

The AI, Blockchain, Cloud and Data (ABCD) Technology Integration in the Philippines: A Literature Review

Joel Mark P. Rodriguez

Human Resource Management Department, College of Business, Entrepreneurship and Accountancy
Rizal Technological University, Mandaluyong City, Philippines

Author Email: jmprodriguez@rtu.edu.ph

Date received: October 26, 2024

Date revised: November 7, 2024

Date accepted: November 25, 2024

Originality: 90%

Grammarly Score: 99%

Similarity: 10%

Recommended citation:

Rodriguez, J.M. (2024). The AI, Blockchain, Cloud and Data (ABCD) technology integration in the Philippines: A literature review. *Journal of Interdisciplinary Perspectives*, 2(12), 490-496. <https://doi.org/10.69569/jip.2024.0588>

Abstract. This literature review examines the integration of ABCD (Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics) technologies in the Philippines, including adoption, worldwide developments, as well as particular applications. Despite the significant potential for ABCD technologies, the integration in healthcare, agriculture, financial, and educational sectors to increase efficiency, security, and ability to make decisions, challenges that are experienced include infrastructure constraints, skill gaps, and regulatory requirements. It manifests the enormous potential of ABCD if applied to engineering models such as Industry 4.0 and digital innovation in health care, e-commerce, and supply chains, predictive maintenance, transparent transactions, and automation. Early adopters can already be discerned in the Philippines, such as AI applications in agriculture and mental health, blockchain for secure records, cloud applications in education, and data analytics in health care- but still, lack of infrastructure and inability to find the people with proper skills slow the movement. Sectors like health and manufacturing, which have high growth potential, these technologies can become competitive engines for the Philippines. Recommendations on digital infrastructure, data privacy, public-private partnerships, and investment in workforce development would facilitate an enabling environment for supporting the culture of ABCD technologies.

Keywords: ABCD technologies; Artificial Intelligence; Digital transformation; Digital infrastructure; Innovation.

1.0 Introduction

Over a year, ABCD technologies, an abbreviation for Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics, have seen much developmental progress at breakneck speed, spreading to the widest canvas of industries. These technologies have focused on aspects such as automation, security, scalability, and the use of data for decision-making and stand at the forefront of innovation across various sectors. AI allows machines to mimic human intelligence, in which systems learn from data and adapt toward specific tasks (Morandín-Ahuerma, 2022; Haenlein & Kaplan, 2019). With the digital ledger being decentralized, blockchain assures safe transactions; thereby, the process is quite transparent. The processes become tamper-proof and cost-effective (Monrat et al., 2019; Gaikwad, 2020). Cloud computing is on-demand access to scalable computing resources over the internet, reducing reliance on physical infrastructure (Sikka & Ojha, 2021; Lamba et al., 2022).

Data analytics or big data allows for processing large datasets to extract actionable insights, contributing significantly to fraud detection, risk management, and decision-making endeavors (Arena & Pau, 2020; Schneider & Weiller, 2022). These technologies can significantly change business operations in the Philippines, especially in the manufacturing and finance sectors. However, this is still handicapped by infrastructure-related limitations and a lack of skilled workers. Therefore, tapping the power of ABCD technologies can enable organizations to navigate the digital landscape better, position themselves for future growth, and, most importantly, increase market leverage through their products and services.

The research gap of this study lies in the fact that there has been a lack of exploration of the actual applications of ABCD technologies in particular sectors such as healthcare, agriculture, finance, or education in the Philippines. This study is also very significant in synthesizing present knowledge, pointing out opportunities by sectors, and offering strategic recommendations to support digital transformation in fostering sustainable growth and innovation. This would surely help policymakers and industry leaders.

2.0 Methodology

This literature review involves the following processes: identification, selection, and analysis of relevant, peer-reviewed articles, reports, and studies related to technologies and their integrations within various sectors of the Philippines. The terminologies used to search in databases such as IEEE Xplore, ScienceDirect, and Google Scholar include ABCD technology integration in the Philippines, AI in the Philippines, blockchain applications in the Philippines, cloud computing in the Philippines, and data analytics in the Philippines. Articles must be from 2019 onwards. These articles must focus more on real-world applications, sector-specific impacts, and adoption challenges. Articles without empirical evidence or those that do not relate to the context of the Philippines are excluded. The thematic synthesis analysis was used to categorize the findings into core themes such as infrastructure limitations, skills gaps, and sectoral opportunities for a holistic overview of the current state and potential of ABCD technology integration.

3.0 Literature Review

The Global Integration of ABCD Technologies

The Integration of ABCD technologies around the world has transformed multiple industries. Most notable are the implementation models of Industry 4.0. Characterizing this fourth industrial revolution is the integration of cyber and physical elements, amplifying the use of ABCD technologies for better prediction, control, and maintenance (Bajic et al., 2021). In the engineering field, these technologies have transformed production processes through the improvement of the quality of products, safety, and productivity that favors mass customization (Sony & Aithal, 2020). For instance, Siemens uses Industrial AI to integrate predictive analytics required in a complex environment with decision-making capacity to tackle some of the challenges of Industry 4.0 (Peres et al., 2020). Similarly, GE could absorb AI and data analytics to predict machinery breakdowns, thus saving tremendous amounts of money and operational efficiency.

While AI, IoT, and blockchain are part of the Industry 4.0 technologies, they have also found their way into construction, e-commerce, and supply chains. These technologies enable automation, robotics, and digital twins in construction, advancing sustainability and resource optimization (Turner et al., 2021). E-commerce platforms, including Amazon, utilize AI and blockchain technologies to enhance the quality of services and customer experience in terms of designing personal, secure, and flawless shopping experiences (Sardjono et al., 2023). ABCD technology also enables Resilient Supply Chain 4.0 to develop crucial indicators such as lead times and chain transparency (Marinagi et al., 2023). Here are some success stories demonstrating efficiency, savings, cost-cutting, and smart decisions by using data at the business level, thus pointing out how the ABCD technologies will transform the industry in the coming years.

The Current Status of AI, Blockchain, Cloud, and Data (ABCD) Integration Technology in the Philippines

The Philippines is gradually embracing ABCD technologies that include Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics in different disciplines, including the application in healthcare, agriculture, and services in employment generation by human resource development (Rosales et al., 2020). In mental health practices, AI is explored to make care more accessible and cost-effective; in higher education institutions (Kee et al., 2021), AI is used to help research academics and administration processes (Asirit & Hua, 2023). Blockchain

technology is also taking center stage, especially in higher education, considering the founding element of secure record-keeping for beneficial utilization being salient (Salandanan, 2020). Cloud computing is also applied to make operations better. For this reason, cloud-based HRIS for employees improves the management of people in governmental departments, including the Department of Health (Manahan et al., 2022). With a boost from cloud computing, data analytics have been applied in fields such as judicial case management to improve real-time decision-making (Ge & Yanli, 2022).

This Philippine government is engaged in initiatives that help establish an encouraging climate of using ABCD technology. For example, the Technology Environment Organization framework supports virtual learning through cloud computing in higher education and streamlines organizational operations and infrastructure (Menta, 2022). What people see through the actual integration of AI in traffic systems, such as contactless violation detection, gives a picture of the government's attempt to include AI in public systems (Jose et al., 2021). Additionally, blockchain is one of the technologies that can ensure the country stays competitive in the global scheme, particularly in its records and financial systems (Bongo & Culaba, 2019).

However, some issues hinder the adoption of these ABCD technologies. Capacity building, specifically in healthcare, has to be stepped up since AI models need to generalize for underrepresented regions such as the Philippines (Gutierrez & Viacrusis, 2023). Infrastructure, lack of experts, and technological gaps remain prevalent in almost all sectors. Policy alignments and changes in business models are also required to help integrate such technologies into one coherent system. Take Broadcasting, for instance; digitalization from analog systems required a paradigm shift toward an alternative business model and aligned policies (Licup, 2023). Overcoming such barriers would be fundamental in helping the Philippines fully realize the benefits of these ABCD technologies and keep ahead of the world.

AI, Blockchain, Cloud, and Data in Different Fields in the Philippines

Integrating the four technologies and the ABCDs – artificial intelligence, blockchain, cloud computing, and data analytics – has started changing multiple sectors in the Philippines. This has resulted in efficiency, security, and accessibility to agriculture, health care, finance, and education, among other sectors, from which every field will have something different to benefit.

AI in Agriculture, Industry, and Public Safety

In agriculture, AI applications make farming more proactive by applying predictive analytics to maximize crop yields, champion sustainable food production, and donate to the entire spectrum of food-related habits (Rosales et al., 2020). Technology-driven solutions, such as AI and big data analytics, are applied in initiatives such as Smart Farming Innovations to boost organic food production, alleviate poverty, and enhance timely decision-making (Matero & Jumawan-Matero, 2020). In the industrial sector, AI would automate redundant tasks, thus making amends for labor shortages and productivity boosts (Concepcion et al., 2019). All these applications are sufficient proof that AI is indeed transforming public safety and would not benefit from integrating AI in bioengineering as a new path toward crime prevention and, at the same time, an ethical and regulatory consideration (Arroyo, 2023).

Blockchain in Education, Healthcare, and Finance

Blockchain provides safety for storing and sharing data; hence, it is crucial for sensitive industries such as healthcare and finance in terms of data security and confidentiality (Singhal et al., 2021). In education, this manifests itself in building on record-keeping involving secure frameworks for a student's record, thereby creating new employment opportunities in the employment market with blockchain-related jobs (Salandanan, 2020). AI and blockchain convergence in these sectors will be aided by advanced analytics to help in decision-making and will help enable data-driven insights.

Cloud Computing in Education and Government Services

Cloud computing revolutionizes the education industry by allowing elastic learning solutions and increasing data-driven student performance insights (Estrellado & Miranda, 2023). The technology allows organizations to create virtual learning environments using models, such as the Technology Environment Organization, that make their work easier and strengthen their foundational infrastructure in higher education institutions (Menta, 2022). More than that, cloud-based systems are improving government services with applications like the HRIS of the

Department of Health, which supports the efficient management of employees and the improvement of program implementation (Manahan et al., 2022).

Data Analytics in Healthcare and Urban Management

Data analytics plays an essential role in healthcare settings. It improves decision-making while enhancing the quality of patient care. To enhance the capability, AI health models must be implemented to influence underrepresented regions in the Philippines, such as regional variances influencing access to care (Gutierrez & Viacrusis, 2023). In urban governance, data analytics and AI are used in contactless traffic violation apprehension systems to improve traffic management and urban planning in congested areas (Jose et al., 2021).

Challenges and Opportunities in the Integration of AI, Blockchain, Cloud, and Data in the Philippines

In the Philippines, integrating ABCD technologies could lead to full-scale transformation but also involves great challenges. ABCD presents many security, scalability, efficiency, and data management opportunities in different sectors, yet their adoption involves significant infrastructure, interoperability, and talent readiness issues.

Infrastructure Limitations

The country has its digital divide, as the technology infrastructure in the Philippines is few and far between, particularly in rural areas. This limitation is causing fewer acceptances of advanced technologies (Estrellado & Miranda, 2023). The absence of adequate computational resources limits the full optimization of cloud computing and AI, mostly in the healthcare and education sectors, where real-time data processing must be executed.

Data Privacy and Security Concerns

The integration of these technologies poses several crucial concerns over data privacy and security. However, blockchain technology provides decentralized, secure, and tamper-proof solutions to many issues. However, this capability is realized only by robust architectures and consensus mechanisms (Nguyen et al., 2019; Murthy et al., 2020). There must be strength in data privacy policy to protect sensitive information because AI relies upon large datasets for training and analytics.

Skills Gap

To utilize ABCD technologies, a proficient workforce must be optimally exploited. More importantly, there is an urgent call for developing skills and building capacity in the Philippines (Rosales et al., 2020). Therefore, bridging this gap will require education and capacity building across industries, as both the technical and ethical underpinnings are involved with AI and blockchain.

Interoperability and Data Management

Integrating AI, blockchain, and IoT in the logistics and manufacturing sectors will pose interoperability and data management issues. In reality, blockchain connected with IoT (BCoT) can provide a singular framework for data exchange. This will benefit data handling and reliability, but practical ways for its real-world application are still under development (Dai et al., 2019).

Opportunities

Enhanced Application Across Sectors

AI, blockchain, and cloud technologies constitute a source of innovative applications for different industries, including healthcare, logistics, and education. Blockchain record-keeping in education is believed to increase transparency and job opportunities among students studying in blockchain fields (Salandanan, 2020). AI combined with blockchain has supported data-driven decision-making, safe records, and efficiency in healthcare (Singhal et al., 2021).

Economic Growth and Job Creation

Proper harnessing of ABCD technologies can be a means of economic growth through the generation of employment due to the progressive transformation of various industries into digital models. In agriculture, AI will predict farming analytics, and in e-commerce transactions, blockchain takes care of security support for productivity and access to new markets (Matero & Jumawan-Matero, 2020; Rosales et al., 2020).

Collaborative Efforts for Technological Advancement

Collaboration opportunities among the public, private, and academic sectors can advance the adoption of ABCD technologies. Partnerships foster an environment where technology innovation can be promoted and resourceful application-based solutions supported through research (Rosales et al., 2020). Policies in the technology environment, including the structure of the Technology Environment Organization, also form the basis upon which such technologies can scale up because efforts are directed toward improving the educational infrastructure as well as efficiencies in the operational virtual learning system (Menta, 2022).

Therefore, these ABCD technologies have enormous transformation opportunities in sectors in the Philippines, realising such benefits, however require overcoming infrastructure challenges, concerns on data privacy, and skill gaps. Through these means, Philippines can seriously implement the benefits from Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics for enhanced operational efficiency, economic growth, and sustainable technological advancement across industries.

Synthesis

The review shows how these sectors, such as health, agriculture, finance, and education, are slowly changed by the application of these ABCD technologies, (Rosales et al., 2020). These infrastructures should take more effort, particularly in the areas where experts are in low supply such as the country-developed Blockchain-secured educational records and AI-driven mental health solutions (Gutierrez & Viacrusis, 2023). The government has provided cloud-based learning systems through the Technology Environment Organization framework (Menta, 2022), but the result is not uniformed because of a lack of connectivity in rural settings (Estrellado & Miranda, 2023).

Cloud computing has supported virtual learning and effective government services like those of cloud-based HRIS by the Department of Health (Manahan et al., 2022). Infrastructure shortcomings and deficiencies only recently permit such near real-time processing of the information along with its extensive integration into other industrial sectors. Blockchain has promised to potentially strengthen data integrity and openness, promising data security, while notable examples were given in education and finance (Salandanan, 2020). Regulation as well as technical shortcomings work against wider dissemination (Bongo & Culaba, 2019). High demonstrated potential for AI in driving innovation in farming through predictive analytics and smart farming techniques, but badly hampered by a lack of skills in technology management (Matero & Jumawan-Matero, 2020).

Public-private partnerships and investment in the training of the workforce will further open these technologies into the pathways of economic growth and job generation (Rosales et al., 2020). Coordinated effort from the academic, public, and private sectors will bring about acceleration in scalable frameworks for broadening the applications of ABCD technologies (Sardjono et al., 2023). These are some of the key ingredients required to strengthen the digital economy in the Philippines for aggressive competition.

4.0 Conclusion

The review of the literature confirms the fact that while integration of the ABCD technologies starts to transform sectors in the Philippines, be it in the country's healthcare, agriculture, finance, and education sectors, there are considerable barriers to adoption. Findings include the fact that infrastructural inadequacies, skills gaps, and regulatory constraints remain significant barriers to across-the-board adoption. Already, there are successful cases, such as AI-driven healthcare solutions and blockchain-secured educational records, that prove the transformational potential of the technologies. Overcoming these hurdles through investment in digital infrastructure, policy enhancements, and training the workforce is key to fully realizing the benefits of ABCD integration.

For future research, it is important to develop practical case studies that will explore the real applications of ABCD technologies in specific sectors of the Philippine economy, that will focus on developing scalable, interoperable frameworks and strong data privacy protocols aligned with local regulations. Also, there should be further research on how the educational programs would address the gap in skills so that the workforce is better equipped to take advantage of these new technologies. Closing these gaps will set the way forward for future efforts toward

a digitally driven, innovative economy that will bring sustainable growth and a more competitive Philippines in the world.

5.0 Contributions of Authors

Joel Mark P. Rodriguez: He was the overall in charge of writing this literature review.

6.0 Funding

No funds were received for this study.

7.0 Conflict of Interests

There is no conflict of interest in conducting this study.

8.0 Acknowledgment

Acknowledged to my family and loved ones for the success of this study.

9.0 References

- Akter, S., Michael, K., Uddin, M.R., McCarthy, G., & Rahman, M. (2020). Transforming business using digital innovations: the application of AI, blockchain, cloud and data analytics. *Annals of Operations Research*, 308, 7-39. <https://doi.org/10.1007/s10479-020-03620-w>
- Arena, F., & Pau, G. (2020). An overview of big data analysis. *Bulletin of Electrical Engineering and Informatics*, 9, 1646-1653. <https://doi.org/10.1591/EEI.V9i4.2359>
- Bobby L. Asirit, L., & H. Hua, J. (2023). Converging perspectives: Assessing AI readiness and utilization in Philippine higher education. *Polaris Global Journal of Scholarly Research and Trends*, 2(3), 1-50. <https://doi.org/10.58429/pgjsrt.v2n3a152>
- Bajić, B., Rikalovic, A., Suzić, N., & Piuri, V. (2021). Industry 4.0 Implementation Challenges and Opportunities: A Managerial Perspective. *IEEE Systems Journal*, 15, 546-559. <https://doi.org/10.1109/ISYST.2020.3023041>
- Barajas, J. R., Sangil, M. J., Aspra, N., Gealone, P. J., Lucero, A., Ramos, M., Padua, O., & Oropesa, R. (2024). Exploratory data analysis of artificial intelligence integration in Philippine engineering programs offered by state universities and colleges: A preliminary assessment. 2024 Systems and Information Engineering Design Symposium (SIEDS), 360-365. <https://doi.org/10.1109/SIEDS61124.2024.10534634>
- Bongo, M. F. & Culaba, A. B. (2019). Blockchain technology in the Philippines: Status, trends, and ways forward. *IEEE 11th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)*, Laoag, Philippines, pp. 1-8. <https://doi.org/10.1109/HNICEM48295.2019.9073349>
- Concepcion, R.S., Bedruz, R.A., Culaba, A.B., Dadios, E.P., & Pascua, A.R. (2019). The Technology Adoption and Governance of Artificial Intelligence in the Philippines. 2019 IEEE 11th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 1-10. <https://doi.org/10.1109/HNICEM48295.2019.9072725>
- Dai, H., Zheng, Z., & Zhang, Y. (2019). Blockchain for Internet of Things: A Survey. *IEEE Internet of Things Journal*, 6, 8076-8094. <https://doi.org/10.1109/IIOT.2019.2920987>
- Estrellado, C. J. P., & Miranda, J. C. (2023). Artificial intelligence in the Philippine educational context: Circumspection and future inquiries. *International Journal of Scientific and Research Publications*, 13(5), 16-22. <https://doi.org/10.29322/IJSRP.13.05.2023.p13704>
- Gaikwad, A. S. (2020). Overview of blockchain. *International Journal for Research in Applied Science and Engineering Technology*, 8(6), 2268-2270. <https://doi.org/10.22214/ijraset.2020.6364>
- Ge, L., & YanLi, P. (2022). Research on network data monitoring and legal evidence integration based on cloud computing. *Mobile Information Systems*, 2022, 1-10. <https://doi.org/10.1155/2022/1544981>
- Gutierrez, K. L. T., & Viacrusis, P. M. L. (2023). Bridging the gap or widening the divide: A call for capacity-building in artificial intelligence for healthcare in the philippines. *Journal of Medicine, University of Santo Tomas*, 7(2), 1325-1334. <https://doi.org/10.35460/2546-1621.2023-0081>
- Haenlein, M., & Kaplan, A. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. *California Management Review*, 61, 14 - 5. <https://doi.org/10.1177/0008125619864925>
- Hemamalini, V., Mishra, A.K., Tyagi, A.K. and Kakulapati, V. (2024). Artificial Intelligence-Blockchain-Enabled-Internet of Things-Based Cloud Applications for Next-Generation Society. In *Automated Secure Computing for Next-Generation Systems*, A.K. Tyagi (Ed.). <https://doi.org/10.1002/9781394213948.ch4>
- Jamwal, A., Agrawal, R., Sharma, M., & Giallanza, A. (2021). Industry 4. 0 technologies for manufacturing sustainability: A systematic review and future research directions. *Applied Sciences*, 11(12), 5725. <https://doi.org/10.3390/app11125725>
- Jose, J., Billones, C., Brillantes, A., Billones, R., Sybingco, E., Dadios, E., Fillone, A., & Lim, L. (2021). Artificial Intelligence Software Application for Contactless Traffic Violation Apprehension in the Philippines. *Journal Advance Computer Intelligence Informatics*, 25, 410-415. <https://doi.org/10.20965/jaciii.2021.p0410>
- Kee, S., Garganera, J., Maravilla, N., Garganera, W., Fermin, J., Aldahoul, N., Karim, H., & Tan, M. (2021). Riding the Tide Toward the Digital Era: The Imminent Alliance of AI and Mental Health in the Philippines. Retrieved from <https://doi.org/10.31219/osf.io/3wg5p>
- Lamba, Dr. S., Mishra, S., & Rastogi, S. (2022). A review paper on cloud computing. *International Journal of Research Publication and Reviews*, 3(3), 1893-1895. <https://doi.org/10.55248/gengpi.2022.3.3.7>
- Licup, J.M. (2023). The Future of Broadcasting: Technology, Policy and AI Integration in the Philippine Setting. *International Journal of Advanced Research in Technology and Innovation*, 5(3), 40-56. <https://doi.org/10.55057/ijarti.2023.5.3.5>
- Luo, D., Thevenin, S., & Dolgui, A. (2022). A state-of-the-art on production planning in Industry 4.0. *International Journal of Production Research*, 61, 6602-6632. <https://doi.org/10.1080/00207543.2022.2122622>
- Manahan, J., Lacatan, L. L., & Miguel, A. R. (2022). Implementation of prime-hrm program using cloud-based technology. *Technium: Romanian Journal of Applied Sciences and Technology*, 4(9), 102-119. <https://doi.org/10.47577/technium.v4i9.7415>
- Marinagi, C., Reklitis, P., Trivellas, P., & Sakas, D. (2023). The impact of industry 4. 0 technologies on key performance indicators for a resilient supply chain 4. 0. *Sustainability*, 15(6), 5185. <https://doi.org/10.3390/su15065185>
- Matero, C., & Jumawan-Matero, M. (2020). Smart Farming Innovations for Philippines: Strategies and Recommendations. *Proceedings of the 1st International Conference on Accounting, Management and Entrepreneurship (ICAMER 2019)*, Advances in Economics, Business and Management Research, 47-50. <https://doi.org/10.2991/aebmr.k.200305.012>
- Menta, A. (2022). Adopting Technology Environment Organization Framework in Virtual Learning through Cloud Computing of Higher Education Institution. *International Journal of Computing Sciences Research*, 6, 822-841. <https://doi.org/10.25147/ijcsr.2017.001.1.75>
- Monrat, A., Schelen, O., & Andersson, K. (2019). A Survey of Blockchain From the Perspectives of Applications, Challenges, and Opportunities. *IEEE Access*, 7, 117134-117151. <https://doi.org/10.1109/ACCESS.2019.2936094>
- Morandín-Ahuerma, F. (2022). What is artificial intelligence? *International Journal of Research Publication and Reviews*, 3(12), 1947-1951. <https://doi.org/10.55248/gengpi.2022.31261>
- Murthy, C., Shri, M., Kadry, S., & Lim, S. (2020). Blockchain Based Cloud Computing: Architecture and Research Challenges. *IEEE Access*, 8, 205190-205205. <https://doi.org/10.1109/ACCESS.2020.3036812>
- Nguyen, D., Pathirana, P., Ding, M., & Seneviratne, A. (2019). Integration of Blockchain and Cloud of Things: Architecture, Applications and Challenges. *IEEE Communications Surveys & Tutorials*, 22, 2521-2549. <https://doi.org/10.1109/COMST.2020.3020092>
- Peres, R., Jia, X., Lee, J., Sun, K., Colombo, A., & Barata, J. (2020). Industrial Artificial Intelligence in Industry 4.0 - Systematic Review, Challenges and Outlook. *IEEE Access*, 8, 220121-220139. <https://doi.org/10.1109/ACCESS.2020.3042874>
- Rosales, M. A., Magsumbol, J. A. V., Palconit, M. G. B., Culaba, A. B. & Dadios, E. P. (2020). Artificial Intelligence: The Technology Adoption and Impact in the Philippines. *IEEE 12th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)*, Manila, Philippines, pp. 1-6. <https://doi.org/10.1109/HNICEM51456.2020.9400025>
- Sadri, H., Yitmen, I., Tagliabue, L. C., Westphal, F., Tezel, A., Taheri, A., & Sibenik, G. (2023). Integration of blockchain and digital twins in the smart built environment adopting disruptive technologies – A systematic review. *Sustainability*, 15(4), 3713. <https://doi.org/10.3390/su15043713>
- Salah, K., Rehman, M., Nizamuddin, N., & Al-Fuqaha, A. (2019). Blockchain for AI: Review and Open Research Challenges. *IEEE Access*, 7, 10127-10149. <https://doi.org/10.1109/ACCESS.2018.2890507>

- Salandan, M. (2020). Blockchain Technology as a Competitive Advantage for Higher Education Institutions in the Philippines. *Millennium Journal of Humanities and Social Sciences*, 1(3), 69–89. <https://doi.org/10.47340/mjhss.v1i3.5.2020>
- Sardjono, W., Martasari, G., & Gui, A. (2023). Impact of Industrial Technology 4.0 in Improving Service Quality and Customer Experience on E-Commerce Platforms. *E3S Web of Conferences*. <https://doi.org/10.1051/e3sconf/202342601007>
- Santiago, C. S., Embang, S. I., Acanto, R. B., Ambojia, K. W. P., Apercho, M. D. B., Balilo, B. B., Cahapin, E. L., Conlu, M. T. N., Lausa, S. M., Laput, E. Y., Malabag, B. A., Paderes, J. J., & Romasanta, J. K. N. (2023). Utilization of writing assistance tools in research in selected higher learning institutions in the philippines: A text mining analysis. *International Journal of Learning, Teaching and Educational Research*, 22(11), 259–284. <https://doi.org/10.26803/ijlter.22.11.14>
- Schneider, F., & Weiller, C. (2022). Big Data and Artificial Intelligence. *International Journal of Management Trends: Key Concepts and Research*, 1(1), 3–14. <https://doi.org/10.58898/ijmt.v1i1.03-14>
- Singhal, T. M., S., Bhargavi, P., Hemavathi. (2021). 1. Coalescence of Artificial Intelligence with Blockchain: A Survey on Analytics Over Blockchain Data in Different Sectors. *Emerging Technologies in Data Mining and Information Security*, 1286, 703–711. https://doi.org/10.1007/978-981-15-9927-9_68
- Sikka, R., & Ojha, M. (2021). An overview of cloud computing. *International Journal of Innovative Research in Computer Science & Technology*, 135–138. <https://doi.org/10.55524/ijircst.2021.9.6.31>
- Sony, M., & Aithal, S. (2020). Transforming Indian Engineering Industries through Industry 4.0: An Integrative Conceptual Analysis. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3684698>
- Turner, C., Oyekan, J., Stergioulas, L., & Griffin, D. (2021). Utilizing Industry 4.0 on the Construction Site: Challenges and Opportunities. *IEEE Transactions on Industrial Informatics*, 17, 746–756. <https://doi.org/10.1109/TII.2020.3002197>