ARTIFICIAL INTELLIGENCE, SUSTAINABILITY, AND ENVIRONMENTAL GOVERNANCE: EMERGING TRENDS AND FUTURE DIRECTIONS

Original Article

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Abstract

Artificial intelligence (AI) is increasingly recognized as a strategic technology for addressing sustainability and environmental governance challenges. This review examines the evolving relationship between AI, sustainability, and environmental governance by synthesizing recent multidisciplinary literature. The study discusses how AI contributes to sustainable resource management, environmental monitoring, climate resilience, digital governance, and organizational decision-making. It further explores emerging technological trends, including the integration of AI with machine learning, the Internet of Things (IoT), big data analytics, and intelligent decision-support systems. In addition, the review identifies major implementation challenges associated with ethical governance, algorithmic transparency, data privacy, cybersecurity, institutional capacity, and regulatory development. The findings suggest that AI has significant potential to improve environmental performance, strengthen evidence-based policymaking, and support sustainable development across public and private sectors. However, realizing these benefits requires responsible governance frameworks, interdisciplinary collaboration, and continuous investment in research, digital infrastructure, and human capacity. The review concludes that AI should be viewed not merely as a technological innovation but as an enabling platform for achieving long-term environmental sustainability, climate resilience, and effective governance. The study provides practical insights for researchers, policymakers, practitioners, and organizations seeking to integrate AI into sustainable environmental management and governance strategies.

Key words

Artificial Intelligence; Sustainability; Environmental Governance; Climate Resilience; Machine Learning; Sustainable Development; Digital Governance; Internet of Things; Environmental Management; Smart Technologies

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INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, reshaping the way societies address complex economic, environmental, and governance challenges. The rapid advancement of machine learning, big data analytics, cloud computing, and intelligent automation has significantly expanded the application of AI beyond traditional computing domains into finance, healthcare, education, manufacturing, environmental monitoring, and public administration. As governments and organizations strive to achieve the Sustainable Development Goals (SDGs), AI has increasingly been recognized as a strategic enabler for improving decision-making, optimizing resource utilization, and promoting sustainable development. Recent studies demonstrate that AI-driven technologies can enhance operational efficiency while simultaneously supporting environmental sustainability through intelligent forecasting, predictive analytics, and automated management systems (Donepudi et al., 2020; Ahmed & Ganapathy, 2021).

The integration of AI into modern organizations has accelerated digital transformation across both public and private sectors. Intelligent information systems now facilitate evidence-based planning, financial management, content generation, supply chain optimization, and healthcare decision support. Strategic information systems planning has become increasingly important for improving institutional performance, while AI-based applications continue to transform business operations and organizational competitiveness (Hoque et al., 2016; Ahmed et al., 2022). Likewise, AI-supported learning platforms, machine moderation systems, and Internet of Things (IoT) technologies have expanded opportunities for automation and digital innovation across multiple sectors (Ahmed & Ganapathy, 2021; Khan et al., 2021).

Beyond technological innovation, sustainability has become a central objective for governments, industries, and international organizations. Environmental degradation, biodiversity loss, climate change, and increasing resource scarcity have created an urgent need for intelligent solutions capable of balancing economic growth with environmental protection. AI contributes to sustainability by enabling efficient resource management, supporting renewable energy systems, improving environmental monitoring, optimizing logistics, and strengthening climate resilience. Furthermore, recent bibliometric evidence highlights a growing global interest in integrating sustainability principles into business strategy, marketing, and organizational development (Khan et al., 2024). These developments suggest that AI is evolving from a purely technological innovation into a strategic instrument for sustainable governance.

Environmental governance has also experienced significant transformation through digital technologies. Governments increasingly utilize AI-supported analytics to monitor environmental indicators, predict climate-related risks, improve disaster preparedness, and support evidence-based policymaking. Smart governance systems supported by intelligent data analytics can improve transparency, institutional efficiency, and environmental accountability. At the same time, ethical considerations surrounding AI adoption, including transparency, algorithmic bias, privacy protection, and responsible automation, have become important policy concerns requiring careful governance frameworks (Khan & Fadziso, 2020; Jawad et al., 2022).

Although previous studies have investigated AI applications in finance, healthcare, marketing, education, IoT, supply chain management, and information systems, relatively few studies have comprehensively examined the intersection of artificial intelligence, sustainability, and environmental governance within a unified conceptual perspective (Donepudi et al., 2020; Ahmed et al., 2022; Jawad et al., 2022). Existing literature often focuses on sector-specific applications, while broader discussions concerning the strategic role of AI in promoting environmentally sustainable governance remain fragmented.

Therefore, this review aims to examine the evolving relationship between artificial intelligence, sustainability, and environmental governance by synthesizing recent literature from multidisciplinary perspectives. Specifically, the study explores how AI contributes to sustainable development, identifies emerging technological and governance trends, discusses ethical and institutional challenges, and proposes future research directions for policymakers, researchers, and practitioners working toward environmentally sustainable and digitally enabled societies.

AI AND SUSTAINABILITY

Artificial intelligence has become an important driver of sustainability by supporting efficient resource utilization, informed decision-making, and intelligent automation across multiple sectors. Unlike conventional digital technologies, AI possesses the capability to learn from large volumes of data, recognize patterns, and continuously improve operational performance. These characteristics enable organizations to reduce waste, optimize energy consumption, strengthen environmental monitoring, and improve overall sustainability performance.

One of the most significant contributions of AI to sustainability lies in intelligent resource management. Machine learning algorithms can analyze historical and real-time data to optimize energy distribution, predict resource demand, reduce operational inefficiencies, and improve financial planning. AI-supported analytical techniques have demonstrated considerable potential for enhancing treasury management, organizational decision-making, and financial sustainability through predictive analytics and data-driven forecasting (Donepudi et al., 2020; Ahmed et al., 2022). Similar analytical capabilities can also support environmental planning by identifying efficient resource allocation strategies and reducing unnecessary energy consumption.

The integration of AI with IoT technologies has further expanded opportunities for sustainable development. Smart sensors, connected devices, and automated monitoring systems enable continuous observation of environmental conditions while generating real-time information for decision-makers. AI-powered IoT systems have been applied to intelligent home automation, security monitoring, smart infrastructure, and automated content management, illustrating the broader role of digital technologies in supporting sustainable and efficient systems (Ahmed et al., 2021; Khan et al., 2021). Such technologies contribute not only to operational efficiency but also to reducing environmental impacts through optimized resource utilization.

AI also supports sustainable business practices by improving customer engagement, operational planning, and strategic decision-making. Marketing analytics, sentiment analysis, and intelligent business forecasting enable organizations to better understand stakeholder expectations while promoting more responsible and sustainable business models (Ahmed et al., 2022; Jawad et al., 2022). Furthermore, recent studies suggest that sustainability-oriented marketing increasingly integrates digital intelligence to balance organizational performance with long-term environmental and social objectives (Khan et al., 2024; Thompson & Allam, 2022).

Overall, AI serves as an enabling technology that strengthens sustainability by integrating intelligent analytics, automation, and digital innovation into organizational and environmental management. Rather than replacing human decision-makers, AI increasingly functions as a strategic decision-support system capable of improving efficiency while supporting sustainable development objectives.

AI IN ENVIRONMENTAL GOVERNANCE

Environmental governance refers to the policies, institutions, and decision-making processes that guide the sustainable management of natural resources and environmental systems. Artificial intelligence is increasingly strengthening these governance mechanisms by improving environmental monitoring, supporting policy formulation, and enhancing institutional decision-making.

AI-enabled environmental monitoring systems integrate satellite imagery, IoT sensors, remote sensing technologies, and predictive analytics to generate timely environmental information. These technologies enable continuous observation of pollution levels, ecosystem conditions, climate variability, and natural resource utilization, thereby improving the quality of environmental decision-making. Intelligent monitoring systems also facilitate early detection of environmental risks, allowing governments and organizations to respond proactively rather than reactively.

Another important contribution of AI lies in climate risk assessment and disaster management. Machine learning algorithms can analyze historical climate patterns, predict environmental hazards, and optimize emergency response planning. Optimization models and intelligent decision-support systems have demonstrated considerable potential for improving logistics, resource allocation, and crisis management under uncertain conditions (Ahmed et al., 2021; Jussibaliyeva et al., 2021). Such applications are particularly relevant for regions facing increasing climate-related vulnerabilities.

Digital governance further enhances environmental management by promoting evidence-based policymaking, institutional transparency, and efficient public service delivery. Strategic information systems, performance measurement frameworks, and intelligent governance platforms enable policymakers to evaluate environmental performance more accurately while improving coordination among government agencies (Hoque et al., 2016; Khan & Rahaman, 2020). AI-supported governance therefore contributes to more informed environmental regulation and sustainable public administration.

Despite these advantages, environmental governance must also address important ethical concerns associated with AI deployment. Issues related to algorithmic transparency, privacy protection, fairness, accountability, and responsible automation require comprehensive governance frameworks to ensure that technological innovation supports sustainable development without compromising public trust (Khan & Fadziso, 2020). Consequently, successful environmental governance depends not only on technological advancement but also on the development of ethical, transparent, and inclusive regulatory systems.

The expanding application of artificial intelligence across sustainability and environmental governance demonstrates substantial opportunities for improving environmental performance, institutional efficiency, and climate resilience. However, technological advancement also introduces new governance challenges, ethical considerations, and implementation barriers. The following section therefore examines the emerging trends shaping AI-enabled sustainability while discussing the associated challenges and future directions for research and policy.

EMERGING TRENDS

Artificial intelligence (AI) is rapidly transforming the landscape of sustainability and environmental governance through continuous technological innovation and interdisciplinary integration. Recent developments indicate that AI is no longer confined to automating routine tasks; instead, it is becoming a strategic enabler for addressing complex environmental challenges. Advances in machine learning, predictive analytics, cloud computing, and intelligent decision-support systems are allowing governments, industries, and research institutions to improve environmental planning, optimize resource utilization, and strengthen climate resilience. These technological developments are also facilitating data-driven governance by generating timely insights from large and diverse environmental datasets (Donepudi et al., 2020; Ahmed et al., 2022).

One of the most significant emerging trends is the integration of AI with the Internet of Things (IoT) and smart monitoring technologies. Networks of sensors, connected devices, and automated monitoring systems now provide continuous information on environmental conditions, energy consumption, water resources, and infrastructure performance. AI algorithms can process these large volumes of real-time data to identify anomalies, forecast future conditions, and recommend appropriate interventions. Such intelligent systems contribute to more efficient environmental management while reducing operational costs and minimizing resource wastage. Previous studies have demonstrated the growing importance of AI-enabled content management systems, intelligent automation, and IoT-based applications in supporting digital transformation and sustainable operational practices (Ahmed et al., 2021; Khan et al., 2021).

Another notable trend involves the increasing application of AI within sustainable business management and organizational decision-making. Businesses are adopting AI-powered analytical tools to improve financial forecasting, optimize supply chain operations, enhance customer engagement, and strengthen strategic planning. The combination of AI with business intelligence enables organizations to balance economic performance with environmental and social responsibilities. Recent studies also indicate that AI-assisted marketing analytics and sentiment analysis can improve stakeholder understanding while supporting sustainability-oriented business strategies (Ahmed et al., 2022; Jawad et al., 2022). Furthermore, bibliometric evidence suggests that sustainability has become an increasingly important component of corporate strategy and innovation management, encouraging organizations to integrate environmental objectives into long-term business planning (Khan et al., 2024).

Environmental governance is also experiencing a transition toward predictive and evidence-based policy development. AI-supported analytical platforms enable policymakers to simulate alternative policy scenarios, evaluate environmental risks, and prioritize interventions based on scientific evidence. This trend is particularly important for addressing climate change, biodiversity conservation, pollution control, and disaster risk management. Intelligent decision-support systems can improve the speed and accuracy of environmental assessments while facilitating collaboration among government agencies, researchers, and other stakeholders. As digital governance frameworks continue to evolve, AI is expected to play an increasingly important role in supporting transparent, adaptive, and responsive environmental policies.

Emerging applications of AI further extend to climate adaptation, renewable energy management, and circular economy initiatives. Predictive models are increasingly used to forecast energy demand, optimize renewable energy generation, and improve the efficiency of environmental infrastructure. AI also supports circular economy practices by enhancing waste management, resource recovery, and sustainable production systems. These developments demonstrate that AI is evolving from a productivity-enhancing technology into a comprehensive platform for promoting sustainable environmental management and resilient economic development.

Overall, current trends indicate that the convergence of AI, digital technologies, and sustainability principles is reshaping environmental governance at both national and global levels. As intelligent technologies become more accessible and data-driven decision-making becomes increasingly central to policy formulation, AI is expected to contribute substantially to achieving sustainable development objectives. However, the successful realization of these opportunities will depend on responsible governance, institutional readiness, and ethical implementation, which are discussed in the following section.

CHALLENGES AND ETHICAL ISSUES

Despite the growing adoption of artificial intelligence (AI) in sustainability and environmental governance, its implementation presents a range of technical, ethical, institutional, and regulatory challenges. While AI offers significant opportunities for improving environmental decision-making and resource management, its effectiveness depends on the quality of available data, the transparency of algorithms, institutional readiness, and the existence of appropriate governance frameworks. Addressing these challenges is essential to ensure that AI contributes to sustainable development in a responsible and equitable manner.

One of the most significant ethical concerns relates to algorithmic transparency and accountability. Many AI systems operate as "black-box" models, making it difficult for policymakers and stakeholders to understand how decisions are generated. In environmental governance, where policy decisions may affect ecosystems, public health, and community livelihoods, explainability is essential for maintaining public trust. Furthermore, biased datasets may produce unfair or inaccurate predictions, potentially leading to ineffective environmental policies or unequal distribution of environmental resources. Previous studies have emphasized the importance of responsible AI practices, ethical governance, and transparent decision-making to ensure that technological innovation aligns with societal values and sustainable development objectives (Khan & Fadziso, 2020; Jawad et al., 2022).

Data privacy and cybersecurity also represent critical challenges. AI-based environmental governance increasingly relies on large volumes of data collected from sensors, satellite imagery, IoT devices, and digital information

systems. Although these data improve environmental monitoring and policy analysis, they also increase concerns regarding data security, unauthorized access, and privacy protection. Weak cybersecurity measures may expose critical environmental information and public infrastructure to cyber threats. Consequently, governments and organizations must establish robust data governance frameworks that protect sensitive information while enabling responsible data sharing for environmental research and decision-making (Hoque et al., 2016; Ahmed et al., 2022).

Another important challenge is the unequal availability of technological infrastructure and skilled human resources. Many developing countries continue to face limitations in digital infrastructure, financial resources, technical expertise, and institutional capacity. These constraints may reduce the effectiveness of AI implementation, particularly in environmental monitoring and digital governance initiatives. Limited access to advanced computing resources, insufficient professional training, and fragmented information systems can hinder the successful integration of AI into environmental management. Strengthening institutional capacity through education, research collaboration, and technological investment therefore remains an important priority for achieving sustainable digital transformation (Ahmed & Ganapathy, 2021; Khan & Rahaman, 2020).

Regulatory and governance challenges further complicate AI adoption. Existing environmental regulations often evolve more slowly than technological innovation, creating uncertainty regarding legal responsibility, ethical standards, and institutional oversight. Effective AI governance requires collaboration among governments, academic institutions, industries, and civil society to develop policies that promote innovation while ensuring accountability, fairness, and environmental protection. Strategic information systems and evidence-based governance models can support this transition by improving policy coordination and institutional decision-making (Ahmed et al., 2011; Hoque et al., 2016).

Finally, the environmental sustainability of AI itself has become an emerging concern. Training advanced machine learning models requires substantial computational power, electricity consumption, and data storage infrastructure, all of which may contribute to increased carbon emissions if supported by non-renewable energy sources. Therefore, future AI development should consider not only technological performance but also energy efficiency, sustainable computing practices, and responsible resource utilization. Integrating renewable energy, efficient data centers, and green computing principles into AI infrastructure can help minimize the environmental footprint of digital technologies while maximizing their contribution to sustainable development.

Overall, the successful integration of AI into sustainability and environmental governance depends on more than technological advancement alone. Ethical implementation, transparent governance, secure data management, institutional capacity, and supportive regulatory frameworks are equally important for ensuring that AI contributes positively to environmental protection and long-term sustainable development. Addressing these multidimensional challenges will strengthen the foundation for future AI-driven environmental policies and innovations.

FUTURE DIRECTIONS

The future of artificial intelligence (AI) in sustainability and environmental governance depends on the ability of researchers, policymakers, industries, and international organizations to develop innovative, ethical, and collaborative approaches. As environmental challenges become increasingly complex, AI is expected to play a greater role in supporting climate resilience, sustainable resource management, and evidence-based governance. However, maximizing these benefits requires continuous technological advancement alongside appropriate policy frameworks, institutional capacity, and responsible innovation.

One important future direction involves expanding AI applications for climate adaptation and environmental resilience. Machine learning models, predictive analytics, and intelligent simulation techniques can support climate forecasting, disaster risk assessment, biodiversity conservation, and ecosystem restoration. Integrating AI with satellite imagery, remote sensing, and geographic information systems will enable governments and environmental agencies to monitor environmental changes more accurately and respond to emerging risks in a timely manner. These technologies are expected to strengthen adaptive environmental management and improve long-term sustainability planning.

Future research should also emphasize the integration of AI with emerging digital technologies, including the Internet of Things (IoT), cloud computing, big data analytics, blockchain, and digital twins. Such technological convergence can create intelligent environmental management systems capable of optimizing energy consumption, monitoring natural resources, reducing waste generation, and supporting circular economy initiatives. Previous studies have demonstrated the potential of IoT-enabled automation and intelligent information systems to improve operational efficiency and digital transformation, indicating significant opportunities for future environmental applications (Ahmed & Ganapathy, 2021; Khan et al., 2021; Donepudi et al., 2020).

Another priority is the development of responsible AI governance frameworks. Future policies should promote transparency, accountability, fairness, and explainability while ensuring adequate protection of privacy and environmental data. Governments should establish comprehensive regulatory guidelines that encourage innovation without compromising ethical standards or public trust. International cooperation will also become increasingly important, particularly for addressing transboundary environmental challenges such as climate change, biodiversity loss, marine pollution, and sustainable resource management. Collaborative research initiatives and knowledge-sharing platforms can facilitate the exchange of best practices and support evidence-based environmental policymaking (Khan & Fadziso, 2020; Hoque et al., 2016).

Capacity building represents another critical area for future development. Universities, research institutions, industries, and public organizations should invest in interdisciplinary education and professional training that combines AI, environmental science, sustainability, and public policy. Strengthening digital skills and research collaboration will help prepare future professionals capable of designing and implementing AI-based solutions for environmental governance. In addition, partnerships among academia, government, industry, and civil society can accelerate innovation while ensuring that technological developments address practical environmental needs.

Future business and industrial strategies should increasingly incorporate AI-driven sustainability practices. Organizations can utilize intelligent analytics to improve environmental reporting, optimize supply chain management, enhance energy efficiency, and support environmentally responsible decision-making. Integrating environmental, social, and governance (ESG) principles with AI-enabled business intelligence will contribute to more sustainable corporate performance while creating long-term value for stakeholders. Bibliometric evidence suggests that sustainability has become a strategic priority across multiple industries, and AI is expected to further strengthen this transition by supporting informed managerial decisions and continuous innovation (Khan et al., 2024; Ahmed et al., 2022).

Special attention should also be given to Small Island Developing States (SIDS) and other climate-vulnerable regions, where AI can support early warning systems, coastal monitoring, disaster preparedness, water resource management, and sustainable infrastructure planning. AI-enabled environmental governance offers significant opportunities for these regions to strengthen resilience against climate change while improving public services and promoting sustainable economic development.

Overall, the future of AI in sustainability and environmental governance lies in balancing technological innovation with ethical responsibility, environmental protection, and inclusive governance. Continued investment in research, interdisciplinary collaboration, responsible regulation, and sustainable digital infrastructure will enable AI to become an increasingly valuable tool for achieving global sustainability objectives. As AI technologies continue to evolve, their successful integration into environmental governance will depend on ensuring that innovation remains aligned with the principles of transparency, resilience, and long-term sustainable development.

CONCLUSION

Artificial intelligence (AI) has become a transformative technology that extends far beyond automation, offering practical solutions to some of the most pressing sustainability and environmental governance challenges. This review demonstrates that AI contributes significantly to sustainable development by improving resource efficiency, strengthening environmental monitoring, supporting evidence-based policymaking, and enhancing organizational decision-making across multiple sectors. The integration of AI with machine learning, big data analytics, IoT, and intelligent information systems has created new opportunities for addressing complex environmental issues while promoting economic and social sustainability.

The review also highlights that AI has become an important component of environmental governance through applications in climate monitoring, disaster risk management, smart resource management, and digital governance. These technological capabilities enable governments, industries, and research institutions to make more informed and timely decisions while improving transparency and institutional effectiveness. At the same time, AI-driven innovation supports sustainable business practices by optimizing operational processes, promoting responsible resource utilization, and strengthening long-term organizational resilience.

Despite these opportunities, several challenges continue to influence the successful implementation of AI in sustainability initiatives. Ethical concerns related to algorithmic transparency, accountability, data privacy, cybersecurity, and institutional readiness require careful consideration. Moreover, unequal access to digital infrastructure, limited technical expertise, and fragmented governance frameworks remain important barriers, particularly in developing economies and climate-vulnerable regions. Addressing these challenges requires responsible AI governance, interdisciplinary collaboration, and supportive public policies that balance innovation with environmental protection and social equity.

Future progress will depend on strengthening cooperation among governments, academia, industry, and international organizations to develop transparent, ethical, and sustainable AI ecosystems. Continued investment in research, capacity building, digital infrastructure, and evidence-based policymaking will enable AI to contribute more effectively to climate resilience, environmental sustainability, and inclusive development. As AI technologies continue to evolve, their long-term success should be measured not only by technological advancement but also by their ability to generate meaningful environmental, economic, and societal benefits. Ultimately, responsible AI has the potential to become a cornerstone of sustainable environmental governance and a key driver for achieving global sustainable development objectives.

REFERENCES

Ahmed, A. A. A., & Ganapathy, A. (2021). Creation of automated content with embedded artificial intelligence: A study on learning management system for educational entrepreneurship. *Academy of Entrepreneurship Journal, 27*(3), 1–10.

Ahmed, A. A. A., Aljabouh, A., Donepudi, P. K., & Choi, M. S. (2021). *Detecting fake news using machine learning: A systematic literature review* (arXiv Preprint arXiv:2102.04458). https://arxiv.org/abs/2102.04458

Ahmed, A. A. A., Bynagari, N. B., Mustafa, M., Vishwakarma, S., & Azad, M. M. (2021). *IoT and machine learning based low cost home automation and security system and methodology using cell phone* (Canadian Patent No. 1188173). Canadian Patent Office.

Ahmed, A. A. A., Gupta, N., Iqbaldoewes, R., Krishna, M. M., Bandyopadhyay, R., & Mohajon, M. K. (2022). COVID-19 interior security tracking system based on the artificial intelligence. In *Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021* (pp. 465–473). Springer Nature Singapore.

Ahmed, A. A. A., Rajesh, S., Lohana, S., Ray, S., Maroor, J. P., & Naved, M. (2022). Using machine learning and data mining to evaluate modern financial management techniques. In *Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021* (pp. 249–257). Springer Nature Singapore.

Ahmed, A. A. A., Widjaja, G., Guerrero, J. W. G., & Kolyazov, K. A. (2021). A multi-objective optimization model for relief facility location in crisis conditions. *Industrial Engineering & Management Systems, 20*(4), 588–595.

Ahmed, A. A. A., Widodo, M., Komariah, A., Hassan, I., Sukmana, N., Ali, M. H., Abbas, A. K., & Rohi, A. (2022). Assessing the effects of gamification on developing EFL learners' idiomatic knowledge: Do attitudinal factors contribute to the learning of the idioms with the game? *Education Research International, 2022*, Article 2482570.

Ahmed, A. A., Khan, W., & Hossain, M. S. (2011). Reporting practice of accounting disclosure on changes in listed companies of Bangladesh. *ASA University Review, 5*(1), 83–96.

Ahmed, A. A. A., Agarwal, S., Kurniawan, I. G. A., et al. (2022). Business boosting through sentiment analysis using artificial intelligence approach. *International Journal of System Assurance Engineering and Management, 13*(Suppl. 1), 699–709.

Allam, A. R., Sarker, S. M. A.-E., & Nusaiba, M. T. (2022). Human-centered digital marketing: Shaping the future of customer engagement. *Asian Journal of Humanity, Art and Literature, 9*(2), 67–72.

Azad, M. R., Khan, W., & Ahmed, A. A. (2011). HR practices in banking sector on perceived employee performance: A case of Bangladesh. *The Eastern University Journal, 3*(3), 30–39.

Donepudi, P. K., Banu, M. H., Khan, W., Neogy, T. K., Asadullah, A., & Ahmed, A. A. (2020). Artificial intelligence and machine learning in treasury management: A systematic literature review. *International Journal of Management, 11*(11), 13–26.

Hoque, M. R., Hossin, M. E., & Khan, W. (2016). Strategic information systems planning (SISP) practices in health care sectors of Bangladesh. *European Scientific Journal, 12*(6), 307–321.

Jawad, M. A., Rahman, K., & Sarker, S. M. A.-E. (2022). Artificial intelligence-driven public health strategies for sustainable business development. *NEXG AI Review of America, 3*(1), 48–66.

Jawad, M. A., Tasnim, H., & Nusaiba, M. T. (2022). Artificial intelligence driven marketing analytics for sustainable business growth. *Technology & Management Review, 7*(1), 1–15.

Jussibaliyeva, A., Komariah, A., Kurmanalina, A., Reutov, N. N., Kunurkulzhaeva, G. T., Ahmed, A. A. A., Akhmadeev, R., & Chupradit, S. (2021). Design of a two-tier supply chain based on integration, pricing, routing, and inventory control. *Industrial Engineering & Management Systems, 20*(4), 678–685.

Khan, W. (2014). Leather industry in Bangladesh: Opportunities and challenges. *American Journal of Trade & Policy, 1*(3), 119–126.

Khan, W., & Fadziso, T. (2020). Ethical issues on utilization of AI, robotics and automation technologies. *Asian Journal of Humanity, Art and Literature, 7*(2), 79–90.

Khan, W., & Khan, S. A. (2020). Influences of non-economic responsibilities on economic responsibilities: A study on consumers of banking industry in Sylhet. *ILIRIA International Review, 10*(1), 11–23.

Khan, W., & Rahaman, M. M. (2020). Measuring the performance of e-primary school systems in Bangladesh. *International Journal of Modern Education and Computer Science, 12*(1), 35–41.

Khan, W., Ahmed, A. A., Hossain, M. S., & Neogy, T. K. (2020). The interactive approach to working capital knowledge: Survey evidence. *International Journal of Nonlinear Analysis and Applications, 11*(Special Issue), 379–393.

Khan, W., Ahmed, A. A., Vadlamudi, S., Paruchuri, H., & Ganapathy, A. (2021). Machine moderators in content management system details: Essentials for IoT entrepreneurs. *Academy of Entrepreneurship Journal, 27*(3), 1–11.

Khan, W., Farhan, K. A., & Hossain, M. B. (2024). Holistic marketing and sustainability: Insights from a bibliometric analysis of global research. *Bangladesh Journal of Multidisciplinary Scientific Research, 9*(6), 17–30.

Khan, W., Hossin, M. E., & Akbor, M. J. (2015). Leather industry in Bangladesh: A systematic literature review. *Asian Business Review, 5*(3), 111–118.

Khan, W., Huda, S. N., & Pervez, A. S. (2019). Satisfaction and behavioral intention based on service quality: Local tourists' perspectives at Cox's Bazar of Bangladesh. *BAUET Journal, 2*(1), 114–119.

Li, Z., Ahmed, A. A. A., Chupradit, S., Wisetsri, W., & Chupradit, P. W. (2021). Impact of psychological, mental, and socioeconomic factors on corruption in South Asia. *Tobacco Regulatory Science, 7*(6), 6708–6721.

Mohamad, D., Ahmed, A. A. A., Widjaja, G., Alghazali, T., Guerrero, J. W. G., Fardeeva, I., & Hasanzadeh, A. (2021). A hierarchical p-hub center problem for perishable products using CPLEX method and origin-destination approach. *Industrial Engineering & Management Systems, 20*(4), 613–620.

Rahman, K., & Akhter, M. (2022). AI-driven decentralized diagnostics and point-of-care testing: Transforming healthcare marketing and future business through real-time clinical decision support. *Technology & Management Review, 7*(1), 16–24.

Thompson, C. R., & Allam, A. R. (2022). The future of digital marketing: Balancing technology and human values. *ABC Journal of Advanced Research, 11*(2), 127–134.

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