Editorial
Overview of Digital Literacy of Employees and Organizational Transformation and Innovation

I. Major Objective and Background Information of This Special Issue

THIS special issue (SI) aims to provide organizations with a theoretical, conceptual, and applied grounded discussion of the *Digital Literacy of Employees and Organizational Transformation and Innovation* to aid in innovative, sustainable development, and effective decision-making. By doing so, our SI hopes to expand the technology management discipline in understanding the human side of technological innovations.

Research on digital transformation is on the rise and dominantly covers modernization and changes in an organization's structure, processes, functions, and business models due to adopting digital technologies, such as the Internet of Things [1], [2]. Yet, the existing literature largely focuses on external factors, notably its relationship with customers, ignoring the role of internal factors, such as employees in this process [1], [3]. The impact of digital transformation is far more than anticipated in the literature, and it is going to change the way engineering and technology management is carried out in companies [4]. Researchers and managers should better understand the challenges engineers and employees face during various digital implementations [3], [5]. We hope our collection of papers in the SI could increase the successful adoption of these technologies while paying attention to those who make it happen: employees, engineers, and managers.

A study [6] found that the greatest challenge in many organizations for digital transformation and innovation is reimagining the employee experience. Another study [7] argues that the employees' experience is already the new battleground for competitive advantage for organizations. Outside academic research, international associations, such as the European Commission [8] and OECD [9] or consultancy companies, such as McKinsey [10], increasingly emphasize the critical role of digital skills in the digital economy. This fact itself is an alarming indication for calling on researchers to understand the digital literacy of employees, a competency set required for the development and implementation of digital technologies so that it could become possible to develop strategies and policies to deal with the shortage of digital skills [11], [12].

Given that the academic literature has so far widely overlooked how the challenges of digital technologies are handled at the employee level [13], [14], [15], the theme of this SI highlights the need for conceptualization and empirical study of the implications of employees' digital literacy on organizational transformation and innovation. For this SI, we particularly are interested in ways to measure and advance the digital literacy of employees in the wake of artificial intelligence, robots, and other emerging digital technologies [16].

We are delighted to introduce our SI on "Digital Literacy of Employees and Organizational Transformation and Innovation." Our initial call was announced in 2021. We aimed to explore, theorize, and test guidelines for upholding and implementing digital technologies for transformation and innovation. We solicited case studies, surveys, experiments, qualitative, design science, and collaborative action research studies.

Our target audience with the SI were academics, executives, and policymakers who could illustrate innovative approaches, resolutions, and solutions to the described tensions, risks, and opportunities. We especially sought papers that offered theoretical models, observations, or evidence of consequences related to these models.

Overall, our call yielded 25 number of submissions. Submissions were screened for fit by the SI guest editors, leading to three initial desk rejections. The remaining papers were sent out for review to at least two reviewers. After more than 2 rounds of revisions, 11 papers were accepted for publication. These papers covered a good spectrum of topics, methodology, industry, and geographical location.

II. Special Issue Papers

Papers in the SI follow one of the three key themes showing the areas of change in organizations: skills, digital workplaces, and supply chains. The summary of these contributions is given as follows according to their theme.

A. Theme 1: Skills

The first article titled "The Role of Employees in Digital Transformation: A Preliminary Study on How Employees' Digital Literacy Impacts Use of Digital Technologies," is written by Dilek Cetindamar, Babak Abedin, and Kunio Shirahada [A1]. This article elaborates on how employees' digital skills play a role in digital transformation by conducting an empirical study in Australia. The study draws on the Theory of Planned Behavior for analyzing preliminary empirical data collected from 124 Australian employees' technology use intentionality and behavior. This article brings forward the novel concept of digital literacy to explore the role of employees in understanding

Date of current version 23 April 2024.
Digital Object Identifier 10.1109/TEM.2023.3322182

the wide variety of opportunities of digital technologies and their actualization through the example of cloud technologies. Digital literacy becomes the antecedent of the cognitive behavior of employees in utilizing cloud technology at companies. The findings point out a positive relationship between employees' digital literacy and the utilization of cloud technology at companies. Considering that technology management literature is overpopulated with technology focus when it comes to analyzing digital transformations, this article brings forward the involvement of employees' digital skills, measuring it as digital literacy.

The second paper studies "Relevance of Engineering Management courses to managerial skills in the industry," written by Mansa Kotha, Sojen Pradhan, and Dilek Cetindamar [A2]. They argue that the modern workplace is reshaped by digital technologies and hybrid working, exacerbated by the Covid-19 pandemic. Hence, educational institutions must adjust programs to offer skillsets that align with these changes. The study is an empirical work on 6 Australian universities offering various engineering management courses and 20 experts from the industry. The findings highlight that digital intelligence and empathy are the major themes identified in the literature review that are the most sought after by engineer managers. The findings highlight the importance of digital and emotional intelligence for managers.

The third paper, "The Elephant in the Room: New Skills and Work Dimensions of Turkish White Goods Industry Engineers in Industry 4.0 Era," examines the impact of Industry 4.0 implementations on engineers. Kubra Simsek Demirbag and Nihan Yildirim [A3] collect and analyze digital transformation data in the Turkish white goods industry. The article aims to determine the new skills expected from engineers and the impact of the usage level of Industry 4.0 technologies by engineers on the dimensions of engineering work. The results highlight three categories of new skills expected from engineers: intrinsic motivation, technology, and data and information skills. A final finding underlines how the sociability level of the engineers who use adaptive robots and additive manufacturing technologies is higher than the ones using data analytics, AI, and simulation.

B. Theme 2: Digital Workplace

Sophie Altrock, Anne-Laure Mention, and Tor Helge Aas [A4] contribute to the SI with their article "Being Human in the Digitally Enabled Workplace: Insights From the Robo-Advice Literature." In the fourth paper of the SI, the authors introduce their study in the financial sector, which has been experiencing automation of increasing tasks undertaken by human workers. Robo-advisors (RAs) are platforms defined by a set of algorithms and they are used in finance companies to supply wealth management advice online. After conducting a systematic literature review, the article develops and presents a conceptual framework showing possible automation scenarios for financial advisors working with RAs. The authors highlight the linkages between automation potential, human traits, and technological possibilities that must be considered in digital transformation strategies regarding the use of RAs with service professionals' work.

Sophia Xiaoxia Duan and Hepu Deng [A5] delve into the work-life balance-related problems associated with the adoption of digital technologies. Their work is the fifth paper of the collection with the title "Intrinsic needs and job performance in digital work: the mediating role of work-life balance." While digital technologies transform traditional working environments, there is little work on understanding the interplay among individuals, work-life balance, and digital technology use. This article is based on an empirical work. The research starts with a literature review and then develops a conceptual framework to understand how work-life balance mediates the association between intrinsic needs of individuals and job performance in digitalized working settings. The authors test the framework through the survey data collected in Australia. Findings show the significant impact of achievement and work-life balance on job performance. It, further, discloses how the need for autonomy indirectly influences job performance through the full mediation of work-life balance.

İzlem Tekin Bayrak and Ferhan Cebi [A6] wrote the sixth paper with the heading of "Procedure Model for Industry 4.0 Realization for Operations Improvement of Manufacturing Organizations." Industry 4.0 has opened new opportunities to improve operational efficiency, develop new business models, and improve customer experience. However, manufacturing organizations struggle to manage their transformation processes. The research conducts a literature review to develop a procedure model enabling manufacturing organizations to oversee the overall process. The proposed model is tested and validated at a Turkish company operating in the white goods industry.

In the seventh paper entitled "Modelling and analysing the online food delivery services (OFDS) using Design thinking: An optimization approach," G. Rejikumar, V. G. Venkatesh, Nacef Mouri, Yangyan Shi, and Mathew Thomas Gil [A7] examine food delivery businesses. The article conducts an in-depth study on redesigning and deploying digital technologies to meet customer demand during a rare event, such as the COVID-19 pandemic. Researchers followed a four-step research design to identify the optimal factors for OFDS. Relying on the literature review and using numerous design thinking tools, the article describes the optimal factors for customer-oriented/service-provider-oriented delivery services. The option to select the delivery person and conditions was the most optimal customer-oriented attribute.

C. Theme 3: Supply Chain

V. Kamala, Vijaya Sunder M, V Raja Sreedharan, Kaoutar Chargui, Tarik Zouadi, and Guilherme Luz Tortorella [A8] contribute to the SI with a study on original equipment manufacturers (OEMs) that are operating at volatility, uncertainty, complexity, ambiguity (VUCA) conditions. Their study is the eight contribution titled "Testing the S-Curve Theory in OEM for Lean Operations: A Study on Organizational Transformation in the VUCA World." This article proposes integrating lean tools with decision-making techniques to achieve productivity benefits. Hence, the article tests the S-curve in the lean deployment of an OEM. Findings show how new technologies provide real-time active solutions for decision-making, prediction, and planning of resources, resulting in numerous benefits to OEM.

In the paper entitled "Strategising a logistics framework for organizational transformation: A technological perspective," Zakaria El Hathat, Tarik Zouadi, V. Raja Sreedharan, and Vijaya Sunder [A9] focus on the logistics industry. Their study, the ninth paper in the SI, argues that logistic companies increasingly rely on emerging digital technologies to overcome contextual factors, summarized in the acronym of VUCA. The article conducts a systematic literature review using the Transfield approach, followed by a content analysis of 310 articles. Through text mining, the article found key facets related to logistics, leading to a unique framework based on the VUCA world and proposes an implementation framework for VUCAT.

The tenth article of the SI has a heading clearly indicating the content: "Exploring the academic—industry collaboration in knowledge sharing for supplier selection: Digitalising the OEM," Ayon Chakraborty, Jinil Persis, and Kamran Mahroof [A10] examine how academic–industry collaboration could allow for knowledge sharing. This article analyzes case studies and conducts interviews with experts in various Asian automakers. The study results reveal that the criteria related to firms' financial transparency have been highly prioritized by the manufacturer for supplier evaluation followed by the suppliers' cost control, quality control, and manufacturing capabilities. The article has significant theoretical and practical implications by developing a digital ecosystem for OEMs in making supplier-related decisions.

Melisa Ozbiltekin-Pala and Burcu Aracıoglu's paper [A11] is the last SI paper, "Barriers of Using Digital Technologies in Pharmaceutical Supply Chains in Emerging Economies: Comparative Study between Manufacturers and Distributors in Turkey." Supply chains are globalizing with increasing population and demand, and supply chains are becoming operationally complex. This article focuses on an empirical study of supply chains to observe the barriers to adopting digital technologies that could ensure sustainability and resiliency in the pharmaceutical industry. The article lists key barriers for manufacturers and distributors in the pharmaceutical supply chains.

We hope the SI readers find a wide range of topics on *Digital Literacy of Employees & Organizational Transformation and Innovation* to be current and informative.

As a final note, we are grateful for the help and support from the many authors, reviewers, and the editorial staff at *IEEE TEM*. In particular, we would like to express our gratitude to Prof. T. Daim, who provided useful advice and guidance on the SI.

DILEK CETINDAMAR, *Guest Editor*
Faculty of Engineering & IT
University of Technology Sydney
Ultimo, NSW 2007, Australia
email: Dilek.ck@uts.edu.au

BABAK ABEDIN, *Guest Editor*
Macquarie Business School
Macquarie University
Sydney, NSW 2109, Australia
email: Babak.Abedin@mq.edu.au

NATHASIT GERDSRI, *Guest Editor*
College of Management
Mahidol University
Nakhon Pathom 73170, Thailand
email: nathasit.ger@mahidol.ac.th

KUNIO SHIRAHADA, *Guest Editor*
School of Knowledge Science
Japan Advanced Institute of Science and Technology
Ishikawa 923-1211, Japan
email: kunios@jaist.ac.jp

APPENDIX: RELATED ARTICLES

[A1] D. Cetindamar, B. Abedin, and K. Shirahada, "The role of employees in digital transformation: Application of the theory of planned behavior on Australian employees' cloud technology usage," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7837–7848, 2024, doi: 10.1109/TEM.2021.3087724.

[A2] M. Kotha, S. Pradhan, and D. Cetindamar, "Relevance of engineering management courses to managerial skills in the industry," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7849–7862, 2024, doi: 10.1109/TEM.2023.3269069.

[A3] K. Ş. Demirbağ and N. Yıldırım, "The elephant in the room: New skills and work dimensions of Turkish white goods industry engineers in Industry 4.0 era," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7863–7875, 2024, doi: 10.1109/TEM.2023.3297516.

[A4] S. Altrock, A.-L. Mention, and T. H. Aas, "Being human in the digitally enabled workplace: Insights from the robo-advice literature," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7876–7891, 2024, doi: 10.1109/TEM.2023.3291820.

[A5] S. X. Duan and H. Deng, "Intrinsic needs and job performance in digital work: The mediating role of work-life balance," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7892–7900, 2024, doi: 10.1109/TEM.2022.3218925.

[A6] İ. T. Bayrak and F. Cebi, "Procedure model for Industry 4.0 realization for operations improvement of manufacturing organizations," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7901–7912, 2024, doi: 10.1109/TEM.2023.3292337.

[A7] G. Rejikumar, V. G. Venkatesh, N. Mouri, Y. Shi, and M. T. Gil, "Modeling and analyzing online food delivery services using design thinking: An optimization approach," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7913–7929, 2024, doi: 10.1109/TEM.2023.3249041.

[A8] V. Kamala, V. Sunder, M. V. R. Sreedharan, K. Chargui, T. Zouadi, and G. L. Tortorella, "Testing the S-curve theory in OEM for lean operations: A study on organizational transformation in the VUCA world,"

IEEE Trans. Eng. Manage., vol. 71, no. 1, pp. 7930–7945, 2024, doi: 10.1109/TEM.2023.3267040.

[A9] Z. El Hathat, T. Zouadi, V. R. Sreedharan, and V. Sunder M., "Strategizing a logistics framework for organizational transformation: A technological perspective," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7946–7967, 2024, doi: 10.1109/TEM.2023.3249577.

[A10] A. Chakraborty, J. Persis, and K. Mahroof, "Exploring the academic–industry collaboration in knowledge sharing for supplier selection: Digitalizing the OEM," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7968–7978, 2024, doi: 10.1109/TEM.2023.3260042.

[A11] M. Ozbiltekin-Pala and B. Aracıoglu, "Barriers to using digital technologies in pharmaceutical supply chains in emerging economies: A comparative study on manufacturers and distributors in Turkey," *IEEE Trans. Eng. Manage.*, vol. 71, no. 1, pp. 7979–7987, 2024, doi: 10.1109/TEM.2022.3229697.

References

[1] G. J. Kane, A. N. Phillips, J. R. Copulsky, and G. R. Andrus, *The Technology Fallacy: How People are the Real Key to Digital Transformation*. Cambridge, MA, USA: MIT Press, 2019.

[2] C. Matt, T. Hess, and A. Benlian, "Digital transformation strategies," *Bus. Inf. Syst. Eng.*, vol. 57, no. 5, pp. 339–343, 2015.

[3] D. Cetindamar, K. Kitto, M. Wu, Y. Zhang, S. Knight, and B. Abidin, "Explicating AI literacy of employees at digital workplaces: A dynamic capabilities perspective," *IEEE Trans. Eng. Manage.*, to be published, doi: 10.1109/TEM.2021.3138503.

[4] D. Cetindamar, T. Lammers, D. Kocaoglu, and Y. Zhang, "The anniversary tribute of PICMET: 1989–2018," *IEEE Trans. Eng. Manage.*, vol. 68, no. 2, pp. 612–627, Apr. 2021, doi: 10.1109/TEM.2020.2977364.

[5] W. J. Orlikowski, "Using technology and constituting structures: A practice lens for studying technology in organizations," *Org. Sci.*, vol. 11, pp. 404–428, 2000.

[6] C. Dery, I. M. Sebastian, and N. van der Meulen, "The digital workplace is key to digital innovation," *MIS Quart. Executive*, vol. 16, pp. 135–151, 2017.

[7] M. Liley, P. Feliciano, and A. Laurs, "Employee experience reimagined," Accenture, 2017. [Online]. Available: https://www.accenture.com/au-en/insight-employee-experience-reimagined

[8] "Digital literacy: Skills for the information society," European Commission, 2007. [Online]. Available: http://ec.europa.eu/information_society/tl/edutra/skills/index_en.htm

[9] *Working Party on Measurement and Analysis of the Digital Economy: Skills for a Digital World*. Paris, France: OECD, 2016.

[10] "Jobs lost, jobs gained: Workforce transitions in a time of automation," McKinsey Global Institute, Dec. 2017.

[11] V. O. Gekara and V. X. T. Nguyen, "New technologies and the transformation of work and skills," *New Technol., Work Employment*, vol. 33, no. 3, pp. 219–233, 2018.

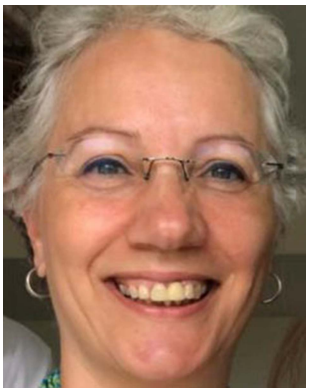
[12] K. S. R. Warner and W. Wäger, "Building dynamic capabilities for digital transformation," *Long Range Plan.*, vol. 52, pp. 326–349, 2019.

[13] J. Li, J. Zhou, and Y. Cheng, "Conceptual method and empirical practice of building digital capability of industrial enterprises in the digital age," *IEEE Trans. Eng. Manage.*, vol. 69, no. 5, pp. 1902–1916, Oct. 2022, doi: 10.1109/TEM.2019.2940702.

[14] M. Murawski and M. Bick, "Digital competences of the workforce—A research topic?," *Bus. Process Manage. J.*, vol. 23, no. 3, pp. 721–734, 2017.

[15] G. Vial, "Understanding digital transformation: A review and a research agenda," *J. Strategic Inf. Syst.*, vol. 28, no. 2, pp. 118–144, 2019.

[16] A. McAfee and E. Brynjolfsson, *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies*. New York, NY, USA: Norton, 2014.



Dilek Cetindamar received the Ph.D. degree in management from Istanbul Technical University, Turkey, in 1996. She is currently a Professor of Contemporary Technology Management with the University of Technology Sydney, Sydney, NSW, Australia. She worked with many universities, including Case Western Reserve University (USA), Chalmers University of Technology (Sweden), and Sabanci University (Turkey). She has more than 220 publications, including 10 books and more than 65 articles in international refereed journals.

Prof. Kozanoglu was the recipient of the PICMET Fellow Award in 2019, the best book award from the International Association for Management of Technology in 2012, and an "encouragement award" from the Turkish Academy of Sciences in 2003.

Babak Abedin received the Ph.D. degree in information systems from UNSW Business School, Sydney, Australia, in 2010. He is currently an Associate Professor in Business Analytics with the Macquarie University's Business School, Sydney, NSW, Australia. He has authored/coauthored several outlets, such as *Information & Management*, IEEE TRANSACTIONS IN ENGINEERING MANAGEMENT, and *Internet Research*. His research interests include positive and negative aspects of business analytics, artificial intelligence, and information systems at organizational and individual levels.

Mr. Abedin is an Associate Editor of Electronic Markets and Communications of AIS.

Nathasit Gerdsri (Member, IEEE) received the Ph.D. degree in systems science/technology management from the Portland State University, Portland, OR, USA, in 2004.

He is currently a Professor, a Consultant, Researcher, and a Technologist with more than 20 years of experience in technology and innovation management supporting the development of corporate strategy and government policy as well as the program development for management education. Recently, he has taken a new initiative as Founder and Head of the Technology Innovation Management and Entrepreneurship Labs. His research interests include roadmapping to enhance the robustness of TRM development process and implementation.

Dr. Gerdsri serves as an Area Editor, Editorial Board Member, and Guest Editor for several journals.

Kunio Shirahada received the Ph.D. degree in technology management from the University of Tokyo, Bunkyo, Japan, in 2009.

He is currently a Professor with the Japan Advanced Institute of Science and Technology, Nomi, Japan. He has authored/coauthored papers in the *Technological Forecasting and Social Change*, *Technology in Society*, *Journal of Service Theory and Practice*, *Journal of Business Research*, *International Journal of Technology Management*, *International Journal of Automotive Technology Management*, *International Journal of Innovation and Technology Management*, and other Japanese service related research papers. His research interests include transformative service research (service sustainability, community revitalization for collective well-being creation, and service for the elderly), neuromarketing using near-infrared spectroscopy technology, motivation management for service employees, and innovative organization design.

Dr. Shirahada presented his paper at Frontiers in Service Conference, QUIS, SERVSIG conference, Transformative consumer research conference, and Portland International Conference on Management of Engineering and Technology.