

ANALYSIS OF HUMAN RESOURCE READINESS IN DIGITAL TRANSFORMATION OF MANUFACTURING PROCESSES IN THE SMART FACTORY ERA

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Abstrak

Keywords:

Human Resource Readiness,
Digital Transformation,
Smart Factory,
Manufacturing, Industrial
Revolution 4.0

Digital transformation in the manufacturing industry is part of the implementation of the Industrial Revolution 4.0, characterized by the application of intelligent technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and automation systems. This change demands the readiness of human resources (HR) who not only possess technical capabilities, but also adaptive, analytical, and collaborative competencies. This study aims to analyze HR readiness in facing the digitalization of manufacturing processes in the Smart Factory era. The method used is a qualitative descriptive approach with a literature study approach that examines various sources related to competency development, challenges, and strategies for increasing HR capacity. The analysis results show that there is still a digital competency gap among the workforce, especially in the lower-middle industrial sector. Therefore, a human resource development strategy is needed through competency mapping, upskilling and reskilling programs, and the implementation of a work culture based on innovation and continuous learning. With the right strategy, human resources can be a key driving force in realizing effective, efficient, and highly competitive digital transformation in the Smart Factory era.

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INTRODUCTION

The development of digital technology has brought about major changes in almost all industrial sectors, including manufacturing. The Smart Factory era is a significant milestone in the Industrial Revolution 4.0, which demands the integration of physical and digital systems through automation, the Internet of Things (IoT), Artificial Intelligence (AI), and Big Data Analytics. This transformation focuses not only on the



use of smart machines or devices, but also on how humans can adapt, manage, and optimize these technologies effectively (Ningrum et al. 2024) .

In the manufacturing industry, digital transformation presents both significant opportunities and challenges. Implementing smart factories can improve efficiency, reduce operational costs, and accelerate production processes. However, without adequate human resource (HR) readiness, this transformation risks creating competency gaps and ineffectiveness in managing new technologies. Therefore, analyzing HR readiness is a strategic step to ensure the success of the digital transformation as a whole.

HR readiness in the digital era not only includes technical capabilities, but also includes cognitive, adaptive, and collaborative aspects. Competent human resources in the smart manufacturing era must be able to understand digital systems, think critically about data, and innovate in creating more efficient solutions. Thus, companies need to review their HR development strategies to align with the demands of high-tech industries.

In addition to individual capability factors, organizational culture and digital leadership also play an important role in determining HR readiness. Companies need to build a work ecosystem that supports continuous learning and encourages cross-functional collaboration. Visionary and adaptive leadership will be able to guide the transformation process in an inclusive and innovation-oriented manner.

In Indonesia, many manufacturing industries are gradually adopting digital technology. However, the level of human resource readiness varies, particularly in the lower-middle sector. Frequent challenges include limited digital knowledge, resistance to change, and a lack of technology-based training. An in-depth analysis of the level of human resource readiness is crucial for determining strategies to strengthen capacity and increase the competitiveness of the national industry (Nst et al. 2025) .

Based on the description above, research or studies on the analysis of HR readiness in the digital transformation of manufacturing processes in the Smart Factory era are very relevant. This study is expected to provide a comprehensive overview of the workforce's capabilities and readiness to face technology-driven change. The results of this analysis can also serve as a basis for companies and policymakers in formulating HR development strategies oriented toward the future of the digital industry.

RESEARCH METHODS

The research method used in this study is a qualitative descriptive method with an analytical study approach. This study aims to describe and analyze the level of human resource (HR) readiness in facing digital transformation in the manufacturing process in the Smart Factory era. Data were collected through literature review from various sources such as scientific journals, industry reports, books, and policy documents relevant to HR development and Industry 4.0 technology. Data analysis was conducted by reviewing , interpreting, and linking findings from the literature to obtain a comprehensive picture of the competencies, challenges, and strategies for improving HR readiness in facing manufacturing digitalization.

RESULTS AND DISCUSSION

Human Resources Competence and Readiness in Facing Digital Transformation

Digital transformation in the manufacturing world demands major changes in work structures, production systems, and the role of human resources (HR). HR is no longer merely performing routine tasks, but is also required to be able to understand, operate, and optimize technologies based on automation, the Internet of Things (IoT), Artificial Intelligence (AI), and big data analysis . Therefore , HR competency is the main foundation for the successful implementation of *a Smart Factory* . Without adequate readiness and capabilities, digitalization will only be an additional burden without providing significant added value to the company (Ahmad Gunawan 2025) .

Human resource readiness can be measured through several aspects, including technical skills, critical thinking skills, as well as mental readiness and work culture. In a technical context, workers in the Industry 4.0 era must have good digital literacy, understand automation systems, and be able to interact with intelligent machines. Meanwhile, from a cognitive perspective, workers must have analytical, problem-solving, and data-based decision-making skills. This capability is important because digital systems produce large and complex volumes of information, so they require human resources who are able to filter and interpret this data appropriately.

Besides technical and cognitive skills, mental readiness is also an important factor in facing digital change. Many workers struggle to adapt because they feel unprepared for new technologies or fear losing their roles due to automation. Therefore, companies need to instill a positive mindset toward change, emphasizing that technology is not a threat, but rather a tool to increase efficiency and productivity. This process requires good internal communication, management support, and policies oriented toward empowering human resources.

Education and training are also an important part of building HR competencies in the era of digital transformation. The education sector must adapt to industry needs by providing curricula relevant to modern manufacturing technology. Meanwhile , companies must provide *upskilling* and *reskilling programs* for employees to ensure their skills continually develop in line with technological advancements. Synergy between education, industry, and the government will accelerate the process of improving the quality of human resources ready to face the challenges of *the Smart Factory era* .

Organizational readiness also significantly impacts individual readiness. A work culture that supports innovation, collaboration, and continuous learning *will* accelerate human resource adaptation to digital transformation. Companies that prioritize learning and competency development tend to adopt new technologies more quickly. Furthermore , digital leadership is essential to provide direction, motivation, and support to employees as they navigate the change process. Visionary leaders are able to create a work environment open to innovation and embracing the courage to experiment (Rama et al. 2024) .

Thus, human resource competency and readiness are strategic elements for the success of digital transformation in the manufacturing sector. Superior human resources are determined not only by their technological skills but also by their ability to adapt, think critically, and collaborate in a dynamic digital environment. Through continuous investment in education, training, and building an organizational culture that supports

innovation, the manufacturing industry can create a resilient, efficient, and competitive work environment in the *Smart Factory era*.

HR Challenges in the Digitalization Process of the Manufacturing Industry

Digital transformation in the manufacturing industry is bringing fundamental changes to work methods, organizational structures, and workforce competency requirements. On the one hand, digitalization opens up significant opportunities to increase efficiency, accuracy, and productivity. However, on the other hand, various challenges arise that must be faced by human resources (HR). These challenges are not only technical but also encompass psychological, social, and cultural aspects of work. If not managed properly, digitalization can actually create skill gaps among workers and slow down organizations' adaptation to new technologies (Pratiwi 2025).

One of the main challenges facing HR is limited digital literacy and technological skills. Many workers in the manufacturing sector are still accustomed to working manually and do not yet have the skills to operate automation-based systems or digital devices. This is an obstacle in implementing the *Smart Factory concept* which requires integration between machines, data, and humans. Lack of training and access to the latest technology means that most workers are unprepared for rapid change.

Apart from limited competencies, resistance to change is also a major challenge. Many workers feel anxious about digitalization because of concerns about losing their jobs due to automation or robotization. This fear often leads to resistance to innovation and hinders the implementation of new systems. Therefore, companies need to prioritize an open and empathetic communication approach, explaining that technology is intended to support, not replace, humans. Visionary and participatory leadership also plays a crucial role in fostering human resource confidence and commitment to the digital transformation process.

Another challenge is the lack of policy support and organizational structures that adapt to technological change. Some manufacturing companies still use rigid, traditional management models, making it difficult to adapt to the dynamic demands of digitalization. The absence of a data-based and innovation-based HR development strategy makes it difficult for companies to map new skills needs. Without clear policy support, the digitalization process tends to be slow and unsustainable.

Furthermore, the gap between generations of workers is also a barrier. Younger generations, who are more familiar with technology, often have different perspectives and work styles than older generations. If not managed properly, these differences can lead to internal conflict and hinder team collaboration. Therefore, companies need to build an inclusive work culture that combines the experience of older generations with the creativity of younger generations, thus creating energy in the digitalization process (Zainuddin Latuconsina et al. 2025).

Thus, the HR challenges in the digitalization of the manufacturing industry are multidimensional and require a comprehensive approach. Companies need to make continuous investments in improving competencies, strengthening adaptive cultures, and developing digital leadership capable of effectively directing change. Through the right strategy, these challenges can be transformed into opportunities to create a resilient, productive workforce that is ready to face the *Smart Factory era* in a sustainable manner.

Human Resource Development Strategy Towards Smart Factory

In facing *the Smart Factory era*, human resource (HR) development is a strategic aspect that determines the success of the digital transformation of the manufacturing industry. HR is not only seen as an operational implementer, but also as the main driver of change and innovation. Therefore, human resource development strategies must focus on enhancing digital competencies, data analysis capabilities, and readiness to adapt to new technologies. With superior and visionary human resources, companies can optimally leverage the potential of technology to increase competitiveness amidst increasingly fierce global competition (SUNDARI and SE 2023).

The first step in a human resource development strategy is competency mapping. This process aims to identify gaps between the workforce's existing skills and those required in a digital technology-based work environment. Through this mapping, companies can determine training priorities and design targeted development programs. Competency mapping also helps companies prepare career paths that are relevant to technological developments and future industry needs.

upskilling and *reskilling* programs is an important step in building HR readiness to face *Smart Factories*. *Upskilling* focuses on enhancing existing skills to better align with technological developments, while *reskilling* prepares the workforce to master new skills in different fields. Both programs can be implemented through in-house training, collaboration with educational institutions, or industry-government collaboration. Continuous training will create a workforce that is adaptable and innovative to digital change.

The next strategy is to build a work culture based on innovation and continuous *learning*. This culture encourages every individual to always be open to new knowledge, dare to try, and be ready to collaborate across functions. In the context of *Smart Factory*, success does not only depend on technological sophistication, but also on the ability of human resources to think creatively and work collaboratively. Therefore, companies need to create a work environment that supports the exploration of ideas and provides space for employee self-development.

Apart from increasing competence, digital leadership is also an important element in HR development strategies. Leaders in the digital era must be able to understand technology as well as have adaptive, visionary, and inspiring managerial skills. They act as transformational leaders, encouraging collaboration, open communication, and data-driven decision-making. With the right leadership style, the HR development process can be more effective and aligned with the company's vision for manufacturing digitalization (Pasaribu and Widjaja 2021).

Thus, a human resource development strategy toward a *Smart Factory* must be holistic and sustainable. The combination of competency mapping, ongoing training, an innovative culture, and digital leadership will create a resilient workforce ready to face the challenges of Industry 4.0. Skilled, adaptive, and learning-oriented human resources are not only an asset to the company but also a key driver in realizing a highly competitive digital transformation at the national and global levels.

CONCLUSION

Based on the discussion that has been outlined, it can be concluded that the readiness of human resources (HR) plays an important role in the success of the digital

transformation of the manufacturing industry towards *the Smart Factory era* . Digital competence, data analysis skills, and mental readiness are the main factors that determine the effectiveness of implementing technologies such as automation, the Internet of Things (IoT), and artificial intelligence (AI). However, various challenges such as low digital literacy, resistance to change, and limited human resource development policies remain obstacles that need to be addressed systematically and sustainably.

To achieve optimal digital transformation, a targeted HR development strategy is needed through competency mapping, *upskilling* and *reskilling programs* , and the formation of a work culture based on innovation and continuous learning. Digital leadership support and synergy between government, education, and industry are also crucial to creating a technology-adaptive work ecosystem. With these strategic steps, human resources in the manufacturing sector will be able to become the primary driving force behind efficiency, innovation, and industrial competitiveness in the *Smart Factory era* .

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