

Navigating The Workforce Challenges and Skill Development in The Era of Industry 4.0

Bagas Ananta Aji^{1*}, Disa Insanul Ikhlas¹, Intan Ratna Wati¹

¹ Faculty of Economics and Business, Universitas Diponegoro, Semarang, Indonesia

Corresponding author: bagasanantaaji23@students.undip.ac.id

Abstract

This study aims to explore the impact of employee competencies on organizational performance in the context of Industry 4.0, focusing on the essential skills required to adapt to technological advancements. With the rapid development of digital technologies and automation, employees are expected to possess a diverse set of competencies, including technical, digital, social, and personal skills. These competencies play a crucial role in addressing complex problems, fostering creativity, and ensuring organizational growth. A qualitative research approach is utilized, starting with a literature review to establish a theoretical framework on employee competencies, technological adaptation, and training practices. Data is collected through interviews with industry experts, HR managers, and employees to understand the specific challenges and opportunities related to workforce skill development. Data analysis is conducted using a descriptive approach, identifying recurring themes and trends in the competencies needed for Industry 4.0. The findings indicate that companies must prioritize continuous training and development programs to equip employees with the necessary skills to thrive in a rapidly evolving digital environment. The study highlights the importance of investing in employee competencies to drive organizational success, emphasizing the need for a proactive approach to skill development in an increasingly automated world

Keywords

Employee Competencies, Industry 4.0, Skill Development, Digital Transformation, Organizational Performance.

1. Introduction

In recent years, manufacturing and service companies have increasingly focused on Industry 4.0, which brings both significant opportunities and challenges associated with automation and digitalization (Abulibdeh et al., 2024). Industry 4.0 encompasses the real-time digital integration of suppliers, manufacturers, and customers across the value chain and business models (Dhanpat et al., 2020), leveraging technologies such as the Internet of Things (IoT), Big Data, and cloud computing (Flores et al., 2020). This industry model fosters smart factory environments rooted in cyber-physical systems, where continuous communication between people, machines, and resources shapes a new industrial era.

Moreover, surveys reveal that many large companies in Brazil have strategically embraced Industry 4.0, particularly through the use of Cloud Computing and Big Data (Li, 2022). In IT companies, implementing Industry 4.0 involves understanding organizational needs, identifying changes in business areas, and adopting new technologies (Li, 2022). However, increased digitalization also impacts the workforce, particularly in logistics and administrative roles where simple tasks can now be automated, reducing the errors typical in manual work (Hernandez-de-Menendez et al., 2020).

Industry 4.0 technologies, such as collaborative robots (CoBots), allow seamless human-machine interaction without traditional safety barriers, introducing the concept of Operator 4.0—a worker supported by adaptive automation and human-machine interaction technology (Khang et al., 2023). Beyond manufacturing, Industry 4.0 also impacts agriculture through "Agriculture 4.0," where digital technologies enhance food production (Mukhuty et al., 2022). These advancements urge companies to collaborate more closely with educational institutions to ensure a skilled workforce and recognize that Industry 4.0's success relies on social acceptance in addition to technical implementation (Singh et al., 2022).

Companies in the Industry 4.0 era face various present and future challenges. Certain production processes still require labor-intensive manual assembly, meaning not all activities can be automated. This situation raises questions about the fate of workers potentially affected by automation. Consequently, skill development becomes a central challenge for professionals and HR departments, given the rising need for more complex knowledge (Asif, 2021). Additionally, new organizational structures that can support corporate strategies are essential. In Industry 4.0, HR must prioritize adapting the required skill sets, addressing challenges related to technical preparedness and data privacy regulations (GDPR), and creating strategies to attract and retain quality employees amid intense labor market competition. Selecting the right employees is crucial, as recruitment mistakes can increase turnover if new hires cannot meet job demands (Brahma et al., 2021).

2. Literature Review

Employee training programs are designed to develop skills, knowledge, and competencies, ultimately having a positive impact on job performance. Effective training allows acquired skills to be applied in the workplace, thereby enhancing overall productivity and efficiency. Furthermore, continuous training helps employees stay up-to-date with the latest technological advancements, crucial in dynamic industrial sectors (Cohen et al., 2019). Well-structured training programs have been shown to significantly contribute to employee performance improvement, especially in dynamic technology sectors (Quyen, 2020). Data indicates that continuous, targeted training is critical to maintaining high performance standards, as employees are required to adapt constantly to evolving technology and industry demands. In this context, employee training is recognized as a core component of effective human resource development strategy, a view supported by several foundational theories (Reaves, 2019).

Human Capital Theory (Hung & Ramsden, 2021) emphasizes the importance of investing in the development of employee skills and knowledge through training, which is believed to drive organizational productivity. By instilling new skills and knowledge in employees, organizations can improve job effectiveness and ensure that their workforce remains competitive in a constantly changing market (Goulart et al., 2022). This concept rests on the assumption that enhancing employee competencies will have a direct impact on individual performance and, ultimately, the overall performance of the organization. In the long term, investing in training can also reduce costs associated with employee turnover or low performance, as skilled and knowledgeable employees are better equipped to handle work challenges.

Additionally, Bandura's Social Learning Theory (1977) provides a highly relevant perspective on training development. This theory suggests that employees learn not only through direct experience but also through observation and imitation of others' behaviors (Koutroubas & Galanakis, 2022). In the workplace, this means that training programs designed to allow employees to interact and learn from their peers can accelerate knowledge and skill transfer (Shah, 2022). Training that incorporates collaborative elements, such as group discussions, work simulations, and case studies, enables employees to observe and internalize best practices that can then be applied effectively in their work environments. Social Learning Theory also highlights the importance of role models in the learning process, where employees can learn from mentors or leaders with superior skills and knowledge in a given area (Rumjaun & Narod, 2020).

3. Methods

The aim of this study is to investigate the impact of employee competencies on organizational performance in the context of Industry 4.0, with a focus on the skills required for adaptation to technological changes. Specifically, this research explores the need for technical, digital, social, and personal competencies among employees,

and how these competencies contribute to effective problem-solving and organizational growth. A qualitative approach will be employed to provide an in-depth understanding of the issue. The study will begin with a comprehensive literature review, focusing on previous studies related to employee competencies, Industry 4.0, and training programs. This will help establish a theoretical framework to guide the analysis. Data will be collected through interviews with industry experts, HR managers, and employees to gather insights into the challenges and opportunities associated with the competencies required in the industry 4.0 era. Data analysis will be conducted using a descriptive approach, focusing on identifying common themes, patterns, and trends related to the competencies required for Industry 4.0 adaptation. The findings will be interpreted to highlight key areas where training and skill development are essential for both employee performance and organizational success. This method will provide a comprehensive understanding of the evolving workforce needs in the digital age.

4. Results

Some companies have adopted business plans that include quality management procedures aligned with ISO 9001 standards, especially in IT and data management. As data volumes grow, the need for detailed data handling and security becomes increasingly critical. Key challenges here include safeguarding data, particularly within HR, where sensitive information is handled, making GDPR compliance and data protection essential. Additionally, employee training presents an ongoing challenge, as losing trained employees incurs significant costs. Companies also struggle to find experts with the skills Industry 4.0 demands, as many workers lack digital skills on par with younger generations. The main challenge lies in finding employees who are not only open to change but also motivated to pursue continuous self-development (Kouzes & Posner, 2023).

According to a Deloitte report, competency shifts will occur by 2030 due to advances in digitalization and automation, where future skills will give employees an edge over machines in areas where automation is limited. The high demand for these competencies creates opportunities for new types of jobs. The report categorizes future competencies into three main areas. Firstly, knowledge in specific domains. Key fields expected to dominate new job markets by 2030 include Customer and Personal Services, English Language, Education and Training, Computer and Electronics, and Mathematics. The first two fields alone are expected to create about 600,000 new jobs. Additionally, certain specialized knowledge areas are anticipated to see a 30% rise in new jobs by 2030, such as psychology, sociology, and anthropology, where automation capacity is low. In contrast, sectors like manufacturing, mechanics, and food are expected to experience job declines. Secondly, skills—creative skills, such as complex problem-solving and social skills, along with specialized skills like data analysis within systems, are critical focuses. Lastly, abilities, including foundational abilities that support the development of

other capabilities, along with logical and creative abilities with low automation potential, will be essential for nearly half of future jobs.

According to a study by Wong (2020), various types of employee competencies have also been successfully identified through a literature review, including:

Table 1: Technical, Digital, Social and Personal of Employee Competencies

Competencies	Description
Technical	Knowledge in scientific disciplines (basic and specific).
Digital	Data control, evaluation and analysis, data security and protection, data utilization.
Social	Interdisciplinary collaboration, teamwork skills, communication skills, decision making, organizational and leadership competencies, project management.
Personal	Analytical thinking, problem solving, flexibility, abstract thinking, ability to learn continuously.

Technical competencies require a deep understanding of processes and systems, enabling control and monitoring of production workflows and the early detection of issues that may affect product or service quality. Meanwhile, digital competencies focus more on data analysis and evaluation, emphasizing the development and use of systems at the user level. Data security and the protection of sensitive information have now become critically important aspects. Social competencies include basic communication skills and the ability to work in teams, increasingly moving towards an interdisciplinary approach. Personal competencies, which require special attention, are challenging to obtain solely through formal education or advanced training.

Employers seek employees who can address problems within the organization (Baird & Parayitam, 2019). In the Industry 4.0 era, standardized and manual tasks have largely been automated, shifting labor needs towards knowledge-based jobs with higher skill requirements (Bonaccio et al., 2020). Routine problem-solving tasks are now automated, leaving employees in the industry 4.0 era to tackle novel or undefined problems. The diversity of these problems varies depending on the work context and differs across organizations. Consequently, employees need the ability to accurately identify problems and implement relevant solutions within the appropriate application context. Vertical integration leads to various departments within companies being digitally connected, so problem-solving now requires a multidisciplinary perspective. Employees must also consider how their solutions impact other departments, meaning any solution must meet the requirements of all involved departments. When problems are complex and ambiguous, such as those in Industry 4.0, employees with high creativity may be more effective at solving them (Gajdzik & Wolniak, 2022).

In Industry 4.0, horizontal integration makes many issues cross-organizational, necessitating solutions that take into account the constraints and objectives of each collaborating organization. In dealing with such problems, it's vital for all entities involved in the value or supply chain to maintain alignment with their strategic goals. Solutions must involve more than one organization in their implementation. End-to-end integration generates vast amounts of data that need to be gathered, organized, and analyzed for problem-solving. Creative data analysis can provide new insights for problem-solving, potentially creating new business opportunities and supporting corporate strategy. Skills needed for creative problem-solving among employees include research, analysis, decision-making, creative thinking, and communication. Employees must also find solutions that are timely and cost-effective, making creative problem-solving abilities essential for tackling complex issues arising from Industry 4.0 applications (Farrell et al., 2021).

The implementation of Industry 4.0 has made work more complex, drastically changing the tasks employees perform. Technical systems within Industry 4.0 continue to evolve, requiring employees to engage continuously in learning, training, and education. Information and communication technology (ICT) skills are now essential in nearly every discipline, with an increasing focus on information technology and artificial intelligence. Employees are expected to keep refining these skills to stay relevant and productive. They must also develop cross-disciplinary knowledge and adapt quickly to an integrated work environment. The ability to recognize skill needs and independently take steps to acquire them is a key factor in employee adaptability. For example, manufacturing employees must also understand customer relationship management skills, now an explicit part of job profiles in the industry 4.0 era (Mian et al., 2020).

Beyond its theoretical relevance, continuous, targeted training is also crucial to helping employees cope with changes brought about by technological advances. In the fast-paced Industry 4.0 era, employees must constantly update their skills to remain relevant. Ongoing training enables employees to stay abreast of the latest developments, whether in software, equipment, or work processes. Training programs specifically aimed at meeting industry needs often include learning about new technical skills, digital security practices, and analytical and critical skills essential in the digital era. These skills are necessary to keep up with the rapid pace of innovation in the technology sector, allowing organizations to maintain their competitive edge. Besides enhancing technical competencies, ongoing training also aids in the development of soft skills like communication, teamwork, and problem-solving skills. These soft skills are increasingly important in today's work environment, which requires cross-departmental collaboration and involvement in complex projects. The ability to communicate clearly, work effectively in teams, and solve problems creatively are skills that boost efficiency and foster a more innovative and adaptive workplace culture (Grybauskas et al., 2022).

5. Conclusion

As businesses embrace Industry 4.0, the demand for specialized competencies and continuous employee development becomes paramount. ISO 9001-aligned quality management procedures, particularly in IT and data management, have become essential for companies to handle the increasing complexity of data security and compliance requirements like GDPR. The need for skilled workers has surged, yet there is a significant gap in digital literacy and the ability to adapt to constant technological changes. Industry 4.0 has transformed the workplace, shifting job roles towards knowledge-based tasks that require advanced skills in problem-solving, creative thinking, and interdisciplinary collaboration. In this environment, training programs designed to develop technical, digital, social, and personal competencies are crucial. Theoretical frameworks, such as Human Capital Theory and Bandura's Social Learning Theory, underscore the importance of investing in employee skill development to improve job performance and organizational productivity. Continuous learning is not only essential to keep up with technological advancements but also to foster a workplace culture that values adaptability and innovation. As automation takes over routine tasks, employees must acquire new skills that complement and enhance machine capabilities, making them indispensable in solving novel and complex problems. Therefore, investing in employee training and development is not just a strategic priority but a necessary investment for businesses to maintain competitiveness and ensure sustainable growth in the industry 4.0 era.

References

- Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. *Journal of Cleaner Production*, 140527.
- Asif, M. (2021). Evaluation of factors affecting carbon accounting information disclosure: A case of ASEAN countries. *Arthatama*, 5(2), 39-50.
- Baird, A. M., & Parayitam, S. (2019). Employers' ratings of importance of skills and competencies college graduates need to get hired: Evidence from the New England region of USA. *Education+ Training*, 61(5), 622-634.
- Bonaccio, S., Connelly, C. E., Gellatly, I. R., Jetha, A., & Martin Ginis, K. A. (2020). The participation of people with disabilities in the workplace across the employment cycle: Employer concerns and research evidence. *Journal of business and psychology*, 35(2), 135-158.

- Brahma, M., Tripathi, S. S., & Sahay, A. (2021). Developing curriculum for industry 4.0: digital workplaces. *Higher Education, Skills and Work-Based Learning*, 11(1), 144-163.
- Cohen, Y., Naseraldin, H., Chaudhuri, A., & Pilati, F. (2019). Assembly systems in Industry 4.0 era: a road map to understand Assembly 4.0. *The International Journal of Advanced Manufacturing Technology*, 105, 4037-4054.
- Dhanpat, N., Buthelezi, Z. P., Joe, M. R., Maphela, T. V., & Shongwe, N. (2020). Industry 4.0: The role of human resource professionals. *SA Journal of Human Resource Management*, 18(1), 1-11.
- Farrell, L., Newman, T., & Corbel, C. (2021). Literacy and the workplace revolution: a social view of literate work practices in Industry 4.0. *Discourse: Studies in the cultural politics of education*, 42(6), 898-912.
- Flores, E., Xu, X., & Lu, Y. (2020). Human Capital 4.0: a workforce competence typology for Industry 4.0. *Journal of Manufacturing Technology Management*, 31(4), 687-703.
- Gajdzik, B., & Wolniak, R. (2022). Smart production workers in terms of creativity and innovation: The implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(2), 68.
- Goulart, V. G., Liboni, L. B., & Cezarino, L. O. (2022). Balancing skills in the digital transformation era: The future of jobs and the role of higher education. *Industry and Higher Education*, 36(2), 118-127.
- Grybauskas, A., Stefanini, A., & Ghobakhloo, M. (2022). Social sustainability in the age of digitalization: A systematic literature Review on the social implications of industry 4.0. *Technology in Society*, 70, 101997.
- Hernandez-de-Menendez, M., Morales-Menendez, R., Escobar, C. A., & McGovern, M. (2020). Competencies for industry 4.0. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 14, 1511-1524.
- Hung, J., & Ramsden, M. (2021). The application of human capital theory and educational signalling theory to explain parental influences on the Chinese population's social mobility opportunities. *Social Sciences*, 10(10), 362.
- Khang, A., Jadhav, B., & Birajdar, S. (2023). Industry revolution 4.0: workforce competency models and designs. In *Designing workforce management systems for industry 4.0* (pp. 11-34). CRC Press.
- Koutroubas, V., & Galanakis, M. (2022). Bandura's social learning theory and its importance in the organizational psychology context. *Psychology*, 12(6), 315-322.
- Kouzes, J. M., & Posner, B. Z. (2023). *The leadership challenge: How to make extraordinary things happen in organizations*. John Wiley & Sons.
- Li, L. (2022). Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond. *Information Systems Frontiers*, 1-16.
- Mian, S. H., Salah, B., Ameen, W., Moiduddin, K., & Alkhalefah, H. (2020). Adapting universities for sustainability education in industry 4.0: Channel of challenges and opportunities. *Sustainability*, 12(15), 6100.

- Mukhuty, S., Upadhyay, A., & Rothwell, H. (2022). Strategic sustainable development of Industry 4.0 through the lens of social responsibility: The role of human resource practices. *Business Strategy and the Environment*, 31(5), 2068-2081.
- Quyen, T. H. (2020). The relationship between green procurement practices and organizational performance in the manufacturing industry of Vietnam. *Arthatama*, 4(1), 1-16.
- Reaves, J. (2019). 21st-century skills and the fourth industrial revolution: a critical future role for online education. *International Journal on Innovations in Online Education*, 3(1).
- Rumjaun, A., & Narod, F. (2020). Social learning theory—albert bandura. *Science education in theory and practice: An introductory guide to learning theory*, 85-99.
- Shah, M. H. (2022). Impact of green marketing strategy on business performance—mediating role of corporate image in construction industry of Kenya. *Arthatama*, 6(1), 1-11.
- Singh, R. K., Agrawal, S., & Modgil, S. (2022). Developing human capital 4.0 in emerging economies: an industry 4.0 perspective. *International Journal of Manpower*, 43(2), 286-309.