya before the document was finalized. It is anchored on three key pillars: Economic Pillar, Social Pillar and Political Pillar. Education and training are considered critical components in the realization of Kenya Vision 2030. As part of the Social Pillar, the government of Kenya envisions an education system that not only increases access to schooling but also delivers high-quality, relevant, and globally competitive knowledge and skills. The overarching goal is to develop a skilled, innovative, and productive human capital base to drive national development and support Kenya’s transition into a middle-income, industrialized country (Kenya Vision 2030, 2025).

The artificial intelligence comes in handy as a catalyst toward the realization SDGs and vision 2030 especially in the education sector. Artificial intelligence evolvement and advancement since its inception in 2022 has presented opportunities and challenges in equal measures. The actors in the educations sectors need to strike a balance on application of the artificial intelligence in the realization of the SDGs and vision 2030Jean-Baptiste Alphonse Karr, 1849”). It is against this background which forms the basis of this article’s objectives which was to critically review

empirical literature on the Artificial Intelligence and Sustainability in Higher Education in Relationship with UN SDGs and Vision 2030

2.0 EMPIRICAL LITERATURE REVIEW

Fernandes et al., (2024) in their study on Artificial intelligence and sustainability in higher education found that; artificial intelligence in higher education gained relevance with the advent of the Covid-19 pandemic. During this period, there was a significant change in the educational landscape, driving the adoption of innovative technologies to meet the demands of higher education. In this context, artificial intelligence emerged as a tool not only to enhance teaching methods but also to integrate sustainability concepts. This emphasis highlights the fundamental role of this technology and its impact on promoting quality education, contributing to the achievement of the Sustainable Development Goals (SDGs). Leal (2023) also support this by stating that technology can provide a significant contribution to achieving the United Nations' 17 Sustainable Development Goals (SDGs) through more comprehensive monitoring of data on actions toward the SDGs and sharing information among stakeholders.

Libertson, (2023), highlightd the role of artificial intelligence in "higher education," "e-learning," "challenges," "implementation," "strategy," "educational sustainability," "deep learning," "design," and "blockchain." The current context, marked by the increasing use of technology, has reflected on higher education institutions directing actions with a focus on sustainability, requiring the adaptation of their teaching methodologies to align with artificial intelligence. Although the literature emphasizes the benefits of artificial intelligence in education, in the context of higher education, there are many challenges regarding the use of this technology. One of the challenges is the lack of knowledge and skills of teachers to use AI in teaching. Educational community needs to develop new skills to diversify and expand teaching methods aiming to develop skills and competencies in students and teachers through the use of this technology. Focusing efforts on using AI to teach students about sustainability, it is possible to train committed professionals prepared to face the consequent challenges of the future.

According to Al Darayseh (2023), the presence of AI in the higher education system promotes a comprehensive educational revolution, anchored in the triad of sustainable education, innovation, and technological advances of Industry 4.0. AI not only personalizes learning to meet individual student needs but also brings a shift in how information is conveyed and absorbed. The connection of AI with Industry 4.0, big data, and the Internet of Things amplifies this transformation, enhancing the adoption of more agile and predictive approaches in higher education. This scenario, driven by the relationship of these technologies, not only optimizes operational efficiency but also prepares students for a future filled with challenges and opportunities, thus contributing to the formation of innovative professionals aware of the importance of sustainability in the global context.

According to Marquez (2023), AI in higher education, much research has emphasized the impact of this technology on students' teaching and learning, assessing its efficiency with the integration of sustainability performance concepts. Similarly, the incorporation of AI technologies like machine learning can be used as an instrument for sustainable data management, addressing environmental and energy-related issues. This relationship highlights the importance of AI in building a more efficient, student-centered academic environment aligned with emerging sustainability demands. Therefore, it is possible to observe that various AI related themes began to be investigated, initially related to Covid-19, e-learning, efficiency, and educational sustainability. Next, there is a highlight for themes involving AI and higher education relating to challenges, performance, systems, big data, innovation, industry 4.0, students, digital transformation, deep learning, design, Sustainable Development Goals (SDGs), artificial neural network, machine learning, and sustainability.

Nasir,(2023) in their study pointed out that, to achieve the Sustainable Development Goals (SDGs) of the UN (United Nations) proposed in Agenda 30, AI can help achieve these goals, such as ensuring quality education and access to information. Therefore, AI technologies have a significant role to play in both higher education and sustainable development. By providing personalized and data-driven educational tools, AI can enhance the quality and efficiency of education, as well as contribute to the achievement of the SDGs through its ability to provide data-driven solutions to complex economic, social, and environmental challenges. Educators and policymakers need to embrace the potential of AI to fully harness its benefits and contribute to a more sustainable future.

Filho et al., (2024) argue that Artificial intelligence (AI) can significantly contribute to the implementation of the United Nations Sustainable Development Goals (SDGs) by offering innovative solutions and enhancing the efficiency of processes aimed at achieving these goals.The researcher deployed a multi-methods approach. The first one was a bibliometric analysis of publications in the topic. The second method used was an assessment of a set of case studies, that illustrate how artificial intelligence is being deployed among a sample of universities in support of efforts to implement the SDGs and a survey aimed at identifying current and future trends.The paper has identified successful examples of the deployment of AI in various sustainability contexts, illustrating what are the success factors for them. Moreover, the survey identified the fact that the use of AI is quite widely spread, and is likely to increase in coming years, due to a greater demand. Finally, AI also poses several challenges, such as authenticity and ethics in assessment (case studies), ‘lack of access to software/materials’, and ‘lack of information technology training for myself/my colleagues’ (survey). Overall, AI offers a powerful toolset to accelerate and enhance the implementation of the UN SDGs. By analysing vast datasets, predicting outcomes, optimising processes, and providing new insights, AI has the potential to address complex sustainability challenges across various sectors.

Kim (2025) carried out a study on Artifcial Intelligence in Achieving Sustainable Development by drawing upon various qualitative data, including class observation, focus group interviews, and learning activity outcomes generated by 240 students across 7 diferent majors, this case study

explores the expected roles of AI as well as barriers to AI adoption for sustainable development perceived by undergraduate students. The study revealed that students anticipated AI to play diverse roles, including data analyst, a bridge to connect people and resources, and a barrier breaker. On the other hand, students addressed multiple barriers to AI adoption for sustainable development including access to high-quality data and lack of a goal-oriented AI model and skills in AI development and use. These fndings suggest how AI can be conceptualized and positioned as a development intervention as well as ofer implications on AI-driven interventions for SDGs.

AlSagri and Sohail (2024) evaluated the role of Artificial Intelligence in sustainable development goals with an emphasis on "quality education".In this study,the researcher argued that, the integration of Artifcial Intelligence (AI), particularly advancements in Generative AI technologies such as Large Language Models (LLMs)—of which ChatGPT is a notable example—marks a pivotal step in addressing global challenges within the framework of Sustainable Development Goals (SDGs). Specifcally, within SDG4 (Quality Education), these open AI technologies have the potential to revolutionize education by providing scalable, personalized learning experiences, improving access to quality education, and optimizing resource allocation. By reducing barriers to educational equity and supporting lifelong learning, AI contributes not only to enhancing educational outcomes but also to the broader pillars of sustainability—social, economic, and environmental. Despite these promising applications, the existing literature reveals signifcant gaps in understanding the full scope of AI's role in achieving SDGs. This study employs a bibliometric analysis to quantify the current research on AI's contribution to sustainable development, with a particular focus on educational quality and sustainability. Our analysis highlights emerging trends, key contributors, and prevalent themes in the academic discourse, providing a robust foundation for future research. We argue that a deeper understanding of AI's capabilities can inform more efective policies and strategic initiatives, fostering equitable and sustainable educational systems. Future research should further explore ethical considerations and long-term societal impacts of AI integration into education and other sectors. This study ofers a comprehensive overview of the current research landscape, identifes critical areas for future investigation, and sets the stage for continued academic inquiry into AI and sustainability.

Vinuesa, et al., (2020) carried out a study on the role of artificial intelligence in achieving the Sustainable Development Goals.In their ,they had a perspective that, the emergence of artificial intelligence (AI) and its progressively wider impact on many sectors requires an assessment of its effect on the achievement of the Sustainable Development Goals. Using a consensus-based expert elicitation process, we find that AI can enable the accomplishment of 134 targets across all the goals, but it may also inhibit 59 targets. However, current research foci overlook important aspects. The fast development of AI needs to be supported by the necessary regulatory insight and oversight for AI-based technologies to enable sustainable development. Failure to do so could result in gaps in transparency, safety, and ethical standards.

Zawacki-Richter etal., (2019) carried a study on Systematic review of research on artificial intelligence applications in higher education – where are the educators? In the study,the author

argues that; according to various international reports, Artificial Intelligence in Education (AIEd) is one of the currently emerging fields in educational technology. Whilst it has been around for about 30 years, it is still unclear for educators how to make pedagogical advantage of it on a broader scale, and how it can actually impact meaningfully on teaching and learning in higher education. This paper seeks to provide an overview of research on AI applications in higher education through a systematic review. Out of 2656 initially identified publications for the period between 2007 and 2018, 146 articles were included for final synthesis, according to explicit inclusion and exclusion criteria. The descriptive results show that most of the disciplines involved in AIEd papers come from Computer Science and STEM, and that quantitative methods were the most frequently used in empirical studies. The synthesis of results presents four areas of AIEd applications in academic support services, and institutional and administrative services: 1. profiling and prediction, 2. assessment and evaluation, 3. adaptive systems and personalisation, and 4. intelligent tutoring systems. The conclusions reflect on the almost lack of critical reflection of challenges and risks of AIEd, the weak connection to theoretical pedagogical perspectives, and the need for further exploration of ethical and educational approaches in the application of AIEd in higher education.

Dwivedi et al.,(2021) carried out a study on Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy.The study discuss that; As far back as the industrial revolution, significant development in technical innovation has succeeded in transforming numerous manual tasks and processes that had been in existence for decades where humans had reached the limits of physical capacity. Artificial Intelligence (AI) offers this same transformative potential for the augmentation and potential replacement of human tasks and activities within a wide range of industrial, intellectual and social applications. The pace of change for this new AI technological age is staggering, with new breakthroughs in algorithmic machine learning and autonomous decision-making, engendering new opportunities for continued innovation. The impact of AI could be significant, with industries ranging from: finance, healthcare, manufacturing, retail, supply chain, logistics and utilities, all potentially disrupted by the onset of AI technologies. The study brings together the collective insight from a number of leading expert contributors to highlight the significant opportunities, realistic assessment of impact, challenges and potential research agenda posed by the rapid emergence of AI within a number of domains: business and management, government, public sector, and science and technology. This research offers significant and timely insight to AI technology and its impact on the future of industry and society in general, whilst recognizing the societal and industrial influence on pace and direction of AI development.

Muchiri and Waweru (2024) argues that; Artificial Intelligence (AI) is revolutionizing sectors across the globe, and education is no exception. The integration of AI in higher education is reshaping traditional pedagogical practices, enhancing personalized learning, streamlining administrative tasks, and improving student engagement. In Kenya, this transformation is gaining momentum, with institutions embracing AI to drive educational reform. As AI becomes more

ingrained in the educational landscape, it brings both opportunities and challenges, especially regarding equity and accessibility. To navigate these complexities, the development of an AI competency framework for educators is crucial. The integration of AI into Kenya's higher education system presents a pivotal opportunity to enhance learning, improve administrative efficiency, and foster inclusivity. However, to fully realize these benefits, institutions must address the challenges of equity, access to technology, and educator preparedness. By developing a comprehensive AI competency framework, Kenya can empower educators to use AI responsibly and effectively, ensuring it serves as a tool for empowerment rather than exclusion. This holistic approach will contribute to a more inclusive, effective, and future-ready higher education system in Kenya, aligned with national goals and global trends in educational technology.

A study conducted by Dauner and Petrov(2025) from Hochschule München University of Applied Sciences explores the environmental implications of using large language models (LLMs), particularly when handling complex reasoning tasks in higher education and research contexts. The study evaluates the carbon emissions and energy costs associated with 14 different LLMs, focusing on how the depth and complexity of queries influence their ecological footprint. The researchers found that complex academic queries—such as those related to abstract algebra, philosophy, and logic—require significantly more computational power than simpler tasks. On average, these complex tasks generate up to 6 times more carbon emissions per query than straightforward factual questions. This discrepancy is primarily due to the generation of hundreds more "thinking tokens" required for reasoning-intensive outputs, which increases CPU and GPU utilization and extends processing time. Furthermore, the study identifies a clear accuracy–sustainability trade-off: models with higher reasoning accuracy tend to emit substantially more CO_2. For instance, LLMs achieving over 80% accuracy on complex tasks emitted nearly 500 grams of CO_2 per individual query**.** These findings raise sustainability concerns regarding widespread LLM integration in educational institutions, particularly where environmental commitments are central, such as under UN SDG 13 (Climate Action) and Vision 2030's ecological agenda. The study advocates for the development of more energy-efficient AI architectures and encourages responsible AI use in pedagogical settings.

Okulich-Kazarin, et al., (2023) argues that; the rapid development of artificial intelligence (AI) has affected higher education. Students now receive new tools that optimize the performance of current tasks. Universities have also begun implementing AI technologies to help university teachers and improve the quality of educational services and solve the Sustainable Development Goal 4. Hypothetically, it is possible to replace university teachers by using AI technologies. This is a hidden conflict of Sustainable Development Goal 4 and Sustainable Development Goal 8. This research aimed to examine the perceptions of Eastern European students about the possibility of replacing university teachers through AI technologies. The authors used an information study with a bibliometric analysis of 2000 sources, planning the experiments and compiling the questionnaire, surveying 599 students using an electronic questionnaire and cloud technologies, statistical processing questionnaires using Excel tables, and verifying statistical hypotheses. Verification of

statistical hypotheses for replies of 599 respondents showed that more than 10% of the surveyed students from Eastern European universities are confident that AI will replace university teachers in five years. It was shown that the opinions of students in the 1st stage (undergraduate study) from the countries of the European Union and countries outside the European Union have significant differences. The obtained results were proven using one-sided testing and standard hypothesis testing level, $\alpha = 0.05$. The article was completed with multilevel managerial and pedagogical recommendations. These recommendations are designed to increase higher education's sustainability in AI implementation.

3.0 MATERIAL AND METHODS

A systematic review was undertaken to evaluate Artificial Intelligence and Sustainability in Higher Education in Relationship with UN SDGs and Vision 2030. The methodology involved four key steps. The first step included literature search. A comprehensive search was conducted across databases such as PubMed and Google Scholar. Keywords including " artificial intelligence, and "sustainability in higher education," were used to find articles published in English. This search focused on identifying peer-reviewed articles, review papers, and empirical studies that explored AI's application in research writing. The second step was defining inclusion and exclusion criteria to refine search. Studies were included if they directly addressed AI's integration into research writing.

Step three included data extraction and synthesis. Information was extracted from the identified studies regarding the study main AI focus, key findings, AI integration in research writing, limitations, and recommendations. This data was then synthesized to identify areas where AI can support sustainability in higher education. The final step involved a detailed analysis of the extracted information to understand how AI can be used to support sustainability in higher education, the outcomes achieved, and potential areas for future application. This systematic approach was designed to rigorously assess the current state of AI in sustainability of higher education and identify avenues for further research and development. All works quoted in this study have been cited to avoid plagiarism or self-plagiarism.

4.0 RESULT AND FINDINGS

The search generated 50 potential studies. Duplicate studies 11 were excluded based on their titles while 12 were excluded based on the title and abstract review, where 13 cases were excluded as they did not meet the eligibility criteria. A total of 14 cases underwent a full text review. The analysis from the selected study identified a number of findings which demonstrate how artificial intelligence has enhanced sustainability in higher education with reference to SDGs and vision 2030 social pillar. A study by Zawacki-Richter etal., (2019) found that AI enhances personalized learning, automated feedback, and adaptive instruction systems in higher education which supports SDG 4 and vision 2030 pillar of ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all and providing globally competitive quality education, training, and research for development respectively. Dwivedi et al., (2021) found that AI's

enhances digital infrastructure and innovation ecosystems in sectors including higher education supporting SDG 9 on Industry, Innovation and Infrastructure. Rolnick, et al.,(2019) finding point out that; machine learning can support climate modeling, energy efficiency, and sustainable education practices aligned with SDG 13. Muchiri and Waweru (2024) in their study found that; AI enhances access, efficiency, and innovation in Kenyan universities, directly supporting Kenya Vision 2030's social pillar on education.

Some study found that Artificial intelligence have negative impact on higher education in relationship with SDGs and Vision 2030. A study Dauner and Petrov (2025) found that LLM queries demanding complex reasoning consume up to 6× more energy than simpler queries, generating significantly higher CO_2 emissions—even per query—pointing to environmental downsides of AI adoption. Artificial intelligence has also been critiqued due to contribution on Erosion of Critical Thinking & Academic Integrity. Various study points out that; Universities are currently facing AI cheating crisis where AI-generated work results to diluted educational trust. LLM-based grading poses serious ethical and practical issues: low transparency, poor replicability, privacy flaws, and reduced human oversight. There is also a risk of overdependence on AI such as diminished motivation, devaluation of traditional teaching, plagiarism, and vulnerability to bias from automated decisions (Al-Awadhi et al., 2025). There is also a threat to Teaching Jobs & Learning Depth where AI-driven teacher displacement lowers the economic sustainability of universities (SDG 8), reducing creative potential and quality-based employment (Okulich-Kazarin, et al., 2023).

Table 1: Summary of result; positive impact of artificial intelligence in higher education

SDG / Vision 2030 Pillar	Brief Description of the Pillar	AI Application in Higher Education	How It Supports Sustainability
SDG 4: Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	- AI-powered adaptive learning systems tailor content to student needs. - Intelligent tutoring systems improve individual outcomes. - AI enables real-time feedback and grading.	-Increases access to quality learning resources. -Enhances inclusivity for learners with disabilities or in remote areas. -Promotes equitable and personalized education.
SDG 9: Industry, Innovation & Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	- AI fosters innovation through research automation and data analysis. - Promotes development of EdTech solutions - Facilitates digital infrastructure in universities	- Drives innovation in pedagogy and operations - Supports STEM and AI-related curriculum development - Encourages a culture of research and problem-solving
SDG 13: Climate Action	Take urgent action to combat climate change and its impacts.	- AI tools optimize energy use on campus (smart buildings) - AI models analyze environmental data for awareness and action - AI supports research on climate solutions	-Reduces carbon footprint of university operations. -Builds climate literacy among students -Supports green campus initiatives
Vision 2030: Social Pillar (Education & Training)	Aims to provide globally competitive quality education, training, and research for development.	-AI supports data-driven policy decisions in education. - AI enhances capacity building and workforce readiness. -Supports e-learning and distance education.	-Accelerates human capital development. -Fosters equity, efficiency, and access in higher education. -Contributes to national development through skilled graduates.

Source: Author (2025)

Table 2: Summary of Result; negative impact of artificial intelligence in higher education

Pillar/Goal	Brief Description	Criticism of AI in Higher Education	Negative Sustainability Impact
SDG 4: Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	- Over-reliance on AI may reduce critical thinking and deep learning. - AI-generated content can increase plagiarism and undermine academic integrity. - Risk of inequity for students lacking digital access.	- Erodes authentic learning experiences. - Exacerbates digital divides in under-resourced institutions. - Undermines the long-term quality and credibility of education.
SDG 9: Industry, Innovation, and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	- Innovation driven by AI may lead to automation of academic and administrative jobs. - AI systems can entrench bias if not properly designed. - Infrastructure investments may prioritize tech over people.	- Reduces employment opportunities in the education sector. - Risks embedding systemic inequalities through algorithmic bias. - Displaces focus from human-centered innovation.
SDG 13: Climate Action	Take urgent action to combat climate change and its impacts.	- AI models consume high energy and water, especially for reasoning-intensive tasks. - Data centers supporting AI tools contribute significantly to CO_2 emissions. - AI encourages device dependence.	- Increases institutional carbon and water footprint. - Contradicts green campus and low-emission goals. - Shifts universities away from sustainable IT practices.
Vision 2030: Social Pillar (Education Sector)	Aims to provide globally competitive quality education, training, and research for development.	- AI may marginalize educators and reduce the value of human mentorship. - Ethical concerns over surveillance, data privacy, and decision transparency. - Misalignment with local socio-cultural needs.	- Undermines teacher empowerment and professional development. - Compromises inclusive, value-based education models. - Risks mis-fitting global AI trends into Kenya's contextualized goals.

Source: Author (2025)

5. CONCLUSIONS

The integration of Artificial Intelligence (AI) in higher education presents a double-edged sword in the context of sustainable development. On one hand, AI offers transformative potential to advance key global and national goals, including UN Sustainable Development Goals (SDG 4, 9, 13) and Kenya Vision 2030's Social Pillar. AI-powered learning systems enhance access, personalization, and innovation in teaching and research. These technologies have the capacity to optimize energy use, support climate research, and foster data-driven educational policies—making education more inclusive, efficient, and forward-looking.

However, the rapid and often uncritical adoption of AI raises serious concerns. Studies reveal that AI can undermine educational integrity, erode critical thinking, and contribute to social and digital inequalities. Technological overreach also threatens to displace educators, misalign with local socio-cultural needs, and introduce ethical and data privacy risks. Furthermore, the environmental costs of AI—especially in terms of energy and water consumption—may run counter to the very sustainability goals it aims to support, particularly SDG 13 (Climate Action)**.**

In conclusion, AI should not be viewed as a panacea but as a tool whose sustainability impact depends on how it is governed, designed, and implemented. The challenge for higher education institutions and policymakers lies in striking a balance—leveraging AI's benefits to enhance education quality and sustainability while addressing its risks through ethical, inclusive, and ecologically responsible practices**.** Such a balanced approach will be key to ensuring AI supports rather than hinders the realization of both global and national development visions.

6. LIMITATION OF THE STUDY

This study focused on exploring the role of Artificial Intelligence and Sustainability in Higher Education in Relationship with the UN Sustainable Development Goals (SDG 4, SDG 9, SDG 13) and Kenya Vision 2030's Social Pillar**.** As AI is still an emerging and rapidly evolving field, many of the studies reviewed are relatively recent and based on short-term assessments. Consequently, the reliability and validity of the findings may be limited, as long-term impacts remain largely unknown. The positive outcomes reported in some cases may reflect initial benefits that could differ significantly over time.

Additionally, the reviewed literature revealed contextual, conceptual, and methodological gaps. Some studies produced inconsistent or inconclusive findings, while others lacked statistical rigor or failed to clearly establish the significance of AI's impact on sustainability goals. A number of studies were also predictive or descriptive in nature, limiting the extent to which causality could be inferred.

This study was limited to a literature review approach, relying on secondary data and published academic and grey literature. Primary data collection and stakeholder engagement (e.g., from students, educators, or policy-makers) were not conducted. Furthermore, due to the rapid advancements in AI technologies, it is possible that recent and relevant sources were not fully

captured, and the review may not have exhausted all available literature in this dynamic and interdisciplinary field.

7. RECOMMENDATIONS

While the integration of Artificial Intelligence (AI) in higher education presents numerous opportunities aligned with sustainable development goals, it also brings significant challenges that must be carefully managed. To maximize its positive contributions while mitigating potential negative consequences, the following recommendations are proposed.

First, institutions should adopt AI strategically and responsibly, ensuring its application aligns with the objectives of SDG 4 (Quality Education) and the Social Pillar of Vision 2030. AI can support personalized learning, promote inclusivity, and enhance teaching efficiency; however, its use must not replace human interaction or diminish the development of critical thinking and ethical reasoning. Policies should be developed to balance AI support with human mentorship and pedagogical integrity**.**

Second, there is a need to build the capacity of educators, administrators, and students to effectively and ethically use AI tools. Training should focus not only on technical use but also on understanding the social, ethical, and sustainability dimensions of AI. This will help promote digital equity, reduce misuse, and foster a culture of responsible innovation.

Third, institutions should prioritize the use of environmentally sustainable AI technologies**,** especially in relation to SDG 13 (Climate Action)**.** Given the high energy and water consumption associated with some AI applications, universities should invest in energy-efficient systems, monitor their digital carbon footprint, and integrate sustainability criteria into digital procurement policies.

Fourth, higher education institutions and policymakers should work together to develop and enforce ethical, legal, and regulatory frameworks governing AI usage. These frameworks should address data privacy, algorithmic bias, academic integrity, and transparency to ensure that AI is used in a way that upholds human rights and educational values. Such oversight is essential to prevent the negative consequences associated with automation, surveillance, and inequality.

Fifth, it is important to encourage the development of locally relevant and inclusive AI solutions. AI tools should be customized to the needs of Kenyan universities and learners, reflecting local languages, curricula, infrastructure levels, and cultural contexts. This supports the goals of SDG 9 (Innovation) and Kenya's Vision 2030 by fostering innovation that is inclusive, equitable, and sustainable.

Sixth, further longitudinal and empirical research is needed to assess the long-term effects of AI in higher education. Much of the current literature reflects short-term or conceptual outcomes. Robust, data-driven studies will provide evidence to guide future investments, curriculum reforms, and technology governance in line with national development goals.

Lastly, successful integration of AI into higher education requires multi-stakeholder engagement. Universities should actively involve educators, students, IT professionals, and policymakers in planning, implementation, and monitoring of AI initiatives. Such collaborative approaches ensure that AI benefits are shared, concerns are addressed early, and adoption is both effective and sustainable.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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