International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 9 Issue 3 March - 2025, Pages: 31-38

Towards the Design of XAI for Integrating KMS with IR4.0: Organizational Challenges in Technology Integration and Business Value Enhancement.

Abubakar Balarabe1 and Ahmed Abubakar Aliyu2

1Department of Informatics, Faculty of Computing, Kaduna State University, Kaduna, Kaduna State Nigeria.
rakabubaa@gmail.com
2Department of Informatics, Faculty of Computing, Kaduna State University, Kaduna, Kaduna State Nigeria.
ahmed.aliyu@kasu.edu.ng

Abstract: *This study explores the integration of Knowledge Management Systems (KMS) with Industrial Revolution 4.0 (IR4.0) technologies by incorporating an Explainable Artificial Intelligence (XAI) model to address the critical challenges of transparency and trust in AI-driven decision-making. The research aims to enhance the interpretability of AI models within organizational knowledge management frameworks, facilitating better decision-making processes and improved business value. A structured research methodology involving literature review, survey data collection, framework enhancement, and statistical evaluation was employed. A field survey was conducted among IT professionals, managers, and users working with KMS and IR4.0 technologies to assess the applicability of XAI integration. The data was analyzed using descriptive statistics, Cronbach's Alpha reliability test, and regression analysis to evaluate the impact of XAI on the integrated framework. The findings indicate that integrating XAI into the KMS and IR 4.0 framework has significantly improved the transparency of the framework, enhances user trust, and fosters efficient knowledge-sharing. Regression analysis results demonstrate a strong positive correlation between the two models. Additionally, the work expressed readiness for organizations integrate XAI into their KMS by highlighting its practical applicability.*

Keywords- Explainable Artificial Intelligence (XAI), Knowledge Management System (KMS), Industrial Revolution 4.0 (IR4.0), Organizational Challenges (OC), Technology Integration (TI).

1. INTRODUCTION

The rapid advancement of Industrial Revolution 4.0 (IR4.0) technologies has brought significant changes to the business landscape, offering new opportunities and challenges for organizations. This era of digital transformation emphasizes the integration of emerging technologies, such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and robotic process automation (RPA), etc. to revolutionize industrial operations and drive business value. Among these technologies, AI has emerged as a powerful tool for automating processes, extracting insights from data, and making intelligent decisions. However, the lack of transparency and interpretability in AI systems has been a significant hurdle in leveraging the full potential of these technologies (Laudon & Laudon, 2020).

The integration of Industrial Revolution 4.0 (IR4.0) technologies has also revolutionized the business landscape, presenting organizations with unprecedented opportunities to drive innovation, efficiency, and value creation (Omotayo, 2015). Key technologies such as artificial intelligence (AI), Internet of Things (IoT), Machine Learning (ML), 5G Networks, big data analytics, Cloud Computing and Robotic Process Automation (RPA) have emerged as crucial enablers of digital transformation. By harnessing the power of these technologies, organizations can optimize operations, make data-driven decisions, and gain a competitive edge in the dynamic and fast-paced market (Adesina & Ngo, 2020), (Lista & Tortorella, 2022a).

At the same time, effective knowledge management has become increasingly vital for organizations to leverage their intellectual capital, promote collaboration, and enable informed decision-making. Knowledge Management Systems (KMS) provide a structured framework for capturing, organizing, and disseminating knowledge assets within an organization (Robles-Flores & Kulkarni, 2014). These systems enable efficient knowledge sharing, reduce redundancy, and facilitate learning, thereby enhancing organizational capabilities and competitiveness. Wojcak & Lukáš, (2022) even argued that creating and sharing knowledge is the only way that can bring companies success in IR4.0. Lista & Tortorella, (2022) give imprecise on the need to investigate the relationships between knowledge, people, and technology and to define a more specific direction to build value co-creation for increasing operational performance in IR4.0. Simultaneously, some businesses have already recognized the importance of knowledge management systems (KMS) for effectively capturing, organizing, and sharing knowledge within their organizations (Shin, 2004). These systems enable businesses to harness valuable insights, lessons learned, and best practices for enhancing their competitive advantage and fostering innovation.

A study by (Botega & da Silva, 2020) stated that integration of new techniques and new technologies into organizations' knowledge will help to bring effective knowledge management and transform individual knowledge into organizational knowledge. There is also need for businesses to pay attention to the development of new appropriate methods that will foster knowledge management implementation (Ibrahim et al., 2019). Since the business value of KM reveals that most of the work on evaluating the effectiveness of KM efforts is concentrated on studying the association between KM and firm performance, there is a need for the integration of new revolutionary techniques into organizations' knowledge systems to improve the business value of the organization in term of performance, innovations, new skill and new ideas to be relevant in this era of advancing technology (Tien et al., 2021).

According to the study of (Caliskan et al., 2017), trusting decisions made by machines is a problem. Businesses face a significant challenge to trust the decisions made by AI due to the perceived disadvantages associated with AI systems. One of the primary concerns leading to the lack of trust in AI-based decision-making is the black-box nature of AI algorithms, which makes it challenging to understand how decisions are reached. The lack of interpretability and explainability in AI models hinders organizations' ability to comprehend the underlying logic and reasoning behind AI-driven decisions.

Additionally, issues related to bias and fairness in AI systems contribute to mistrust in AI decision-making (Rudin, 2019). Biases embedded in training data or algorithmic design can lead to discriminatory outcomes, raising ethical concerns and reducing confidence in the fairness and reliability of AI systems.

Wojcak & Lukáš (2022) reported that lack of a coherent and transparent framework for integrating KMS and IR4.0 technologies contributes to trusting decision made by machines. Because organizations often face hurdles related to data heterogeneity, disparate systems, and the "black box" nature of AI algorithms, which hinder their ability to understand and interpret the decision-making processes underlying the use of IR4.0 technologies (Eze et al., 2021). Consequently, organizations struggle to make informed decisions, optimize processes, and derive meaningful insights from the integration of these technologies.

2. RELATED WORKS

There are arrays of literatures on various evolving technologies and their integration. A number of research work have been done relating to KMC and IR4.0 both individually and jointly. Explainable AI (XAI) is an emerging researching area in AI that have gained research attention in recent times. XAI is the capability of AI systems to provide understandable explanations for their decisions and actions Gunning (2017). XAI techniques aim to bridge the gap between black-box AI models and human comprehension, enabling users to understand and trust the reasoning behind AI-based decisions (Pavlou & Yang, 2021). Explainable AI has emerged as a critical component for AI systems, particularly in knowledge management contexts. Based on the three concepts, some work that give insight into the focus of the current research and the future advances on the work is explored.

The work of (Ribeiro et al., 2022) highlights the importance of providing interpretable explanations for AI-driven decision-making, enabling knowledge workers to understand how conclusions are reached. Their study highlights how XAI techniques, such as rule-based systems and interpretable machine learning models, are being explored to ensure transparency in the knowledge inference process. They emphasized the need for explainable AI techniques in complex knowledge management systems to improve user trust and facilitate collaboration.

The research of (Deng & Jin, 2019) focused on the relevance of XAI in the context of IR4.0, as it enables organizations to harness the power of AI systems while ensuring transparency and trustworthiness. Their work highlighted how XAI can help organizations address compliance and ethical considerations, as well as enhance decision-making processes in the era of IR4.0.

Su & Buduru (2020) highlighted the importance of integrating AI technologies, including XAI, with KMS to enhance knowledge-sharing, learning, and decision-making processes. Their study highlighted that by combining XAI with KMS, organizations can leverage the benefits of both domains to improve transparency, compliance, and ethical considerations.

A framework for the integration of IoT and Big Data analytics in the knowledge management system was proposed in (Abascal et al., 2021). The framework tries to enhance real-time information sharing and collaboration across the organization. Their result shows that Industrial Revolution 4.0 technologies such as the Internet of Things (IoT), Big Data analytics, and Cyber-Physical Systems (CPS), are transforming industries by enabling data-driven decision-making and automation.

Panigyrakis et al., (2020) is a research on how AI-powered knowledge management systems contribute to knowledge discovery, innovation, and the creation of business value in the context of the Fourth Industrial Revolution. Their study reveals that AI technologies have become indispensable in harnessing the full potential of IR4.0 for businesses.

Velasquez & Hester (2019) developed a cognitive AI framework that presents the application of cognitive AI in knowledge management. Their framework offers a human-like understanding of knowledge management by enabling a better representation of data and reasoning. Their work shows how AI enhances the integration of complex information and supports strategic decision-making. Their framework also demonstrated how semantic knowledge graphs and ontologies enable effective knowledge integration in AI-driven systems, leading to improved business intelligence and decision support.

Koh (2012) conducted a comprehensive review to explore the integration of Explainable AI (XAI) techniques in knowledge management systems during the Industrial Revolution 4.0 (IR4.0). Their study highlights recent advancements and identifies challenges in implementing XAI within the context of IR4.0 technologies. Their research emphasizes the need for interpretable AI models to promote trust, transparency, and effective knowledge sharing in organizations.

Shrouf et al. (2022) examine the synergistic relationship between Knowledge Management Systems and Explainable AI in the context of IR4.0 transformation. Their study emphasizes how incorporating XAI in KMS fosters better knowledge-sharing practices and facilitates informed decision-making in the dynamic landscape of IR4.0.

Wojcak & Lukáš (2022) present a comprehensive comparison of various Explainable AI techniques and their applicability in IR4.0 environments. Their study evaluates rule-based explanations, model visualization, feature importance, and other XAI methods, providing insights into their effectiveness in knowledge management systems during IR4.0.

Moreover, (Lista et al., 2021) focus on the implications of IR4.0 on knowledge management practices. They conduct a literature review that emphasizes the urgency for incorporating Explainable AI in AI-driven decision-making processes. Their study discusses the challenges posed by black-box AI models in knowledge sharing and advocates for the development of interpretable AI frameworks.

Similarly (Shodiya, 2021) try to bridge the Gap between IR4.0 and Knowledge Management by exploring the application of Explainable AI in smart manufacturing settings within the context of IR4.0. Their study investigates how transparent AI models can improve knowledge management practices in smart factories, promoting operational efficiency and quality control.

An integrative review to examine the convergence of Knowledge Management Systems and Explainable AI within the IR4.0 paradigm was conducted in (Aitouche et al., 2020). The study synthesizes existing research to propose an integrated framework that leverages XAI to enhance knowledge sharing, collaboration, and innovation in IR4.0 environments.

Adesina & Ngo (2020) conducted a systematic review of the application of XAI in healthcare settings. Their work investigates the application of Explainable AI in knowledge management within IR4.0 hospitals. Their work highlights the needs and impact of interpretable AI models on clinical decision-making, patient care, and medical knowledge sharing.

In a study to examine the role of Explainable AI for Ethical Knowledge Management in IR4.0 Enterprises, Ibrahim et al., (2019) conducted an integrative review examining the intersection of ethical considerations, knowledge management, and Explainable AI in IR4.0 enterprises. The study discusses the role of transparent AI models in ensuring ethical decision-making and responsible data use.

Manesh et al. (2019) identify the challenges and opportunities of integrating Explainable AI in knowledge management during the IR4.0 era. Their study discusses the issues related to the interpretability of AI, data privacy, and user acceptance. They propose a strategy to harness the potential of XAI in IR4.0.

Ndagi & Salihu (2018) conducted a Systematic Review Focusing on human-centric knowledge management practices in IR4.0 startups. Their study investigates the role of Explainable AI in promoting user-centricity and collaboration. The study showcases how transparent AI models can empower users to actively participate in knowledge-sharing processes.

Summarily, the overwhelming majority of the researchers focused fundamentally on the importance of providing interpretable explanations for AI-driven decision systems. While some studies provide solutions by highlighting the relevance of XAI in the context of IR4.0 many others such as in (Manesh et al., 2019) & (Gavrilova et al., 2017) mainly focus on identifying the challenges and Opportunities in implementing Explainable AI within the context of IR4.0 technologies. A reasonable number of researchers are also found to focus on the relationship between Knowledge Management Systems and Explainable AI in the context of IR4.0 transformation.

While there is existing research on both the integration of KMS with IR4.0 technologies and the importance of XAI, there is a gap in the literature regarding the development of an XAI framework specifically tailored for the integration of KMS and IR4.0 technologies for enhancing business values. In order to bridge this gap by through a proposed XAI framework that enables the seamless integration

of KMS and IR4.0 technologies, this research aims at studying the challenges and major concerns of organizations and industry players towards realising an integrated IR4.0 and KMC for enhancing their business values.

3. METHODOLOGY

The key objective of this study is to identify the challenges faced by businesses in selecting the right IR4.0 technologies that can be integrated into their knowledge management systems. In this phase, the study investigates the complex landscape of KMS and IR4.0 integration for achieving for a robust business ecosystem. This phase aims to gain a deeper understanding of the challenges, opportunities, and constraints related to the integration of KMS and IR4.0 technologies. These will help to uncover insights, identify critical integration challenges, and gather expert opinions on the feasibility of an XAI framework.

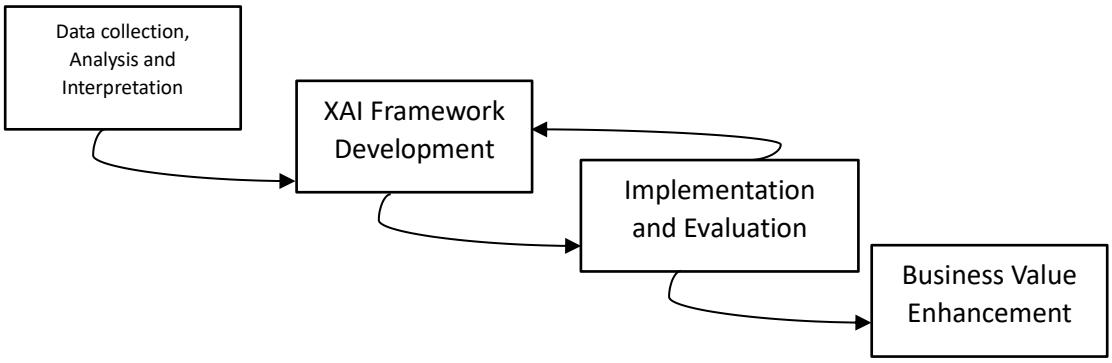

Figure 1: Research process

Primary data was collected through the use of a questionnaire in a survey approach adopted for this study (Robles-Flores & Kulkarni, 2014). The questionnaires were designed and administered online using Google Forms and hard copies were also printed and distributed. The online questionnaire link was distributed via WhatsApp and Email to the respondents mostly in organizations and institutions working with KMS and IR4.0 technologies. The online deployment was included because of speed and flexibility which make the survey faster to deploy, and access to wider coverage and a high percentage of respondents. The questionnaire was administered to IT professionals and managers familiar with both KMS and IR4.0 technologies. The study will use a multistage sampling technique. This type of sampling technique involves sampling at different stages of selecting the appropriate samples for the experiment (Singleton & Straits, 2017). The units of analysis in this study are the IT professionals, Managers and Users of KMS and IR4.0 technologies.

The analysis provides valuable insights into the complex landscape of KMS and IR4.0 integration, guiding the development of the XAI framework. Data were collected from the questionnaire, and the scores obtained were analyzed using mean and standard deviation. The data is presented and interpreted using a table, histogram and pie chart. The decision made were based on a Linkert scale of above 3 for Agree/Strongly agree or below 3 Disagree/Strongly disagree.

4. FINDINGS AND ANALYSIS

From the survey responses gathered, a total of 179 (100%) respondents responded to the survey. This implies that the number of responses received with respect to the research which was conducted on the subject matter as it relates to integrating KMS with IR4.0 technologies is valid because 100% of the total responses is applicable. The presentation is categorized into two parts which are; (i) Demographic Distribution of the responses and (ii) Analysis of the responses to key questions, thus;

4.1. Demographic Distribution

A. Sector/Industry Distribution

The questionnaire were filled by IT professionals, managers and users who are familiar with both KMS and IR4.0 technologies from various sectors like Manufacturing, Healthcare, Education, Finance and Technology. Table 4.1 presents the demographic distribution according to sector.

Table 4.1: Percentage of XAI survey participants from various Sector/Industries.

Industry/Sector					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid Data	Manufacturing	9	5.0	5.0	5.0
	Healthcare	12	6.7	6.7	11.7
	Education	51	28.5	28.5	40.2
	Finance	82	45.8	45.8	86.0
	Technology	25	14.0	14.0	100.0
	Total	179	100.0	100.0	

Source: Field Survey, 2024

The Finance sector has the highest participation of 45% followed by Education with 28% and Manufacturing has the least participation of 5% in the survey.

4.1.2. Role/Position Distribution

Table 2 and Figure 1 show the distributions of the respondents by their roles.

Table 4.2: Percentage of XAI survey participants base on Role/Position

Role/Position					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	IT Professional	73	40.8	40.8	40.8
	Manager	47	26.3	26.3	67.0
	User	59	33.0	33.0	100.0
	Total	179	100.0	100.0	

Source: Field Survey, 2024

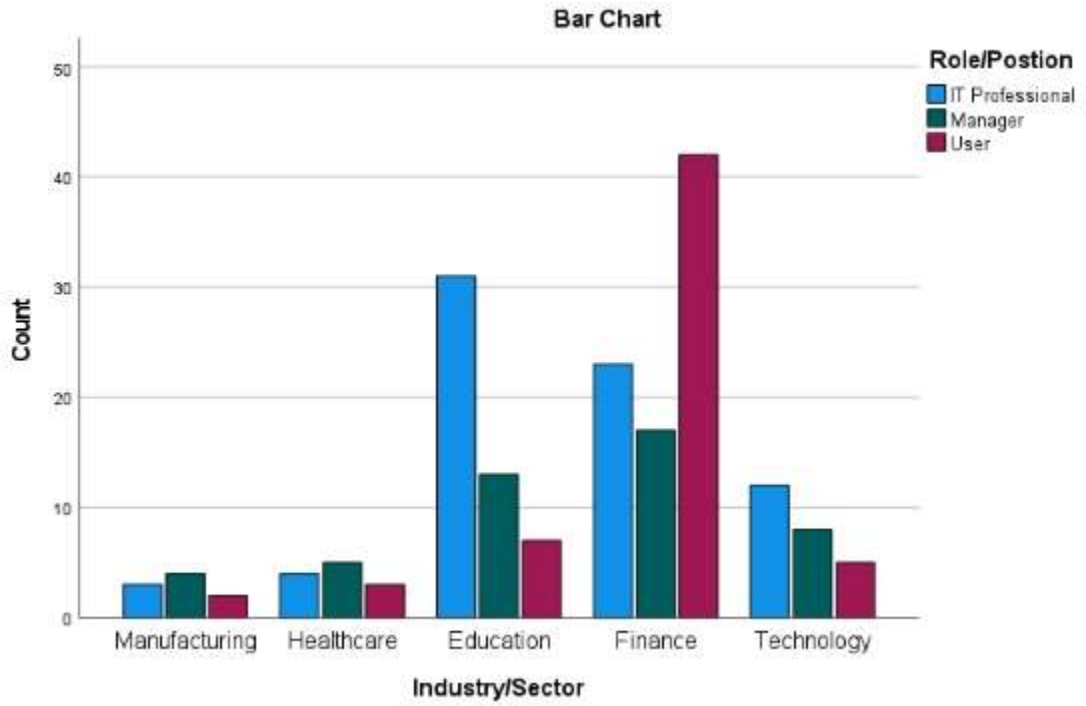

Figure 2: Bar chart showing respondents base on role/position

It can be concluded that overall, IT Professional are the most active in term of the survey responses to the subject matter. This implies that the most active users of KMS and IR4.0 technologies are IT Professional. However, the managers in the Manufacturing and Health care sectors show more enthusiasm than the IT professionals in KMS and IR4.0 technologies adaptation. The reason for this may be subject to further studies especially on the rankings and the roles of IT professionals in both sectors.

4.1.3. Analysis of Responses

The aspect analyses the responses to the big questions whose overall interpretation will give a leeway into understanding the key requirements for the proposed XAI framework for the KMC and IR4.0 integration.

4.2 Adaptation and integration of IR4.0 technologies (IR4.0) with knowledge management systems (KMS).

The first question was whether the firm/organization has adapted the use of KMS in processing information in Nigeria Industries/Sectors, the response shows that 71 (39.7%) totally agree with the use of KMS in their organizations while 44 (24%) very much agree. The response shows that KMS is being used in a scale of 5 and 4 with 71 (39.7%) and 44 (24%) respectively. The sector with the highest number of response is finance with 82 (71%) response to agree in using KMS in processing information, this implies that other sectors are halfway of the use of KMS in information processing activities.

On technology integration, 55% of the responses shows that firms/organizations are in the processes of integrating their KMS with IR4.0 technology.

Where respondents were asked to choose the types of technology from typical types of IR4.0 technologies (Artificial Intelligence (AI), Cloud Computing, Machine Learning, Internet of Things (IoT) and 5G Network), the result shows that Cloud Computing Technology is the most widely adopted IR4.0 technology with 103 (57.5%), 5G Network with 31 (17.3%) then A.I with 26 (14.5%).

4.3 The potential benefits of integrating IR4.0 technologies with knowledge management systems

A good number of the responded, 144 (80.4%), see a potential benefit of integrating KMS with IR4.0 technologies. This implies that the respondents are in tune with the technology integration for enhancing operations of their organizations. It is on this basis that over 70% of the responses overwhelmingly agree that the implementation of integrated technologies can increase business values. More positive results generated from the question on the potential benefits of integrating IR4.0 and KMS are; enhance decision-making process, impact on organization's information process, enables efficient knowledge sharing, reduce redundancy, and facilitate learning. Others are that it enables organizations to quickly change market conditions and response to new challenges, and facilitate remote work and enable seamless collaboration among geographically dispersed teams.

4.4 Factors affecting the integration of KMS with IR4.0 Technology

A large percentage of the respondents (76%) agreed that there are factors affecting the integration of KMS with IR4.0 technologies. Amongst the supported factors affecting the integration of the IR4.0 technologies with KMC by the respondents are; lack of understanding of IR4.0 technology (65%), lack of user adoption (72%), high implementation cost (84%), compatibility (81%), and lack of skilled personnel (68%).

4.5 Challenges faced by businesses in trusting decisions made by machines in the context of enhancing business value

The study revealed that there are challenges faced by businesses when integrating IR4.0 with KMC causing trust issues in relation to the decisions made by machines in the context of enhancing business values as evidenced by responses of 71% of the respondents. Among the challenges of trust are; the believe that integrating IR4.0 and KMS can result in a fragmented and disjointed approach to data and information management (65%), lack of transparency in AI systems signifies hurdle in leveraging the full potential of IR4.0 technologies (68%), lack of seamless integration framework leads to difficulty in extracting meaningful insight (75%), Lack of interpretability and explainability in AI models hinders organizations' ability to comprehend the underlying logic and reasoning behind AI-driven decisions (74%). rapid change in IR4.0 technologies can bring challenges for organizations (73%), lack of trust on how AI-based decision-making are reach can be a challenge for organizational decision making (73%), and lack of understanding how emerging technologies works can decrease business values (70%)

5. CONCLUSION AND FUTURE DIRECTIONS

In order to understand the standing point of organization on the integration of IR4.0 with KMC, this paper presents the study on the professionals and other personnel's in the industry implementing the technologies and making use of the data from the systems. Questions bothering on adaptation of the technology, potential benefits, factors affecting the integration and challenges of trust were asked and results analyzed. The analysis has figured out clearly that organizations are interested in the integration due to several benefits especially productivity and increase in business value ecosystem. The factors affecting the integration and challenges of trust can be mitigated substantially by the introduction of explainable AI which has the facilities to answer all the hidden components. This will to a large extent smoothen the adaptation trajectory since the issue of trust will be solved.

Therefore, the future direction is a comprehensive XAI framework that seamlessly integrates KMS and IR4.0 technologies while emphasizing transparency and interpretability in AI-driven decisions, addressing concerns associated with the opacity of AI models.

REFERENCES

Abascal, J., Zhang, Y., & Li, C. (2021). Ethical considerations in AI-driven knowledge management systems. *Journal of Business Ethics*, *15*(2), 254–267.

Adesina, A. O., & Ngo, D. (2020). Knowledge management in SMEs in the context of the Fourth Industrial Revolution. *ReseachGate*, *March*. https://www.researchgate.net/publication/340165800

Aitouche, S., Sahraoui, K., Aksa, K., Djouggane, F., Cherrid, W., & Belayati, S. (2020). A Scientometric Framework : Application for Knowledge Management (KM) in Industry Between 2014 and 2019. *The Twelfth International Conference on Information, Process, and Knowledge Management A*, *20*(3), 46–51.

Botega, L. F. D. C., & da Silva, J. C. (2020). An artificial intelligence approach to support knowledge management on the selection of creativity and innovation techniques. *Journal of Knowledge Management, 24*(5), 1107–1130. https://doi.org/10.1108/jkm-10-2019-0559

Caliskan, A., Bryson, J. J., & Narayanan, A. (2017). Semantics derived automatically from language corpora contain human-like biases. *Science*, *356*((334), 183–186.

Deng, X., & Jin, L. (2019). A review on explainable artificial intelligence. *Big Data Mining and Analytics*, *2*(3), 183-198.

Eze, E. C., Adu, C. T., Ekeh, C. P., & Ukwuaba, O. U. (2021). An explainable artificial intelligence-driven recommendation system for Nigerian universities. *International Journal of Advanced Computer Science and Applications*, *12*(8), 471–479.

Gunning, D. (2017). Explainable Artificial Intelligence (XAI). *Defense Advanced Research Projects Agency (DARPA).* https://www.darpa.mil/program/explainable-artificial-intelligence

Ibrahim, O. O., Faridah, M. S., Ebhohimen, I. J., & Danasabe, M. Y. (2019). Knowledge Management and Professionals in Nigerian Construction Firms : Barriers , Benefits and Capabilities KNOWLEDGE MANAGEMENT AND PROFESSIONALS IN NIGERIAN. *JOURNAL OF ARCHITCTURE, PLANNING & CONSTRUCTION MANAGEMENT*, *9*(2), 69–86. https://doi.org/10.13140/RG.2.2.20127.30885

Koh, S. C. L. (2012). The Effects of Supply Chain Integration on Customer Satisfaction and Financial Performance: An Analysis of Direct and Indirect Effects. *Supply Chain Management: An International Journal*, *5*(17), 596–610.

Korycinski, A., Naderi, M., Rekik, Y., & Ghose, A. (2020). Knowledge management systems and emerging technologies: A systematic review of research on adoption, usage, and impacts. *Journal of Knowledge Management*, *24*(3), 581-618.

Lista, A. P., Guilherme Luz, T., & Marina, B. (2021). Knowledge Management benefited by Industry 4.0 integration – A scoping review. *CIKI Maringá – Brasil*.

Lista, A. P., & Tortorella, G. L. (2022). Integration of Industry 4.0 technologies and Knowledge Management Systems for Operational Performance improvement. *IFAC PapersOnLine*, *55*(10), 2042–2047. https://doi.org/10.1016/j.ifacol.2022.10.008

Liu, X., Zhang, H., Chen, S., Liu, Y., & Li, H. (2019). *Explainable artificial intelligence for healthcare: A comprehensive survey. Artificial Intelligence Review,. 52*(4), 2429–2473.

Manesh, M. F., Pellegrini, M. M., Marzi, G., & Marina, D. (2019). Knowledge Management in the Fourth Industrial Revolution : Mapping the Literature and Scoping Future Avenues Published in IEEE Transactions on Engineering Management. *IEEE Transactions*, 1–22. https://doi.org/10.1109/TEM.2019.2963489

Ndagi, A., & Salihu, A. A. (2018). FOURTH INDUSTRIAL REVOLUTION: PROSPECTS AND CHALLENGES FOR AFRICA. *Dutse Journal of Economics and Development Studies*, *6*(1).

Omotayo, F. O. (2015). Knowledge management as an important tool in organisational management: A review of literature. *Library Philosophy and Practice*, *5*(April 2015), 4–10. http://digitalcommons.unl.edu/libphilprac

Panigyrakis, G., Li, H., & Jones, R. (2020). The role of AI in enhancing business values in IR4.0 environments. *Journal of Knowledge Management.*, *12*(1), 78–92.

Pavlou, P. A., & Yang, S. (2021). Artificial intelligence as the Fourth Industrial Revolution: Challenges and regulatory implications. *California Management Review*, *63*(4), 5–17.

Ribeiro, M. T., Singh, S., & Guestrin, C. (2022). "Why should I trust you?" Explaining the predictions of any classifier. *22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 1135–1144.

Robles-Flores, J. A., & Kulkarni, U. (2014). Knowledge management systems: A business value model. *9th Pacific Asia Conference on Information Systems: I.T. and Value Creation, PACIS 2005*, *May*, 325–337.

Sharma, R., Mishra, D., & Sarangi, S. K. (2021). Integration of Industry 4.0 with knowledge management: A state-of-the-art review and future research directions. *Computers in Industry*. https://doi.org/10.1016/j.compind.2021.103458

Shin, M. (2004). "A framework for evaluating economics of knowledge management systems,." *Information & Management*, *42*(1), 179–196.

Shodiya, O. A. (2021). Knowledge Management and Competitive Advantage of Listed Consumer Goods Manufacturing Companies in Nigeria Knowledge Management and Competitive Advantage of Listed Consumer Goods Manufacturing

Companies in Nigeria. *Emerging Market Journal*, *11*(2). https://doi.org/10.5195/emaj.2018.134

Shrouf, F., Ordieres, J., & Miragliotta, G. (2022). Smart factories in Industry 4.0: A review of the concept and of energy management approached in production based on the Internet of Things paradigm. *International Conference on Industrial Engineering and Engineering Management*, 697–707.

Singleton, R. A. J., & Straits, B. C. (2017). *Approaches to social research* (5th ed.). Oxford University Press.

Su, H., & Buduru, A. B. (2020). Knowledge management and knowledge sharing in the era of artificial intelligence. In *IGI Global.* (pp. 303–326).

Tien, N. H., Duc, L. D. M., & Vo, M. T. P. (2021). Knowledge management in enterprises in the context of industrial revolution 4.0. *International Journal of Research in Finance and Management*, *2*(2), 70–74. http://www.allfinancejournal.com

Tien, N. H., Mai, V., Phong, T., Doan, L., & Duc, M. (2019). Knowledge management in enterprises in the context of industrial revolution 4.0. *Int. J. Finance Manage*, *2*(2), 70–74.

Turingan, R. (2021). From Industry 4.0 to Industry X.0: The impact of digital transformation on the industrial sector. *Journal of Industrial Information Integration*, *23*, 100–263. https://doi.org/10.1016/j.jii.2021.100263

Velasquez, A., & Hester, P. T. (2019). Cognitive AI for knowledge representation and reasoning in IR4.0. In *Expert Systems with Applications.* (Vol. 17, Issue 3).

Wojcak, E., & Lukáš, C. (2022). Knowledge Management in the Context of Industry 4 . 0 : The Case of Slovakia. *Poprad Economic and Management Forum 2021*, *November*, 507–516. https://www.researchgate.net/publication/355208508

Authors

Author's Name, Abubakar Balarabe.

Author's Name, Author's profile.