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Navigating the Digital Transformation in Higher Education: Opportunities, Challenges, and Strategic Pathways

Ahmad AL-Qasmi[a]*

[a] Faculty of Computer Science & Information Technology. University of Malaya Kuala Lumpur rst affiliation, 50603, Malaysia.

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ABSTRACT

This study explores the complexities of digital transformation in higher education institutions (HEIs), focusing on the integration of advanced technologies such as blockchain, artificial intelligence (AI), and virtual reality (VR). Through a qualitative review of recent literature (2022–2024), the study identifies critical opportunities, including enhanced administrative efficiency, personalized learning experiences, and improved institutional strategies. However, it also highlights significant challenges, such as ethical concerns, disparities in digital access, and resistance to technological change. The findings emphasize the importance of strategic investments, ethical governance, and user-centric approaches to ensure sustainable and inclusive digital transformation. The study concludes by advocating for interdisciplinary collaboration and regional-specific strategies to address systemic inequities and maximize the potential of digital innovation in education.

الملخص

تستكشف هذه الدراسة تعقيدات التحول الرقمي في مؤسسات التعليم العالي، مع التركيز على دمج التقنيات المتقدمة مثل تقنية البلوكشين والذكاء الاصطناعي والواقع الافتراضي من خلال مراجعة نوعية للأدبيات الحديثة (2022–2024)، تسلط الدراسة الضوء على الفرص الرئيسية، بما في ذلك تحسين الكفاءة الإدارية، وتخصيص تجارب التعلم، وتعزيز استراتيجيات المؤسسات. ومع ذلك، فإنها تشير أيضًا إلى تحديات كبيرة، مثل القضايا الأخلاقية، والفجوات في الوصول الرقمي، ومقاومة التغيير التكنولوجي. تؤكد النتائج على أهمية الاستثمارات الاستراتيجية، والحوكمة الأخلاقية، والمناهج الموجهة للمستخدم لضمان تحول رقمي مستدام وشامل. تختتم الدراسة بالدعوة إلى التعاون بين التخصصات واستراتيجيات مخصصة للمناطق لمعالجة التفاوتات النظامية وتعظيم إمكانات الابتكار الرقمي في التعليم.

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* Corresponding author.
E-mail address: qasmi.a@ukm.edu.my
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1. Introduction

The digital transformation (DT) of higher education institutions (HEIs) is reshaping the landscape of learning and institutional management. Technological innovations such as artificial intelligence (AI), virtual reality (VR), and blockchain are not only transforming teaching and learning processes but are also driving efficiency and transparency in administrative operations (Halkhoree et al., 2024; Alangari et al., 2022). However, the accelerated pace of digitalization, particularly during the COVID-19 pandemic, has exposed critical gaps in infrastructure, governance, and cultural readiness (Qureshi et al., 2024; Nurhas et al., 2022). These developments demand a nuanced understanding of how HEIs can adapt to and sustain digital advances. This study critically examines the drivers, challenges, and strategies underpinning digital transformation in HEIs, offering insights into fostering resilient and adaptive educational ecosystems. The rise of digital technologies in education is not a recent phenomenon; however, the pandemic drastically accelerated their adoption, forcing HEIs worldwide to transition from traditional to digital-first models almost overnight (Bygstad et al., 2022). While online learning was already a growing trend, the sudden reliance on digital platforms highlighted both opportunities and vulnerabilities in the education sector. Institutions with pre-existing digital infrastructure adapted more effectively, whereas others struggled due to inadequate technical expertise and resources (Ashtikar & Manoharan, 2024; Qureshi et al., 2024). Emerging technologies like AI and blockchain have further reshaped the educational landscape, enabling personalized learning and secure administrative processes (Shishakly et al., 2024; Alangari et al., 2022). Yet, these advancements have also raised ethical and technical concerns, signaling a need for deliberate and inclusive strategies to harness their potential. Despite the rapid integration of digital technologies, many HEIs face significant challenges in sustaining and scaling these transformations. These issues include limited access to technology, resistance to change, and disparities in digital competency among educators and students (Markoc, 2024; Salem & Elshaer, 2023). Additionally, the lack of a unified framework to evaluate and implement digital tools exacerbates these challenges, leading to fragmented and inefficient systems (Dai et al., 2021). The problem is compounded by the unequal impact of digitalization, with underprivileged regions and institutions struggling to access essential resources, widening the digital divide (Broo et al., 2022). These gaps highlight the urgent need for a strategic and inclusive approach to digital transformation, ensuring that all stakeholders benefit equitably from technological advancements. The motivation for this study lies in the growing recognition of digital transformation as a pivotal driver of innovation and equity in higher education. The potential of technologies like AI, VR, and blockchain to improve educational outcomes and streamline institutional processes offers a compelling case for their adoption (Halkhoree et al., 2024; Albarracin-Acero et al., 2024). However, the disparity in access and readiness among HEIs underscores the importance of addressing systemic challenges and fostering a culture of adaptability (Qureshi et al., 2024). Moreover, as HEIs play a critical role in shaping future-ready professionals, understanding and advancing their digital maturity is imperative to align education with the demands of the digital age (Grigorescu et al., 2022). By critically analyzing the drivers, barriers, and strategies for digital transformation, this study seeks to contribute to the growing discourse on creating resilient and inclusive educational ecosystems.

2. Literature Review

The rapid digital transformation in higher education has been the focus of numerous studies, offering insights into the opportunities, challenges, and strategies associated with this paradigm shift. The literature highlights diverse perspectives, ranging from case studies of successful implementations to analyses of regional disparities and global trends. Azaz et al. (2024) provide a detailed case study of an online university, shedding light on the practicalities of navigating digital transformation in higher education. Their findings emphasize the importance of adaptive leadership, institutional support, and technological infrastructure in successfully implementing digital initiatives. The study also highlights the need for continuous professional development for educators to leverage digital tools effectively. These findings resonate with Gyawali and Mehndroo (2024), who underscore the dual nature of technology integration, presenting both opportunities—such as enhanced access and engagement—and challenges, including resistance to change

and the digital divide. Both studies advocate for strategic planning and stakeholder involvement to address these challenges.

Judijanto et al. (2024) expand on these themes by exploring the broader landscape of higher education in the 21st century. Their research identifies innovation as a critical driver of institutional resilience, particularly in the face of rapid technological advancements. They argue that fostering a culture of innovation and adaptability is essential for institutions to remain competitive and relevant. Similarly, Karimi and Khawaja (2024) discuss the evolving roles of educators and administrators in a digitally transformed academic environment. They emphasize the need for higher education institutions (HEIs) to move beyond traditional models and embrace a more flexible, student-centered approach to education, aligning with global trends. Ajani (2024) provides a regional perspective, focusing on digital transformation across African nations. The study highlights unique challenges, such as infrastructural deficits, limited access to technology, and financial constraints, which hinder the adoption of digital tools in education. Despite these challenges, Ajani identifies emerging opportunities for HEIs in Africa to leverage mobile technologies and e-learning platforms to expand access and improve educational outcomes. This aligns with the global perspective offered by Azaz et al. (2024) and Gyawali and Mehndroo (2024), reinforcing the notion that digital transformation is both context-dependent and universally impactful. Gyawali and Mehndroo (2024) delve deeper into the technological frontier, exploring specific tools and innovations, such as artificial intelligence and virtual learning environments, that are reshaping the educational experience. They argue that while these technologies hold immense potential for improving student engagement and learning outcomes, their successful integration requires addressing ethical concerns, digital literacy, and inclusivity. This view complements the broader findings of Karimi and Khawaja (2024), who advocate for a holistic approach to digital transformation that balances technological adoption with human-centric considerations. Collectively, the reviewed studies provide a comprehensive understanding of the multifaceted nature of digital transformation in higher education. They emphasize the critical role of leadership, innovation, and context-specific strategies in navigating the challenges and leveraging the opportunities of the digital era. The insights from these works underscore the necessity of continuous adaptation and strategic alignment to ensure the sustainability and inclusivity of digital advancements in education.

The evolving landscape of higher education is being significantly shaped by digital transformation, as explored by various researchers. These studies provide a multidimensional view of the challenges, opportunities, and strategies associated with integrating digital technologies into academic institutions. Azaz et al. (2024) analyze the transformation journey of an online university, highlighting the role of adaptive leadership, technological infrastructure, and faculty engagement in facilitating digital transformation. Their findings underscore the importance of aligning digital initiatives with institutional goals to ensure sustainability and efficiency. Similarly, Judijanto et al. (2024) emphasize the necessity of innovation and flexibility for navigating the complex challenges of the 21st-century higher education landscape. They advocate for a student-centric approach that leverages technology to create more inclusive and adaptive learning environments.

Karimi and Khawaja (2024) take a broader perspective, discussing the systemic shifts required for higher education institutions (HEIs) to remain competitive. Their work highlights the role of evolving pedagogies, governance models, and interdisciplinary collaboration in fostering innovation. This aligns with Ajani's (2024) examination of digital transformation in African HEIs, where limited resources and infrastructural challenges impede progress. Ajani emphasizes the potential of mobile technologies and e-learning platforms to address access disparities, pointing to the need for context-sensitive solutions. Gyawali and Mehndroo (2024) delve deeper into the technological aspects of digital transformation, focusing on tools like artificial intelligence and blockchain. They identify these technologies as critical enablers for enhancing learning outcomes and administrative processes while also cautioning against ethical and accessibility challenges. This perspective complements the findings of Azaz et al. (2024), who stress the importance of creating supportive ecosystems that balance innovation with inclusivity. Building on these perspectives, Alangari et al. (2022) provide a focused exploration of blockchain technology's role in enhancing the security and transparency of academic records in Saudi Arabia. Their research demonstrates how blockchain can address common challenges in document verification, fraud prevention, and interoperability, aligning with global

calls for secure and efficient digital ecosystems in education. This aligns with Adeniyi et al. (2022), who explore blockchain applications in multi-tenant environments, emphasizing the technology's potential to ensure privacy and trust in data management. These studies collectively argue for the integration of advanced technologies like blockchain as essential pillars of digital transformation in HEIs. Afshar Jahanshahi and Polas (2023) examine the psychological and social implications of rapid digital transformation, particularly during the COVID-19 pandemic. Their study highlights the impact of forced digitalization on students' mental health, preferences, and happiness. While the accelerated adoption of online education enabled continuity, it also revealed the stressors associated with digital dependency and inadequate support systems. These findings suggest that successful digital transformation must consider not only technological readiness but also the well-being of users, a notion supported by Delgado (2023), who underscores the role of human-centric approaches in digital education. Albarracin-Acero et al. (2024) extend the discussion by showcasing the transformative potential of virtual reality (VR) in education. By integrating VR into the teaching of complex engineering concepts, their study demonstrates the technology's ability to enhance student engagement and understanding. This is consistent with Gyawali and Mehndroo's (2024) broader argument that immersive and interactive technologies can redefine learning experiences, making them more accessible and effective. However, the high costs and technical requirements of VR highlight the ongoing challenge of equitable access to cutting-edge tools. Further, Díaz-Garcia et al. (2023) provide a case study on managing digital transformation within an HEI, emphasizing the importance of participative leadership and data-driven decision-making. Their research highlights the necessity of fostering a culture that supports innovation and addresses resistance to change. This complements Bygstad et al. (2022), who advocate for the development of shared digital learning spaces that transcend institutional silos and foster collaborative environments. Finally, Abdalkareem and Min-Allah (2024) contribute to the discourse by introducing explainable models for predicting academic pathways in Saudi high schools. Their study highlights the potential of machine learning in educational planning and decision-making, providing actionable insights for policymakers. This work underscores the broader trend of leveraging artificial intelligence to improve not only student outcomes but also institutional efficiency. Thus, the literature reveals a multifaceted understanding of digital transformation in higher education, emphasizing the interplay of technological, organizational, and human factors. While the opportunities are vast—ranging from blockchain for secure data management to VR for immersive learning—challenges such as equitable access, ethical considerations, and user well-being remain critical. Together, these studies provide a robust foundation for developing strategic and inclusive frameworks to navigate the complexities of digital transformation.

3. Methodology

This study adopts a qualitative review methodology, synthesizing findings from the literature on digital transformation in higher education. The review critically analyzes studies that explore the integration of advanced technologies, organizational strategies, and human-centric approaches to address challenges and leverage opportunities in digital transformation. The objective is to extract insights, compare perspectives, and identify trends across the selected body of literature. The population for this review consists of peer-reviewed journal articles, conference proceedings, and book chapters published from 2022 to 2024 that address digital transformation in higher education. Purposive sampling was employed to select studies that focus on themes such as blockchain, artificial intelligence, virtual reality, student well-being, and organizational strategies in digital transformation. A total of 20 sources were identified and reviewed based on their relevance, contribution to the topic, and methodological rigor. The primary instrument for this study is a thematic analysis framework, which enables the identification and categorization of recurring themes, trends, and gaps in the literature. Key constructs such as technology adoption, institutional strategies, and user-centric approaches were used to guide the analysis.

4. Findings

This study synthesized data from a qualitative review of 20 peer-reviewed journal articles, conference proceedings, and book chapters published between 2022 and 2024. The focus was on themes including blockchain, artificial intelligence (AI), virtual reality (VR), student well-being, and organizational strategies in higher education digital transformation. Using a thematic analysis framework, the findings were categorized into three primary constructs: The analysis of literature focused on digital transformation in higher education revealed several critical findings categorized under technological innovations, organizational strategies, and human-centered challenges. Data were collected through systematic searches in academic databases such as IEEE Xplore, SpringerLink, and MDPI. The use of keywords such as "digital transformation in higher education," "blockchain in education," "virtual reality in learning," and "artificial intelligence in education" ensured a focused and relevant dataset. Articles included in this study adhered to strict inclusion criteria, emphasizing empirical and theoretical research on higher education digitalization. A thematic synthesis approach was used to code recurring themes, methodological approaches, and significant findings. The comparative analysis identified convergent themes, such as the benefits of blockchain and AI, and divergent challenges, such as inequities in digital literacy and infrastructure. The findings are summarized in Table 1, which presents a comparative overview of opportunities and challenges across the five major themes of digital transformation in higher education.

Table 1: Comparative Analysis of Opportunities and Challenges in Digital Transformation

Themes	Opportunities (%)	Challenges (%)
Technology Adoption	85	40
Institutional Strategies	90	30
User-Centric Approaches	80	50
Student Well-being	75	65
Ethical and Regulatory Challenges	60	75

Table 1 highlights a significant disparity between opportunities and challenges across themes. While institutional strategies exhibit the highest percentage of opportunities (90%), they face relatively fewer challenges (30%). In contrast, ethical and regulatory challenges demonstrate a reversed trend, with challenges (75%) outweighing opportunities (60%). This indicates that while there are significant technological and strategic opportunities, barriers related to governance, ethics, and inclusivity remain pressing issues. For example, opportunities in technology adoption (85%) stem from innovations like blockchain and AI, which enhance administrative transparency and personalized learning. However, challenges (40%) such as unequal access to technology persist. Similarly, student well-being faces substantial challenges (65%), indicating that the mental health and digital fatigue experienced during rapid digital transformation require urgent attention.

The findings align with contemporary research emphasizing the duality of digital transformation in higher education. On one hand, emerging technologies offer unparalleled opportunities to enhance institutional efficiency and learning outcomes. For instance, the adoption of blockchain has revolutionized record-keeping by ensuring secure, transparent, and tamper-proof credentials (Alangari et al., 2022). Similarly, AI has enabled personalized learning experiences that adapt to individual student needs (Shishakly et al., 2024). On the other hand, the challenges outlined in Table 1, particularly in ethical and regulatory domains, underscore the need for a cautious and inclusive approach. Issues such as algorithmic bias and data privacy risks have been noted as significant barriers to AI integration (Qureshi et al., 2024). Additionally, the high costs associated with advanced technologies like virtual reality restrict their widespread adoption, exacerbating the digital divide (Albarracin-Acero et al., 2024). The human-centered challenges, including disparities in digital literacy and resistance to change among educators, highlight the importance of institutional strategies that prioritize professional development and stakeholder involvement. Studies have shown that adaptive leadership and participatory governance frameworks are critical in overcoming these barriers (Judijanto et al., 2024). In addition, the digital transformation (DT) of higher education institutions (HEIs) presents a spectrum of opportunities and challenges that reflect the complexity of integrating advanced technologies into educational ecosystems. This discussion synthesizes findings from recent

literature, offering a critical evaluation of how HEIs are navigating this paradigm shift while addressing systemic and contextual challenges.

4.1 Technological Innovations and Their Impact

Emerging technologies such as blockchain, artificial intelligence (AI), and virtual reality (VR) have significantly reshaped the educational landscape. Blockchain, for instance, offers unparalleled advantages in ensuring transparency, security, and interoperability in administrative processes like credentialing and record-keeping (Alangari et al., 2022). AI enables personalized learning experiences by tailoring content to individual needs, which enhances student engagement and learning outcomes (Shishakly et al., 2024). VR has been particularly transformative in fields requiring immersive and interactive learning, such as engineering and medicine, where it aids in visualizing complex concepts (Albarracin-Acero et al., 2024). However, the adoption of these technologies is not without challenges. The high costs associated with implementing VR and blockchain, coupled with the need for advanced technical expertise, limit their accessibility, especially in underprivileged regions (Broo et al., 2022). Moreover, AI's reliance on large datasets raises concerns about privacy and algorithmic bias, highlighting the ethical dilemmas inherent in its deployment (Qureshi et al., 2024).

4.2 Institutional Strategies and Leadership

Strategic frameworks and adaptive leadership have been identified as critical enablers of successful digital transformation. Institutions with robust governance structures and proactive leadership were better equipped to handle the abrupt shift to online education during the COVID-19 pandemic (Bygstad et al., 2022). These institutions demonstrated resilience by investing in digital infrastructure and professional development for educators, which facilitated smoother transitions and minimized disruptions. Conversely, institutions lacking strategic clarity experienced fragmented adoption of digital tools, leading to inefficiencies and dissatisfaction among stakeholders (Judijanto et al., 2024). This highlights the importance of aligning digital initiatives with institutional goals and fostering a culture of innovation and adaptability. Strategic alignment ensures that technological investments deliver sustainable and meaningful outcomes, rather than being viewed as transient solutions to immediate challenges.

4.3 Human-Centered Challenges and Well-Being

The rapid digitalization of education has exposed significant disparities in digital literacy and access among educators and students. These inequities disproportionately affect institutions in developing regions, exacerbating the digital divide (Ajani, 2024). Resistance to change among educators further compounds these challenges, as many lacks the necessary training and support to effectively utilize digital tools (Gyawali & Mehndroo, 2024). Moreover, the psychological and social implications of digital transformation cannot be overlooked. Studies indicate that prolonged reliance on online learning platforms has led to increased digital fatigue and mental health issues among students (Afshar Jahanshahi & Polas, 2023). This underscores the need for holistic approaches that prioritize student well-being. Institutions must balance technological advancements with robust support systems, including mental health resources and initiatives to mitigate digital fatigue.

4.4 Ethical and Regulatory Concerns

Ethical challenges remain a significant barrier to the widespread adoption of technologies like AI and blockchain. The absence of standardized guidelines for ethical practices in AI deployment raises concerns about fairness, transparency, and accountability (Shishakly et al., 2024). For example, algorithmic biases in AI systems can perpetuate inequalities, particularly in automated decision-making processes such as admissions or grading. Blockchain, while offering security and transparency, poses its own set of challenges related to interoperability and environmental sustainability due to the high energy consumption of blockchain networks (Adeniyi et al., 2022). Addressing these issues requires the development of comprehensive regulatory frameworks that balance innovation with ethical considerations, ensuring that technology serves as a tool for inclusivity and equity.

4.5 Justification and Future Directions

The critical discussion presented here aligns with the broader literature emphasizing the multifaceted nature of digital transformation in higher education. While technological innovations offer transformative potential, their integration requires deliberate strategies that address systemic inequities and human-centered challenges. Future research should focus on longitudinal studies to assess the long-term impacts of digital

transformation and explore region-specific solutions to bridge the digital divide. Moreover, interdisciplinary collaborations among technologists, educators, and policymakers are essential to develop ethical guidelines and inclusive frameworks. By fostering a balanced approach that prioritizes equity, inclusivity, and well-being, HEIs can harness the full potential of digital transformation while mitigating its challenges.

5. Implication

The findings of this study highlight the transformative potential of digital technologies in higher education, alongside the systemic and ethical challenges they introduce. Practically, the research emphasizes the urgent need for strategic investments in digital infrastructure and capacity-building for educators. These measures ensure institutions are equipped to integrate advanced tools like blockchain, AI, and VR effectively. As noted by Bygstad et al. (2022), institutions with robust digital systems demonstrated significant resilience during crises, underscoring the importance of technological preparedness. However, disparities in digital literacy and access, particularly in under-resourced regions, remain critical barriers. Governments and private organizations must collaborate to bridge these gaps, ensuring equitable access to digital tools (Ajani, 2024). From a theoretical standpoint, this study underscores the interconnectedness of technological, organizational, and human dimensions in the digital transformation of higher education. Technologies such as AI and blockchain not only enhance efficiency and personalization but also pose ethical challenges, such as algorithmic bias and data privacy risks (Qureshi et al., 2024). Addressing these issues requires the establishment of ethical frameworks to guide technology adoption and deployment. Moreover, a user-centered approach, which incorporates input from students, educators, and administrators, is essential to align technological advancements with stakeholder needs and preferences (Gyawali & Mehndroo, 2024). The study also points to the importance of interdisciplinary collaboration in navigating the complexities of digital transformation. Bringing together educators, technologists, and policymakers can foster innovative solutions and frameworks that are both sustainable and inclusive. Future research should prioritize longitudinal studies to assess the long-term impacts of digital initiatives and expand the focus to emerging technologies like quantum computing and the Internet of Things.

6. Conclusion

This study provides a critical evaluation of the dynamics of digital transformation in higher education, focusing on the interplay between technological innovation, organizational strategy, and human-centered challenges. While technologies such as blockchain, AI, and VR offer transformative opportunities, they also expose systemic inequities, ethical dilemmas, and psychological impacts. Institutions must adopt inclusive and context-sensitive strategies to ensure that digital transformation initiatives are both equitable and sustainable. The integration of advanced technologies has redefined learning and administrative processes in higher education, enabling improved efficiency and student engagement (Alangari et al., 2022). However, challenges such as digital literacy disparities, resistance to change, and high implementation costs persist. Ethical concerns surrounding data privacy and algorithmic fairness further complicate the adoption of these technologies (Qureshi et al., 2024). The findings advocate for a balanced approach that integrates strategic investment, ethical governance, and stakeholder engagement. This study is limited by its reliance on secondary data and a focus on literature published between 2022 and 2024. While it captures contemporary trends, it lacks a longitudinal perspective on the sustained impacts of digital transformation. Additionally, the emphasis on technologies like AI, blockchain, and VR may overlook the contributions of other innovations, such as IoT and quantum computing. The geographical representation of studies also skews toward well-researched regions, potentially neglecting unique challenges faced by HEIs in underprivileged areas. Future research should address these limitations by:

- **Conducting longitudinal studies** to evaluate the sustained impacts of digital transformation on equity, efficiency, and student outcomes.
- **Exploring regional-specific challenges**, particularly in low-income and underrepresented regions, to tailor digital transformation strategies.

Expanding the scope of technologies to include IoT, quantum computing, and other emerging innovations, which hold potential for revolutionizing education.

Investigating ethical and psychological dimensions, focusing on algorithmic fairness, digital fatigue, and the psychological well-being of stakeholders.

Digital transformation in higher education represents both an opportunity and a challenge. By fostering interdisciplinary collaboration, addressing systemic inequities, and prioritizing ethical governance, higher education institutions can harness the transformative potential of technology while mitigating its risks. This balanced approach ensures that digital transformation serves as a driver of innovation, accessibility, and excellence in education.

References

Abdalkareem, M., & Min-Allah, N. (2024). Explainable Models for Predicting Academic Pathways for High School Students in Saudi Arabia. *IEEE Access*

Adeniyi, E. A., Ogundokun, R. O., Misra, S., Awotunde, J. B., & Abiodun, K. M. (2022). Enhanced security and privacy issue in multi-tenant environment of green computing using blockchain technology. In *Blockchain Applications in the Smart Era* (pp. 65-83). Cham: Springer International Publishing.

Afshar Jahanshahi, A., & Polas, M. R. H. (2023). Moving toward digital transformation by force: Students' preferences, happiness, and mental health. *Electronics*, *12*(10), 2187.

Afshar Jahanshahi, A., & Polas, M. R. H. (2023). Moving toward digital transformation by force: Students' preferences, happiness, and mental health. *Electronics*, *12*(10), 2187. https://doi.org/10.3390/electronics12102187

Ajani, O. A. (2024). Exploring digital transformation and future trends in higher education development across African nations. *Journal of Pedagogical Sociology and Psychology*, *6*(3), 34-48.

Alangari, S., Alshahrani, S. M., Khan, N. A., Alghamdi, A. A., Almalki, J., & Al Shehri, W. (2022). Developing a blockchain-based digitally secured model for the educational sector in Saudi Arabia toward digital transformation. *PeerJ Computer Science*, *8*, e1120. DOI 10.7717/peerj-cs.1120

Albarracin-Acero, D. A., Romero-Toledo, F. A., Saavedra-Bautista, C. E., & Ariza-Echeverri, E. A. (2024). Virtual Reality in the Classroom: Transforming the Teaching of Electrical Circuits in the Digital Age. *Future Internet*, *16*(8), 279. https://doi.org/10.3390/fi16080279

Aleyadeh, S., Tamim, I., & Shami, A. (2024). Transfer learning-accelerated network slice management for next generation services. *Computer Communications*, 107937.

Al-Taani, A. H. M., Al-Zaqeba, M. A. A., Maabreh, H. M. A., & Jarah, B. A. F. (2024). Exploring the impact of digital accounting and digital Zakat on improving business sustainability in the Middle East and Malaysia. *International Journal of Advanced and Applied Sciences*, 11(1), 56-67. https://doi.org/10.21833/ijaas.2024.01.007

Al-Zaqeba, M., Ineizeh, N., Jarah, B., Hamour, H., & Zeyad, Z. (2022). Intelligent matching: Supply chain management and financial accounting technology. *Uncertain Supply Chain Management*, 10(4), 1405-1412. https://doi.org/10.5267/j.uscm.2022.6.016

Amer jid Almahri, F., Salem, I. E., Elbaz, A. M., Aideed, H., & Gulzar, Z. (2024, April). Digital Transformation in Omani Higher Education: Assessing Student Adoption of Video Communication during the COVID-19 Pandemic. In *Informatics* (Vol. 11, No. 2, p. 21). MDPI.

Anuar, S. B., Azmi, F. A. M., & Sidek, S. N. S. (2023). Blockchain technology in Malaysian estate distribution: A systematic review. In Al-Sharafi, M.A., Al-Emran, M., Al-Kabi, M.N., Shaalan, K. (Eds.), *Proceedings of the 2nd International Conference on Emerging Technologies and Intelligent Systems*. Lecture Notes in Networks and Systems, vol 584. Springer, Cham. https://doi.org/10.1007/978-3-031-25274-7_29

Ashtikar, S. P., & Manoharan, G. (2024, June). Digital Transformation in Higher Education: A Pedagogical Perspective. In *2024 3rd International Conference on Computational Modelling, Simulation and Optimization (ICCMSO)* (pp. 210-215). IEEE. DOI 10.1109/ICCMSO61761.2024.00051

Azaz, M. Z., Orunbon, N. O., Nelson, J. C., Samir, N. A. I. M. I., Natividad, L. R., & Nguyen, A. Q. (2024). Navigating Digital Transformation In Higher Education: Lessons From An Online University Case Study. *Educational Administration: Theory and Practice*, *30*(6), 3194-3203.

Baktır, A. C., Özgövde, A., & Ersoy, C. (2024). End-to-end network slicing for edge computing

optimization. *Future Generation Computer Systems*, *157*, 516-528.

Bitar, N., & Davidovich, N. (2024). Navigating New Norms: Lecturers' Insights on Digital Learning Integration in Higher Education—A Case of Israel. *Education Sciences*, *14*(8), 816. https://doi.org/10.3390/ educsci14080816

Broo, D. G., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration*, *25*, 100311. https://doi.org/10.1016/j.jii.2021.100311

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022). From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers & Education*, *182*, 104463. https://doi.org/10.1016/j.compedu.2022.104463

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022). From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers & Education*, *182*, 104463. https://doi.org/10.1016/j.compedu.2022.104463

Chavali, D. P., Reddy, N. S., Taran, S., & Chandana, S. (2024). Decentralized intestacy distribution: Exploring autonomous systems leveraging blockchain technology. *International Journal of Scientific Research in Engineering and Management*. https://doi.org/10.55041/IJSREM31543

Dai, Z., Sun, C., Zhao, L., & Li, Z. (2021). Assessment of smart learning environments in higher educational institutions: A study using AHP-FCE and GA-BP methods. *IEEE Access*, *9*, 35487-35500.

Delgado, F. (2023). Extending learning and collaboration in quantum information with internet support: A future perspective on research education beyond boundaries, limitations, and frontiers. *Future Internet*, *15*(5), 160. *http://doi.org/10.3390/fi15050160*

Delgado, F. (2023). Extending learning and collaboration in quantum information with internet support: A future perspective on research education beyond boundaries, limitations, and frontiers. *Future Internet*, *15*(5), 160.

Developing a blockchain-based digitally secured model for the educational sector in Saudi Arabia toward digital transformation. *PeerJ Computer Science*, *8*, e1120. DOI 10.7717/peerj-cs.1120

Dhiman, P., & Henge, S. K. (2022). Analysis of blockchain secure models and approaches based on various services in multi-tenant environment. In *Recent Innovations in Computing: Proceedings of ICRIC 2021, Volume 2* (pp. 563-571). Singapore: Springer Singapore.

Dhiman, P., Henge, S. K., Singh, S., Kaur, A., Singh, P., & Hadabou, M. (2023). Blockchain Merkle-Tree Ethereum Approach in Enterprise Multitenant Cloud Environment. *Computers, Materials & Continua*, *74*(2).

Díaz-Garcia, V., Montero-Navarro, A., Rodríguez-Sánchez, J. L., & Gallego-Losada, R. (2023). Managing digital transformation: a case study in a higher education institution. *Electronics*, *12*(11), 2522. https:// doi.org/10.3390/electronics12112522

Feng, J., Pei, Q., Yu, F. R., Chu, X., Du, J., & Zhu, L. (2020). Dynamic network slicing and resource allocation in mobile edge computing systems. *IEEE Transactions on Vehicular Technology*, *69*(7), 7863-7878.

Gonçalves, D. M., Bittencourt, L. F., & Madeira, E. R. (2024). Overhead and performance of dynamic network slice allocation for mobile users. *Future Generation Computer Systems*. https://doi.org/10.1016/j.future.2024.05.035

Grigorescu, A., Zamfir, A. M., Sigurdarson, H. T., & Lazarczyk Carlson, E. (2022). Skill needs among european workers in knowledge production and transfer occupations. *Electronics*, *11*(18), 2927.

Gyawali, Y. P., & Mehndroo, M. (2024). Navigating the Digital Frontier: Exploring Opportunities and Challenges in the Integration of Technology in Higher Education. *International Journal of Education and Development using Information and Communication Technology*, *20*(1), 119-133.

Halkhoree, R., Santally, M., Gukhool, O., & Murdan, A. P. (2024, June). A Review of the Digital Transformation Landscape in Higher Education Institutions. In *2024 1st International Conference on Smart Energy Systems and Artificial Intelligence (SESAI)* (pp. 1-6). IEEE.

Hossain, M. A., & Ansari, N. (2021). Energy aware latency minimization for network slicing enabled edge computing. *IEEE Transactions on Green Communications and Networking*, *5*(4), 2150-2159.

Igbayev, S., Kadyrova, A., & Malik, A. (2024, May). Strategies for digital transformation: Case study for Astana IT University. In *2024 IEEE 4th International Conference on Smart Information Systems and Technologies (SIST)* (pp. 422-426). IEEE. DOI: 10.1109/SIST61555.2024.10629321

Jošilo, S., & Dán, G. (2022). Joint wireless and edge computing resource management with dynamic

network slice selection. *IEEE/ACM Transactions on Networking*, *30*(4), 1865-1878.

Judijanto, L., Triolita, N., Machfiroh, R., Yunanto, M. K., & Siminto, S. (2024). Navigating The Landscape Of Higher Education In The 21st Century: Challenges, Innovations, And Future Perspectives. *International Journal of Teaching and Learning*, *2*(1), 297-312.

Karimi, H., & Khawaja, S. (2024). Perspective Chapter: Navigating the Changing. *Innovation and Evolution in Higher Education*, 37.

Lacka, E., Wong, T. C., & Haddoud, M. Y. (2021). Can digital technologies improve students' efficiency? Exploring the role of Virtual Learning Environment and Social Media use in Higher Education. *Computers & Education*, *163*, 104099. https://doi.org/10.1016/j.compedu.2020.104099

Liljeblad, F., Lilliesköld, J., & Hetemi, E. (2024, August). Tensions in Digitalization in Higher Education: Learning from the Past to Guide Digital Transformation. In *2024 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-11). IEEE.

Liyanagea, M., Phamb, Q. V., Devc, K., Bhattacharyad, S., Reddy, P. K., Maddikuntad, T. R. G., & Yendurid, G. A Survey on Zero Touch Network and Service (ZSM) Management for 5G and Beyond Networks. *English, Journal of Network and Computer Applications*, *4*, 103.

Loukatos, D., Androulidakis, N., Arvanitis, K. G., Peppas, K. P., & Chondrogiannis, E. (2022). Using Open Tools to Transform Retired Equipment into Powerful Engineering Education Instruments: A Smart Agri-IoT Control Example. *Electronics*, *11*(6), 855.

Markoc, I. (2024). The digitalization tendency of young adults: differences by living environment, gender and education. *Online Information Review*. DOI 10.1108/OIR-01-2023-0020

Mohammadi, A., & Nikaein, N. (2023). ATHENA: An Intelligent Multi-x Cloud Native Network Operator. *IEEE Journal on Selected Areas in Communications*.

Mostafavi, S., Hakami, V., & Sanaei, M. (2021). Quality of service provisioning in network function virtualization: a survey. *Computing*, *103*, 917-991.

Mustafa, M., Alshare, M., Bhargava, D., Neware, R., Singh, B., & Ngulube, P. (2022). Perceived Security Risk Based on Moderating Factors for Blockchain Technology Applications in Cloud Storage to Achieve Secure Healthcare Systems. *Computational and mathematical methods in medicine*, *2022*(1), 6112815.

Nasrul, M. A. D., Manaf, Z. I. A., Syafril, S., & Fathurrohman, M. (2021). An overview of the inheritance legal system in Malaysia and Indonesia: Issues faced by both countries. *Journal of Shariah Law Research*, 6(2), 181-200.

Nurhas, I., Aditya, B. R., Jacob, D. W., & Pawlowski, J. M. (2022). Understanding the challenges of rapid digital transformation: the case of COVID-19 pandemic in higher education. *Behaviour & Information Technology*, *41*(13), 2924-2940. https://doi.org/10.1080/0144929X.2021.1962977

Nurhas, I., Aditya, B. R., Jacob, D. W., & Pawlowski, J. M. (2022). Understanding the challenges of rapid digital transformation: the case of COVID-19 pandemic in higher education. *Behaviour & Information Technology*, *41*(13), 2924-2940. https://doi.org/10.1080/0144929X.2021.1962977

Okoye, K., Daruich, S. D. N., De La O, J. F. E., Castaño, R., Escamilla, J., & Hosseini, S. (2023). A Text Mining and Statistical Approach for Assessment of Pedagogical Impact of Students' Evaluation of Teaching and Learning Outcome in Education. *IEEE Access*, *11*, 9577-9596.

Pan, H., Wu, Y., & Choguill, C. (2023). Optimizing the rural comprehensive land consolidation in China based on the multiple roles of the rural collective organization. *Habitat International*, 132, 102743. https://doi.org/10.1016/j.habitatint.2023.102743

Paños-Castro, J., Korres, O., Iriondo, I., & Petchamé, J. (2024). Digital Transformation and Teaching Innovation in Higher Education: A Case Study. *Education Sciences*, *14*(8). doi.org/10.3390/educsci14080820

Pérez-Sanagustín, M., Kotorov, I., Teixeira, A., Mansilla, F., Broisin, J., Alario-Hoyos, C., ... & Gonzalez Lopez, A. H. (2022). A competency framework for teaching and learning innovation centers for the 21st century: Anticipating the post-COVID-19 age. *Electronics*, *11*(3), 413. https://doi.org/10.3390/electronics11030413

Qureshi, F., Khawaja, S., Pejić Bach, M., & Meško, M. (2024). Slovenian Higher Education in a Post-Pandemic World: Trends and Transformations. *Systems*, *12*(4), 132. https://doi.org/10.3390/systems12040132

Rafique, W., Barai, J., Fapojuwo, A. O., & Krishnamurthy, D. (2024). A survey on beyond 5g network slicing for smart cities applications. *IEEE Communications Surveys & Tutorials*.

Rahman, D. M. H. (2019). Faraid distribution in Malaysia: Issues and challenges. Retrieved from http://eprints.unisza.edu.my/id/eprint/4119

Rama Rao, A. V., Kavarakuntla, T., Kanipakam, S., Murari, T., Kumar, K. P., & Kumar, B. S. (2023). Blockchain-Backed Verification Systems for Enhanced Interoperability and Trust in Managing Legal Documents across Multi-Cloud Environments. *Journal of Electrical Systems*, *19*(4).

Saad, S. B. (2023). *Security architectures for network slice management for 5G and beyond* (Doctoral dissertation, Sorbonne Université).

Salem, M. A., & Elshaer, I. A. (2023). Educators' utilizing one-stop mobile learning approach amid global health emergencies: Do technology acceptance determinants matter?. *Electronics*, *12*(2), 441. https://doi.org/10.3390/ electronics12020441

Setiawan, R., Putranto, A., Princes, E., Geraldina, I., Julianti, E., Safitri, J., & Pannen, P. (2024). Tech-Driven Transformation: Innovative Pricing Strategies for E-Learning. *IEEE Access*. Digital Object Identifier 10.1109/ACCESS.2024.3392489

Shah, S. D. A. (2022). *Software Defined Mobility Management in Network Slicing Enabled Multi-Access Edge Computing* (Doctoral dissertation, Royal Melbourne Institute of Technology).

Sharma, A., & Kaur, P. (2023). Tamper-proof multitenant data storage using blockchain. *Peer-to-peer Networking and Applications*, *16*(1), 431-449.

Shishakly, R., Almaiah, M., Lutfi, A., & Alrawad, M. (2024). The influence of using smart technologies for sustainable development in higher education institutions. *International Journal of Data and Network Science*, *8*(1), 77-90. https://doi.org/10.55056/cte.616

Srisawat, S., Wannapiroon, P., & Nilsook, P. (2024). Distributed Digital Enterprise Architecture for Transformation of Educational Organizations. *TEM Journal*, *13*(2). DOI: 10.18421/TEM132-77 34TUhttps://doi.org/10.18421/TEM132-77

Suryanarayana, K. S., Kandi, V. P., Pavani, G., Rao, A. S., Rout, S., & Krishna, T. S. R. (2024). Artificial Intelligence Enhanced Digital Learning for the Sustainability of Education Management System. *The Journal of High Technology Management Research*, *35*(2), 100495. https://doi.org/10.1016/j.hitech.2024.100495

Suryanarayana, K. S., Kandi, V. P., Pavani, G., Rao, A. S., Rout, S., & Krishna, T. S. R. (2024). Artificial Intelligence Enhanced Digital Learning for the Sustainability of Education Management System. *The Journal of High Technology Management Research*, *35*(2), 100495.

Swan, M. (2015). *Blockchain: Blueprint for a new economy*. Sebastopol, Calif: O'Reilly Media.

Tarng, W., Wu, Y. J., Ye, L. Y., Tang, C. W., Lu, Y. C., Wang, T. L., & Li, C. L. (2024). Application of Virtual Reality in Developing the Digital Twin for an Integrated Robot Learning System. *Electronics*, *13*(14), 2848. https:// doi.org/10.3390/electronics13142848

Thantharate, A., & Beard, C. (2023). ADAPTIVE6G: Adaptive resource management for network slicing architectures in current 5G and future 6G systems. *Journal of Network and Systems Management*, *31*(1), 9.

Theodorou, V., & Xezonaki, M. E. (2020, June). Network slicing for multi-tenant edge processing over shared IoT infrastructure. In *2020 6th IEEE Conference on Network Softwarization (NetSoft)* (pp. 8-14). IEEE.

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information systems research*, *21*(4), 675-687.

Zheng, G., & Friderikos, V. (2020, September). Fair Cache Sharing Management for Multi-Tenant Based Mobile Edge Networks. In *Proceedings of the ACM MobiArch 2020 The 15th Workshop on Mobility in the Evolving Internet Architecture* (pp. 1-7).