EMERGING RESEARCH TRENDS IN COMPUTER SCIENCE: A BIBLIOMETRIC ANALYSIS

JAPHET KAIJAGE KASHAIJA AND JANE LISSAH
Email: japhet.kashaija@atc.ac.tz, jane.lissah@atc.ac.tz

ABSTRACT

This study explores emerging research areas in **Computer Science** through **bibliometric analysis** using data retrieved from the **Scopus** database. A systematic search was conducted using a predefined query, initially yielding **6,300 documents**, which were refined based on publication year **(2015–2025)**, subject area **(Computer Science)**, document type **(journal articles)**, language **(English)**, and **Open Access** availability, resulting in **447 articles**. The analysis was conducted by using the generated **bibliometric maps,** including term co-occurrence, and co-authorship networks. The results highlight key **emerging research trends,** including advancements in **artificial intelligence, machine learning, cloud computing, Internet of Things (IoT), cybersecurity, and quantum computing**. Additionally, global collaboration patterns reveal leading research contributors and potential areas for international cooperation. The findings provide valuable insights into the **future directions of Computer Science research,** offering strategic opportunities for institutions like **Arusha Technical College** to contribute to and benefit from these advancements.

KEYWORDS: Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning, Cybersecurity, Cloud Computing, Quantum Computing, Emerging Trends

INTRODUCTION

The field of Computer Science has evolved at an unprecedented pace, becoming a cornerstone of technological innovation and societal transformation(Aldoseri et al., 2024; Rashid & Kausik, 2024). As a dynamic and interdisciplinary domain, it has facilitated groundbreaking advancements in various fields, including artificial intelligence, data science, cybersecurity, quantum computing, and human computer interaction (Radanliev, 2024; Taherdoost & Madanchian, 2023). These advancements have not only revolutionized industries but also reshaped the way people interact with technology in their daily lives. However, the ever-changing nature of technology continues to create new challenges, opportunities, and research questions, giving rise to emerging research areas that demand attention from academia, industry, and policymakers (Dwivedi et al., 2023; Junaid et al., 2022).

Identifying and analyzing these emerging research areas is critical for academic institutions like Arusha Technical College to remain competitive and relevant in the global research ecosystem. Understanding where the field is heading can help institutions align their research priorities, develop future-ready curricula, and prepare students for the demands of the modern workforce (Li, 2024; Southworth et al., 2023). For a growing institution in a developing context, focusing on emerging areas can also contribute to addressing local challenges, fostering innovation, and building capacity for sustainable development through technology.

Emerging research areas in Computer Science are often characterized by their interdisciplinary nature, cutting-edge technological potential, and transformative impact on society (Gill et al., 2022). Fields such as quantum computing, explainable AI, ethical machine learning, and edge computing are pushing the boundaries of what is possible (Górriz et al., 2023).

Japhet Kaijage Kashaija, Department of Information and Communication Technology, Arusha Technical College
Jane Lissah, Department of Information and Communication Technology, Arusha Technical College

At the same time, research addressing global challenges such as climate change through computational modeling, or improving access to healthcare through telemedicine platforms is gaining traction (Bouabida et al., 2022; Dwivedi et al., 2022; Haleem et al., 2023). These trends not only reflect technological progress but also highlight the critical role of Computer Science in addressing pressing societal issues.

This study aims to provide a comprehensive bibliometric analysis of emerging research areas in Computer Science. By analyzing publication patterns, citation trends, and keyword associations in leading academic literature, we seek to uncover the topics and subfields that are gaining prominence. Additionally, we aim to highlight how these trends intersect with societal needs and industry demands, offering actionable insights for academic institutions to prioritize their research and development efforts.

Specifically, this paper explores the following research questions:

1.   What are the most prominent emerging research areas in Computer Science over the last decade?

2.   How do these emerging areas align with global technological and societal needs?

3.   What opportunities exist for Arusha Technical College to contribute to and benefit from these trends? The insights gained from this analysis will not only enhance the understanding of emerging research trajectories but will also provide strategic guidance for fostering innovation, collaboration, and impactful research at the college. By aligning with global trends and focusing on areas of high potential, the institution can position itself as a leader in advancing Computer Science research in Tanzania and beyond.

METHODOLOGY

This study employs bibliometric analysis to identify and evaluate emerging research areas in Computer Science using data retrieved from the **Scopus** database. The data collection process followed a systematic approach to ensure relevance and accuracy. Initially, a broad search query (("emerging research areas" OR "emerging trends" OR "future directions" OR "new advancements") AND ("computer science" OR "computing" OR "information technology")) yielded 6,300 documents. To refine the dataset, the publication years were restricted to 2015–2025, reducing the number of documents to 4,271. Further filtering was applied to focus specifically on the Computer Science subject area, with additional criteria including document type (articles only), publication stage (final), source type (journals), language (English), and Open Access (all open access articles). After applying these criteria, the final dataset comprised 447 documents.

To visualize emerging research trends, *VOSviewer software* was used to generate bibliometric maps based on co-occurrence of keywords, and co-authorship networks. The term co-occurrence analysis helped identify key research areas, while the co-authorship network revealed global research collaborations. These bibliometric techniques provided insights into the most influential topics, authors, and countries contributing to the advancement of Computer Science.

RESULTS AND DISCUSSIONS

Publication Trends in Emerging Research Areas of Computer Science

The bibliometric analysis of Scopus-indexed publications from 2015 to 2025 presented in Figure 1, reveals a significant upward trend in research output related to emerging areas in Computer Science, with a sharp increase from 2018 onwards and a peak in 2024. The initial period (2015–2017) saw limited publications, followed by rapid growth from 2018 to 2021, driven by technological advancements, increased funding, and interdisciplinary collaborations. The peak research activity between 2022 and 2024 underscores the global interest and maturity of emerging fields like AI, Quantum Computing, and Edge Computing. A decline in 2025 is observed, likely due to incomplete data collection. These findings highlight the importance of aligning institutional research with global trends to enhance collaboration, curriculum development, and research impact.
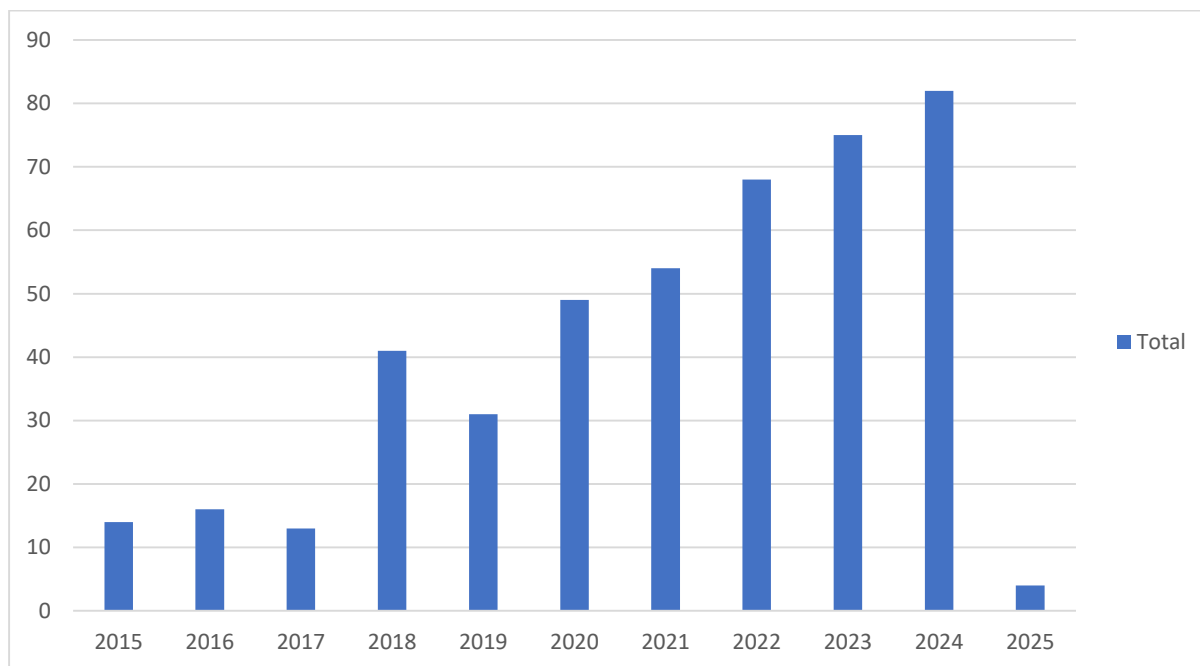
Figure 1. Publication Trends in Emerging Research Areas of Computer Science

1.   What are the most prominent emerging research areas in Computer Science over the last decade?

The term co-occurrence analysis using VOSviewer presented in Figure 2, reveals key research themes in emerging areas of Computer Science, clustered into distinct domains. The *red cluster* predominantly focuses on bibliometric research aspects, including "analysis," "study," "methodology," and "systematic literature review," highlighting the importance of structured research in identifying future directions. The *green cluster* is centered on *networking technologies,* with terms like "device," "network," "cloud," "fog," and "storage," emphasizing the prominence of distributed computing, energy efficiency, and scalability. The *blue cluster* is associated with *IoT, cybersecurity, and trust,* with terms such as "internet," "privacy," "blockchain," and "attack," showcasing concerns around data security and trust in digital ecosystems. The *yellow cluster* represents *AI-related advancements*, including "deep learning," "classification," and "accuracy," indicating the role of artificial intelligence in shaping future computing trends. The interconnected nature of these clusters suggests a strong relationship between AI, networking, and security as core research areas driving technological advancements. These insights reinforce the need for institutions like Arusha Technical College to focus on interdisciplinary research, integrating AI, IoT, and security for impactful innovation.
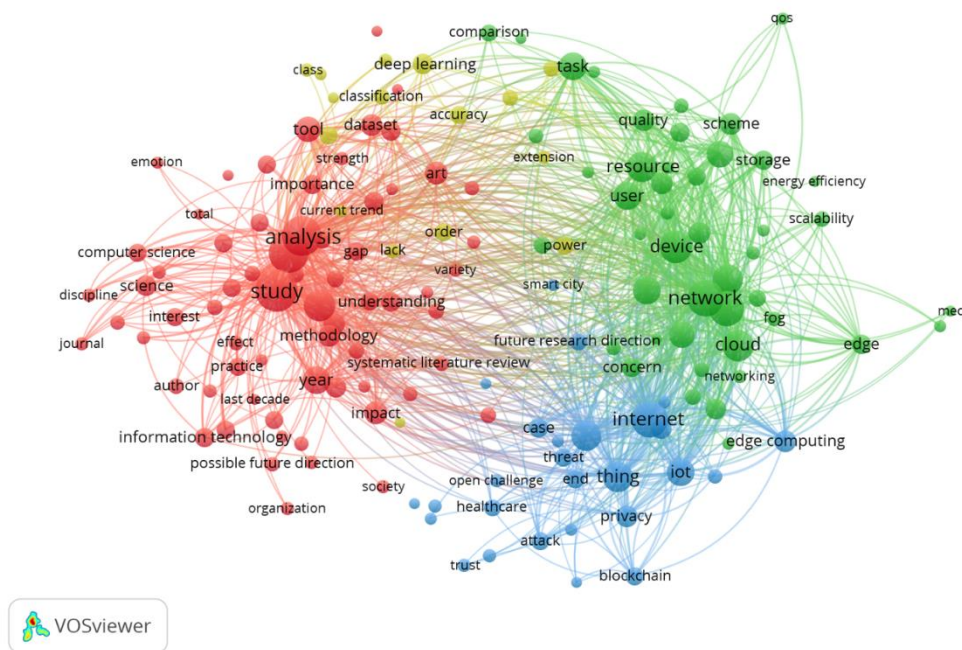
Figure 2. A bibliometric map showing prominent emerging research areas in Computer Science

2. How do these emerging areas align with global technological and societal needs?

The **term co-occurrence network** from VOSviewer presented in Figure 2, reveals that emerging research areas in Computer Science strongly align with global technological and societal needs. The *green cluster* focuses on networking, cloud, and edge computing, addressing the demand for scalable, efficient, and decentralized computing solutions essential for smart cities and IoT. The *blue cluster*, highlighting IoT, privacy, blockchain, and cybersecurity, aligns with global concerns over data security, digital trust, and cyber threats. The *yellow cluster*, representing AI and deep learning, corresponds to advancements in automation, healthcare, and Industry 4.0. Lastly, the *red cluster*, covering bibliometric analysis and research methodologies, reflects efforts to systematize knowledge and identify future research directions. The interconnected nature of these clusters suggests that Computer Science research is actively responding to global challenges such as cybersecurity threats, privacy concerns, AI-driven automation, and sustainable computing, making it imperative for the college to align their research focus with these trends.

3. What opportunities exist for Arusha Technical College to contribute to and benefit from these trends?

Arusha Technical College has significant opportunities to **contribute to and benefit from** emerging trends in Computer Science, as revealed by the bibliometric analysis presented in Figure 2. The *green cluster* (networking, edge computing, and cloud) presents an opportunity to develop expertise in *smart infrastructure, IoT, and energy efficient computing*, aligning with Tanzania's push for digital transformation. The *blue cluster* (cybersecurity, privacy, and blockchain) highlights the need for *cybersecurity training programs and research on secure digital systems*, which can position the college as a leader in digital trust and online security. The *yellow cluster* (AI and deep learning) offers a chance to establish *AI-driven research projects in agriculture, healthcare, and automation*, fostering innovation in local industries. Additionally, the *red cluster* (bibliometric analysis and systematic research) suggests an opportunity for *faculty and students to engage in high impact research collaborations and publications*. By integrating these trends into its curriculum, fostering partnerships with industry, and establishing research centers,

Arusha Technical College can enhance its academic reputation, secure funding, and equip students with cutting-edge skills for the future.

Co-authorship Analysis Based on Countries

The bibliometric analysis of emerging research areas in Computer Science highlights key trends and global collaborations shaping the field. A term co-occurrence analysis reveals strong research focus on *AI, deep learning, IoT, cybersecurity, cloud computing, and edge computing,* aligning with global technological and societal needs such as automation, data privacy,

and smart infrastructure. The co-authorship network shows that *the United States, China, Germany, India, and Australia* dominate research collaborations, with regional clusters emerging in Europe, Asia, and the Middle East. For the College, this presents opportunities to engage in *collaborative research, funding proposals, and academic partnerships* with leading institutions in these regions. By aligning its research focus with these global trends particularly in AI-driven automation, secure digital systems, and sustainable computing the college can *enhance its academic reputation, attract international collaborations, and contribute to solving local and global challenges* in Computer Science.
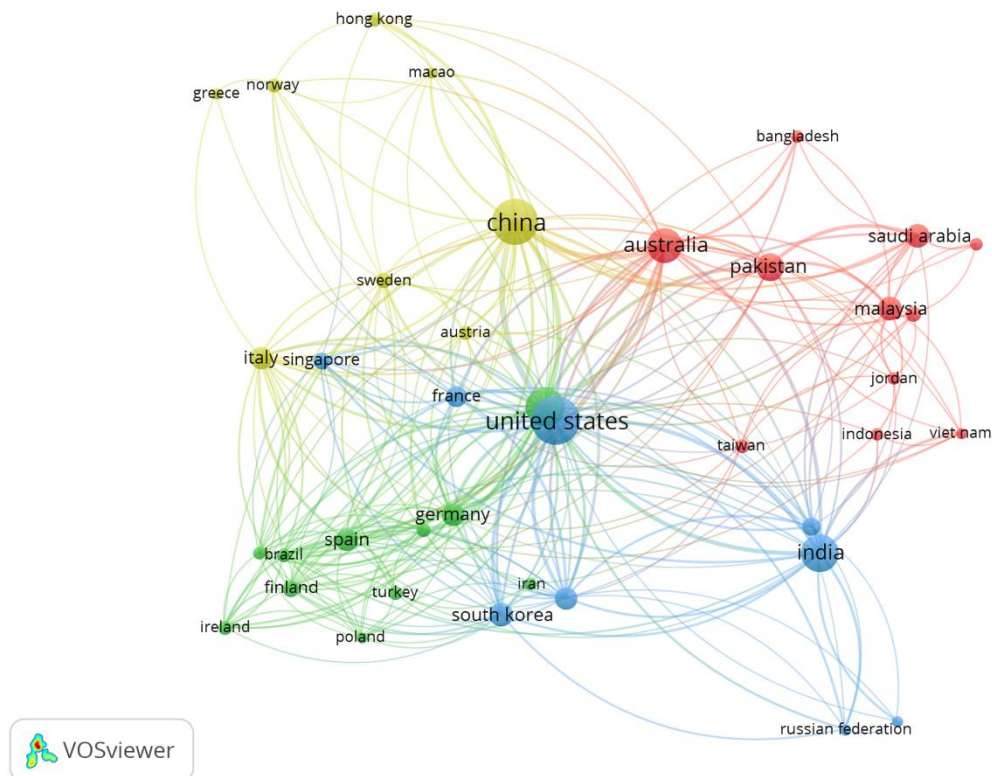

Figure 3. A bibliometric map showing co-authorship analysis based on countries

Co-Authorship Analysis

This co-authorship bibliometric map presented in Figure 4, highlights collaborative networks among researchers, with clusters representing groups of authors who frequently co-publish. Key figures like "(Gill, 2024; Mahmud et al., 2018), are prominently positioned, indicating their significant influence and central role within their respective research networks. The dense connections around (Mahmud et al., 2018)suggest extensive collaborations, while smaller clusters reflect niche research groups. The color coded clusters demonstrate thematic or disciplinary divisions, with strong intra cluster ties and occasional

inter cluster connections, indicating interdisciplinary collaborations.

The thickness of the connecting lines signifies the strength of co-authorship, with thicker lines reflecting stronger collaborative relationships. Authors such as (Deng et al., 2023; Puthal et al., 2019) and (Qadir et al., 2020) also exhibit significant influence in their clusters. Inter-cluster bridging authors play crucial roles in linking separate research areas, fostering knowledge exchange. This map underscores the importance of collaboration in advancing research, with influential authors driving innovation and connecting diverse academic communities.
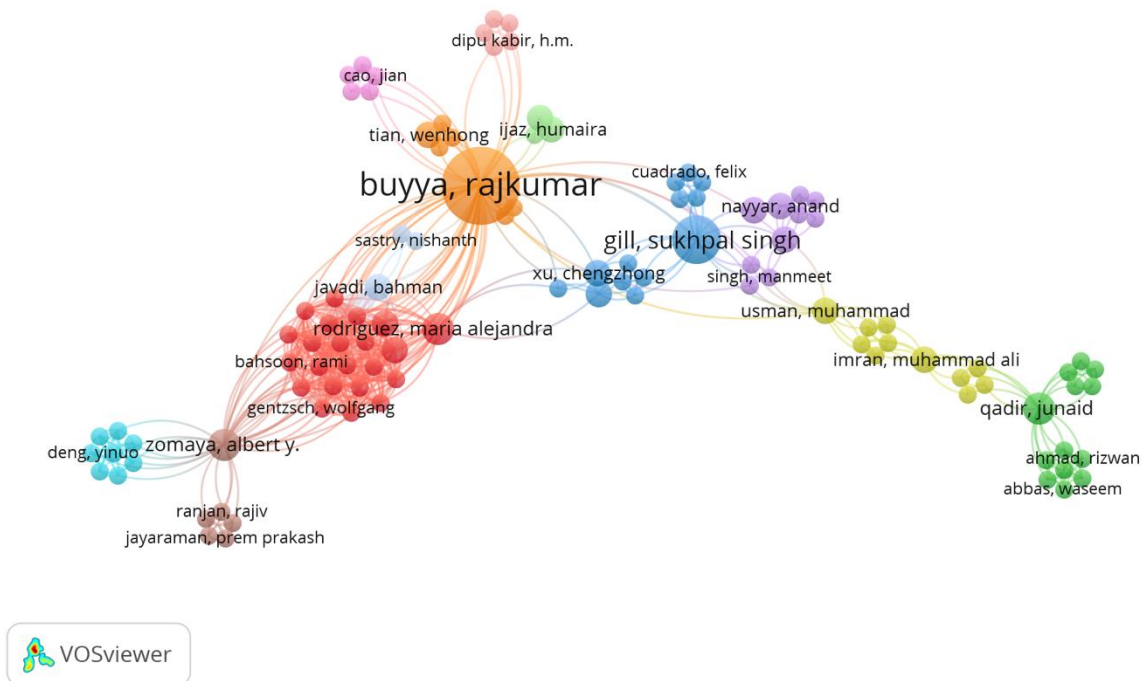
Figure 4. A bibliometric map showing co-authorship with authors as unit of analysis

CONCLUSION AND RECOMMENDATION

The bibliometric analysis of emerging research areas in Computer Science highlights key domains such as AI, deep learning, cybersecurity, IoT, cloud computing, and edge computing, which align with global technological advancements and societal needs. The co-authorship analysis further reveals that the United States, China, Germany, India, and Australia are central to global research collaborations, with regional clusters driving innovation in various parts of the world. For the college, these findings indicate significant opportunities to enhance research output, establish global partnerships, and contribute to technological solutions addressing both local and global challenges.

To leverage these opportunities, it is recommended that:

a) **Strengthen International Collaborations:** Establish research partnerships with leading institutions in the U.S., China, and Europe to enhance joint publications and funding opportunities.

b) **Focus on Key Research Areas:** Prioritize AI, cybersecurity, IoT, and cloud computing research to align with global technological trends.

c) **Develop Industry Academic Partnerships**: Collaborate with local and international industries to apply research findings to real world challenges.

d) **Enhance Research Capacity:** Invest in faculty development, research infrastructure, and grant-seeking efforts to improve the institution's research output and impact.

e) **Encourage Interdisciplinary Research**: Promote cross-disciplinary collaboration within the college to address societal challenges using computing technologies.

By implementing these recommendations, the College can position itself as a key player in the evolving field of Computer Science, driving innovation and contributing to the global knowledge economy.

REFERENCES

Aldoseri, A., Al-Khalifa, K. N., and Hamouda, A. M., 2024. AI-Powered Innovation in Digital Transformation: Key Pillars and Industry Impact. Sustainability, 16(5), 1790. https://doi.org/10.3390/su16051790

Bouabida, K., Lebouché, B., and Pomey, M.-P., 2022. Telehealth and COVID-19 Pandemic: An Overview of the Telehealth Use, Advantages, Challenges, and Opportunities during COVID-19 Pandemic. Healthcare, 10(11), 2293. https://doi.org/10.3390/healthcare10112293

Deng, S., Zhao, H., Huang, B., Zhang, C., Chen, F., Deng, Y., Yin, J., Dustdar, S., and Zomaya, A. Y., 2023. Cloud-Native Computing: A Survey from the Perspective of Services. https://doi.org/10.36227/techrxiv.23500383

Dwivedi, Y. K., Hughes, L., Kar, A. K., Baabdullah, A. M., Grover, P., Abbas, R., Andreini, D., Abumoghli, I., Barlette, Y., Bunker, D., Chandra Kruse, L., Constantiou, I., Davison, R. M., De', R., Dubey, R., Fenby-Taylor, H., Gupta, B., He, W., Kodama, M., … Wade, M., 2022. Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. International Journal of Information Management, 63, 102456. https://doi.org/10.1016/j.ijinfomgt.2021.102456

Dwivedi, Y. K., Sharma, A., Rana, N. P., Giannakis, M., Goel, P., and Dutot, V., 2023. Evolution of artificial intelligence research in Technological Forecasting and Social Change: Research topics, trends, and future directions. Technological Forecasting and Social Change, 192, 122579. https://doi.org/10.1016/j.techfore.2023.122579

Gill, S. S., 2024. Quantum and blockchain based <scp>Serverless</scp> edge computing: A vision, model, new trends and future directions. Internet Technology Letters, 7(1). https://doi.org/10.1002/itl2.275

Gill, S. S., Xu, M., Ottaviani, C., Patros, P., Bahsoon, R., Shaghaghi, A., Golec, M., Stankovski, V., Wu, H., Abraham, A., Singh, M., Mehta, H., Ghosh, S. K., Baker, T., Parlikad, A. K., Lutfiyya, H., Kanhere, S. S., Sakellariou, R., Dustdar, S., … Uhlig, S., 2022. AI for next generation computing: Emerging trends and future directions. Internet of Things, 19, 100514. https://doi.org/10.1016/j.iot.2022.100514

Górriz, J. M., Álvarez-Illán, I., Álvarez-Marquina, A., Arco, J. E., Atzmueller, M., Ballarini, F., Barakova, E., Bologna, G., Bonomini, P., Castellanos-Dominguez, G., Castillo-Barnes, D., Cho, S. B., Contreras, R., Cuadra, J. M., Domínguez, E., Domínguez-Mateos, F., Duro, R. J., Elizondo, D., Fernández-Caballero, A., … Ferrández-Vicente, J. M., 2023. Computational approaches to Explainable Artificial Intelligence: Advances in theory, applications and trends. Information Fusion, 100, 101945. https://doi.org/10.1016/j.inffus.2023.101945

Haleem, A., Javaid, M., Pratap Singh, R., and Suman, R., 2023. Exploring the revolution in healthcare systems through the applications of digital twin technology. Biomedical Technology, 4, 28–38. https://doi.org/10.1016/j.bmt.2023.02.001

Junaid, S. B., Imam, A. A., Balogun, A. O., De Silva, L. C., Surakat, Y. A., Kumar, G., Abdulkarim, M., Shuaibu, A. N., Garba, A., Sahalu, Y., Mohammed, A., Mohammed, T. Y., Abdulkadir, B. A., Abba, A. A., Kakumi, N. A. I., and Mahamad, S., 2022. Recent Advancements in Emerging Technologies for Healthcare Management Systems: A Survey. Healthcare, 10(10), 1940. https://doi.org/10.3390/healthcare10101940

Li, L., 2024. Reskilling and Upskilling the Future-ready Workforce for Industry 4.0 and Beyond. Information Systems Frontiers, 26(5), 1697–1712. https://doi.org/10.1007/s10796-022-10308-y

Mahmud, R., Kotagiri, R., and Buyya, R., 2018. Fog Computing: A Taxonomy, Survey and Future Directions (pp. 103–130). https://doi.org/10.1007/978-981-10-5861-5_5

Puthal, D., Ranjan, R., Nanda, A., Nanda, P., Jayaraman, P. P., and Zomaya, A. Y., 2019. Secure authentication and load balancing of distributed edge datacenters. Journal of Parallel and Distributed Computing, 124, 60–69. https://doi.org/10.1016/j.jpdc.2018.10.007

Qadir, J., Sainz-De-Abajo, B., Khan, A., Garcia-Zapirain, B., De La Torre-Diez, I., and Mahmood, H., 2020. Towards Mobile Edge Computing: Taxonomy, Challenges, Applications and Future Realms. IEEE Access, 8, 189129–189162. https://doi.org/10.1109/ACCESS.2020.3026938

Radanliev, P., 2024. Artificial intelligence and quantum cryptography. Journal of Analytical Science and Technology, 15(1), 4. https://doi.org/10.1186/s40543-024-00416-6

Rashid, A. Bin, and Kausik, M. A. K., 2024. AI revolutionizing industries worldwide: A comprehensive overview of its diverse applications. Hybrid Advances, 7, 100277. https://doi.org/10.1016/j.hybadv.2024.100277

Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., and Thomas, A. 2023. Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. Computers and Education: Artificial Intelligence, 4, 100127. https://doi.org/10.1016/j.caeai.2023.100127

Taherdoost, H., and Madanchian, M., 2023. AI Advancements: Comparison of Innovative Techniques. AI, 5(1), 38–54. https://doi.org/10.3390/ai5010003