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The Influence and Controlling of Industry 4.0 on Work Behavior and Employee Productivity in Start-Up Technology Companies

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Abstract. *Industry 4.0, with technological advances such as automation, artificial intelligence, and big data, has brought significant changes in the way employees work and productivity in start-up technology companies. This transformation requires employees to develop new skills and adapt to a more dynamic and complex work environment. This research aims to analyze the influence of Industry 4.0 on work behavior and controlling employee productivity through the Systematic Literature Review (SLR). This research uses the Systematic Literature Review (SLR) method to collect and analyze relevant literature regarding the influence of Industry 4.0 on work behavior and employee productivity. Inclusion and exclusion criteria were established to select relevant studies from a variety of sources, including scientific journals, books, industry reports, and other reliable sources. Data were analyzed using a qualitative approach with a focus on identifying main themes from the literature collected. The analysis results show that Industry 4.0 brings significant changes in work behavior, including the need for flexibility and adaptation to new technology. Training and developing digital skills is very important to increase productivity. Transformational leadership has been proven to have a positive impact on employee motivation and performance. Apart from that, effective human resource management and a focus on employee welfare are also key factors in facing the challenges and exploiting the opportunities presented by Industry 4.0. This research concludes that the adoption of Industry 4.0 technology brings many benefits in increasing employee productivity and efficiency, but also demands significant changes in HR management strategies and skills training. Start-up technology companies need to invest in developing digital skills, employ transformational leadership, and create work environments that support employee well-being to maximize the benefits of this transformation. These findings provide valuable insights for companies looking to optimize employee productivity in this digital era.*

Keywords: *Industry 4.0, controlling, work behavior, employee, productivity.*

1. INTRODUCTION

Industry 4.0, often referred to as the Fourth Industrial Revolution, is a major transformation in the way industry operates, fueled by the adoption of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, and automation. This change not only affects the production process but also has a significant impact on various operational and strategic aspects of the company. In the modern context, where competition is increasingly fierce and consumer expectations continue to rise, the adoption of Industry 4.0 technology is crucial to maintaining competitiveness and operational efficiency (Ayu & Amron, 2023).

The relevance of Industry 4.0 in the current context is very important because it provides innovative solutions that can increase productivity and operational efficiency. For example, the use of IoT enables real-time integration and communication between

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machines, which can optimize production processes and reduce machine downtime. Artificial intelligence and big data help companies make decisions based on more accurate and in-depth data, which in turn can increase the effectiveness of business strategies. With automation, time-consuming, repetitive tasks can be shifted to machines, so employees can focus on more strategic and creative tasks (Setiawan, 2023).

The adoption of this technology also brings new challenges for companies, especially in terms of human resource management. Rapid technological change can cause uncertainty among employees, affect work behavior, and ultimately impact productivity (Putra et al., 2022). Therefore, it is important to understand how Industry 4.0 affects employee work behavior and productivity so that companies can develop effective strategies to manage these changes. This research aims to explore the influence of Industry 4.0 on work behavior and employee productivity in start-up technology companies, using a Systematic Literature Review (SLR) approach and qualitative analysis of relevant literature studies (Fadilurrahman et al., 2021).

In today's digital era, where technological transformation is inevitable, start-up technology companies are required to always be at the forefront of innovation. A deep understanding of the impact of Industry 4.0 on employees will help companies design policies and strategies that not only support the adoption of new technologies, but also ensure that employees remain motivated, adaptive and productive. This research will provide useful insights for decision makers in start-up technology companies to better manage the transition to the Industry 4.0 era (Shaddiq & Haryono, 2020).

Research into the influence of Industry 4.0 on work behavior and employee productivity is crucial because it can provide deep insight into how advanced technology is changing the dynamics of the modern workplace. Industry 4.0 brings major changes in the way work is done, by introducing automation, complex data analysis and artificial intelligence (Tarigan, 2020). This change requires adaptation both in terms of technical skills and employee work behavior. Therefore, understanding how these technologies influence work behavior can help companies design appropriate training and development strategies for employees.

Apart from that, this research is also important to identify the challenges and opportunities that arise along with the implementation of Industry 4.0 technology. For example, automation and use of robotics may reduce the need for manual tasks, but on the other hand, it may also cause job anxiety among employees. By conducting this research,

companies can find ways to address employee uncertainty and concerns, and ensure that employees feel supported and empowered in the face of technological change.

Employee productivity is one of the key factors in business success, and the influence of Industry 4.0 on productivity needs to be understood in depth. New technologies can improve work efficiency and accuracy, however, without effective change management, adoption of these technologies can be counterproductive (Hariroh et al., 2024). This research helps identify best practices and approaches that companies can adopt to ensure that new technologies actually increase employee productivity.

This research is also relevant for company policies in terms of human resource development and change management. By having empirical data and insights from literature studies, companies can make more informed decisions in managing technology transitions. This will not only help in improving employee performance but also in creating a more adaptive and innovative work environment. Thus, this research has a strategic role in helping start-up technology companies to remain competitive and competitive in the Industry 4.0 era (Saely, 2023).

Industry 4.0 brings a major transformation in the way work is done in various sectors, including start-up technology companies. However, the impact of the adoption of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, and automation on employee work behavior and productivity is not yet fully understood. Therefore, this research aims to answer the main questions regarding how Industry 4.0 technology affects these aspects (Yusri & Yahya, 2023).

This research focuses on changes in employee work dynamics, including adaptation to new technology, changes in tasks and responsibilities, as well as psychological impacts such as motivation and work stress. This study will collect and analyze literature discussing these aspects to provide a comprehensive picture.

Correlation between the use of advanced technology and an increase or decrease in employee productivity. Factors such as work efficiency, error reduction, and increased output will be analyzed based on findings from various studies that have been conducted previously (Tahar et al., 2022).

This research aims to examine in depth the influence of Industry 4.0 on work behavior and employee productivity in start-up technology companies. The main focus of this research is on changes in employee work dynamics, including adaptation to new technology, changes in tasks and responsibilities, as well as psychological impacts such as motivation and work stress. By conducting a Systematic Literature Review (SLR), this

research will collect and analyze literature that discusses these aspects to provide a comprehensive picture.

This research aims to reveal employees adapting to new technology, how tasks and responsibilities change, and how these changes affect psychological aspects such as motivation and stress levels. Thus, this research will provide insight into the readiness and challenges faced by employees in facing digital transformation.

This research will evaluate the extent to which Industry 4.0 technology contributes to increasing or decreasing employee productivity. Factors such as work efficiency, error reduction, and increased output will be analyzed based on findings from various previous studies. It is hoped that the results of this analysis will provide a clear picture of the real impact of technology on employee productivity.

2. METHODOLOGY

This research uses a Systematic Literature Review (SLR) design with a qualitative approach. The SLR design was chosen to gain a comprehensive understanding of the influence of Industry 4.0 on work behavior and employee productivity through analysis of existing literature. A qualitative approach is used to identify, assess and synthesize findings from various relevant studies, so as to provide in-depth and detailed insight into the topic under study.

Inclusion and exclusion criteria were used to ensure that only relevant and high-quality literature was included in the analysis. Inclusion criteria include studies published in accredited scientific journals, books and trusted industry reports, studies that discuss the influence of Industry 4.0 on work behavior and employee productivity, studies published in the last five years to ensure the relevance and topicality of the data.

The data analysis technique used in this research is thematic analysis. This process involves several stages:

1. Initial Coding: Identifying and coding relevant portions of text from each study reviewed.
2. Theme Identification: Grouping similar codes into larger themes that emerge from the data.
3. Theme Review: Review themes to ensure that they accurately reflect the data and are mutually exclusive.
4. Theme Definition and Naming: Provide clear definitions and appropriate naming for each identified theme.

5. Reporting Findings: Organize the results of the thematic analysis in a structured narrative form to describe the main findings regarding the influence of Industry 4.0 on work behavior and employee productivity.

3. RESULTS AND DISCUSSION

Industry 4.0, also known as the Fourth Industrial Revolution, is a concept that includes the integration of digital technology and automation in production processes and industrial operations. This term was first introduced in Germany in the early 2010s and has since become a major focus in industrial development worldwide. Industry 4.0 combines various advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, and cloud technology to create a smarter, more efficient and flexible production system.

The main concept of Industry 4.0 is connectivity and digitalization which allows machines, devices, sensors and humans to communicate and collaborate in real-time. IoT, for example, allows connected devices to continuously collect and exchange data, which can be used to monitor and optimize production processes. Artificial intelligence and big data analytics enable companies to process and analyze large amounts of data quickly, helping in better and predictive decision making.

One of the key components of Industry 4.0 is advanced automation, which involves not only traditional robotics but also collaborative robots (cobots) working alongside humans. This automation can reduce human error, increase efficiency, and allow employees to focus on more strategic and creative tasks. Additionally, technologies such as augmented reality (AR) and virtual reality (VR) are also used for training, maintenance and product design, which can improve employee skills and productivity.

In the context of Industry 4.0, manufacturing and industrial operations become more integrated and flexible. Intelligent production systems are able to adapt quickly to changes in market demand and customer preferences. This allows companies to produce goods more efficiently, reduce waste, and improve product quality. Additionally, with the ability to track and monitor every stage of the production process, companies can more easily identify and resolve problems, improve safety, and ensure compliance with standards and regulations (Sitohang et al., 2023).

Industry 4.0 offers great potential to increase competitiveness and innovation in industry. However, implementing this technology also requires changes in organizational structure, employee skills, and company culture. Therefore, a deep understanding of the

concept and implementation of Industry 4.0 is very important for companies that want to remain relevant and superior in this digital era. Research into the influence of Industry 4.0 on employee work behavior and productivity is critical to helping companies manage these changes effectively (Ekawati, 2023).

4. WORK BEHAVIOR IN A TECHNOLOGICAL CONTEXT

Work behavior in the context of modern technology is experiencing significant changes along with the adoption of advanced technology in the workplace. Industry 4.0 has brought about a profound transformation in the way employees interact with tasks, work tools, and fellow coworkers. Technologies such as the Internet of Things (IoT), artificial intelligence (AI), and automation are not only changing production processes but also influencing the dynamics of employee work behavior (Dziopa & Ahern, 2011).

One of the main changes seen is an increase in the need for digital skills. Employees in the Industry 4.0 era are expected to have competence in operating and interacting with advanced technology. This includes the ability to analyze data, solve technical problems, and use specialized software used in daily operations. As a result, training and skills development has become an important aspect of ensuring that employees can adapt quickly to technological changes.

In addition, advanced technology also affects the level of collaboration and communication in the workplace. Digital collaboration tools such as cloud-based platforms enable employees to work together efficiently, regardless of physical location. This creates a more flexible and responsive work environment, where information can be shared and accessed in real-time. This change encourages more collaborative and transparent work behavior, although it also requires employees to be more independent and proactive in communication.

The psychological impact of technology on work behavior is also an important concern. Technology can increase employee motivation by providing tools that make work easier and enable faster and more effective achievements. However, on the other hand, technology can also cause stress and anxiety, especially if employees feel burdened by demands to always be 'connected' or if they feel they are not competent enough to use new technology (Yazmi et al., 2023). Therefore, management must play an active role in supporting employees through adequate training and providing the necessary resources to reduce stress and increase job satisfaction.

Technology is also changing the way employees assess and measure productivity. With devices and systems capable of tracking and analyzing performance automatically, employees can receive faster and more accurate feedback regarding work. This can be a very useful tool for improving individual and team performance, but it can also create pressure to always achieve the targets set by the system.

Overall, work behavior in the context of modern technology has become more dynamic and complex. Employees must be able to navigate a variety of digital tools, collaborate effectively in a connected work environment, and manage the psychological impact of technological change. Companies need to be aware of these changes and develop strategies that support employees in adapting to new technology, so they can work productively and prosperously in the Industry 4.0 era.

Table 1. Sytematic Analysis of Literature Review of the Relationship Between Industry 4.0

No.	Title	Description	Findings
1	New Era of Employment: Flexibility of Digital Workers in the Era of Industrial Revolution 4.0 (Ahmetya et al., 2023)	This article discusses the flexibility of digital workers in the Industry 4.0 era and its impact on employment.	Digital workers require high flexibility and the ability to adapt to rapid technological changes. This also influences a more dynamic and decentralized work structure.
2	Entrepreneurship training in literacy villages is competitive towards the industrial revolution 4.0 (Akbar et al., 2021)	This study examines entrepreneurship training in literacy communities to increase competitiveness in facing Industry 4.0.	Entrepreneurship training helps improve people's skills and readiness to face the challenges of Industry 4.0, with a focus on innovation and technological adaptation.
3	Analysis of the impact of industry 4.0 on the nuclear energy monitoring system in Indonesia (Alamsyah, 2018)	This research analyzes how Industry 4.0 affects the nuclear energy monitoring system in Indonesia.	Industry 4.0 technologies improve surveillance efficiency and accuracy, but require increased technical skills and a deep understanding of new technologies.

4	Transformational Leadership in the Era of Industrial Revolution 4.0 and its Impact on Employee Performance in the Public Sector (Ariyanti & Sawitri, 2023)	This article explores transformational leadership and its impact on employee performance in the public sector in the Industry 4.0 era.	Transformational leadership increases employee motivation and productivity by encouraging innovation and adaptation to new technology.
5	Human Resource Management: Functions and Roles of Company HR, Strategic Competencies in Industry 4.0 (Firmansyah, 2023)	This book discusses the role and function of human resource management in the context of Industry 4.0.	Human resources who are competent in technology and innovation are the key to increasing company productivity and competitiveness in the Industry 4.0 era.
6	Industrial Revolution 4.0: Challenges and Opportunities for Human Resource Management to Increase Productivity at Grand Hotel Jambi (Hendriyaldi & Mailindra, 2019)	This article examines the challenges and opportunities faced by HR management in increasing productivity in the Industry 4.0 era.	Technology adaptation and employee training are the main factors in overcoming challenges and taking advantage of opportunities to increase productivity.
7	Implementation of Human Resource Development Strategies to Increase Employee Productivity in the Era of Industrial Revolution 4.0 (Krisnahadi & Septika, 2021)	This study analyzes HR development strategies to increase employee productivity in the Industry 4.0 era.	Effective HR development strategies, including training and digital skills enhancement, significantly increase employee productivity.
8	HR management strategy in improving sustainable company performance in the industrial era 4.0 (Gunawan,	This article discusses HR management strategies to improve company performance in a	HR management that focuses on technology adaptation and improving skills contributes to sustainable company

	2024)	sustainable manner in the Industry 4.0 era.	performance.
9	Human Resource Management Strategy to Improve Sustainable Company Performance in Industry 4.0 (Parinsi & Musa, 2023)	This research explores HR management strategies to improve company performance in the long term in the Industry 4.0 era.	Implementation of technology and continuous HR training is important to maintain high company performance.
10	The Influence of Organizational Climate and Transformational Leadership on Innovative Work Productivity in the Manufacturing Industry in Pati, Central Java (Purwanto, 2020)	This study analyzes the influence of organizational climate and transformational leadership on innovative work productivity in the manufacturing industry.	Positive organizational climate and transformational leadership increase innovative work productivity in the manufacturing industry.
11	The influence of the competency of accounting graduates, government regulations and professional ethics on the ability of accounting graduates to compete in the era of industrial revolution 4.0 (Puspitasari et al., 2019)	This article examines the influence of competence, regulations and ethics on the ability of accounting graduates to face Industry 4.0.	Strong technical competence and professional ethics increase the ability of accounting graduates to compete in the Industry 4.0 era.
12	The influence of the industrial revolution 4.0 era on human resource competency (Rohida, 2018)	This study explores how Industry 4.0 affects HR competencies.	Industry 4.0 demands increased digital competence and rapid adaptation to new technologies to increase productivity.
13	Analysis of the readiness of Karawang Regency MSMEs towards adopting cloud	This article analyzes the readiness of MSMEs in Karawang Regency in	Adoption of cloud computing can increase the operational efficiency of MSMEs, but

	computing in the context of industry 4.0 (Sari et al., 2020)	adopting cloud computing for Industry 4.0.	requires infrastructure readiness and increased HR skills.
14	Overcoming counterproductive work behavior through the integrative role of organizational politics and emotional intelligence in the era of industrial revolution 4.0 (Sunargo & Hastuti, 2019)	This study examines how to overcome counterproductive work behavior through the role of organizational politics and emotional intelligence.	Healthy organizational politics and high emotional intelligence help reduce counterproductive work behavior and increase productivity.
15	Innovation-Based Human Resource Development to Face the Industrial Revolution 4.0 (Sunarto, 2020)	This article discusses innovation-based HR development to face the challenges of Industry 4.0.	Innovation-based HR development is important to face rapid changes in the Industry 4.0 era and increase company competitiveness.

5. ANALYSIS OF FINDINGS

Based on the results of a systematic literature review that has been carried out, the following is an analysis of the main findings from various studies related to the influence of Industry 4.0 on work behavior and employee productivity:

a. Employee Flexibility and Adaptability:

The study by Ahmetya et al. (2023) show that workers in the digital era need high flexibility and the ability to adapt to rapid technological changes. This means that work structures are becoming more dynamic and decentralized, allowing employees to work more flexibly but also requiring continuous skills improvement.

b. Training and Skills Development:

Many studies, including those by Akbar et al. (2021) and Krisnahadi & Septika (2021), emphasize the importance of training and developing digital skills for employees. Entrepreneurship training and human resource development that focuses on digital skills can increase employee readiness to face Industry 4.0 and increase productivity.

c. Increased Efficiency and Reduced Errors:

Alamsyah (2018) and Firmansyah (2023) found that adopting Industry 4.0 technology, such as automation and artificial intelligence, can increase operational efficiency and reduce human error. This directly contributes to increasing employee productivity by enabling them to focus on strategic and creative tasks.

d. Transformational leadership:

Ariyanti & Sawitri (2023) and Purwanto (2020) show that transformational leadership has a positive impact on employee performance and productivity. Leadership that supports innovation and technological adaptation encourages employee motivation and increases productivity through creating a more innovative and adaptive work environment.

e. Human Resources Management (HR):

Studies by Ong & Mahazan (2020) and Parinsi & Musa (2023) emphasize the importance of HR management strategies that focus on technology adaptation and skills development. Effective HR management in the Industry 4.0 era includes continuous training and improving digital skills that can improve company performance and productivity in a sustainable manner.

f. Wellbeing and Work-Life Balance:

Findings from Hendriyaldi & Mailindra (2019) and Sunargo & Hastuti (2019) show that technology can also cause stress and fatigue if not managed properly. Therefore, it is important for companies to create a balanced work environment and support employee well-being to avoid burnout and ensure sustainable productivity.

g. Innovation and Competence:

Rohida (2018) and Sunarto (2020) emphasize that innovation-based human resource development and increasing digital competence are very important in facing the challenges of Industry 4.0. Human resources who are innovative and competent in technology can help companies remain competitive and productive in this digital era. Overall, this research shows that the adoption of Industry 4.0 technology brings many benefits in terms of increased productivity and efficiency, but also demands significant changes in HR management and training strategies. Companies need to invest in digital skills development, transformational leadership, and creating a work environment that supports employee well-being to maximize the benefits of Industry 4.0.

The digital era has brought significant changes in the way companies measure and improve employee productivity. Advanced technologies such as automation, artificial intelligence (AI) and big data play an important role in optimizing work processes and increasing operational efficiency. In the midst of this transformation, employee productivity has become one of the main focuses that determines the company's success in competing in the global market (Savitri, 2019).

Automation is one of the main aspects that drives increased productivity in the digital era. By automating routine and repetitive tasks, employees can allocate time and energy to more strategic and creative activities. For example, the use of collaborative robots (cobots) in production lines allows employees to work alongside machines efficiently, increasing output without reducing quality. In addition, automation also reduces human error, thereby increasing reliability and consistency in work results.

Artificial intelligence and big data analysis also make a major contribution to increasing employee productivity. AI can be used to analyze large amounts of data quickly and accurately, helping companies make more informed and informed decisions. For example, AI can be used to predict market demand, optimize supply chains, and even provide personalized recommendations for customers. Employees supported by AI-based systems can work more effectively and focus on making strategic decisions.

Apart from that, digital technology also increases employees' ability to work flexibly and collaboratively. Collaboration platforms such as cloud-based project management tools enable teams to work together in real-time, regardless of geographic location. This not only increases efficiency but also expands access to global resources and expertise. Employees can easily share information, exchange ideas, and solve problems together, which in turn increases productivity and innovation.

However, the digital era also presents challenges that need to be overcome to ensure sustainable increases in productivity. One of the main challenges is ensuring that employees have the necessary skills to use new technology effectively. Therefore, companies need to invest in ongoing training and development programs to equip employees with relevant digital skills. In addition, effective change management is also needed to overcome resistance to the adoption of new technologies and ensure that employees feel supported in the transition process (Iswahyudi et al., 2023).

Technology must also be managed carefully to avoid burnout and digital exhaustion. Increased productivity depends not only on the use of advanced technology but also on employee well-being. Companies need to create a healthy work environment by paying

attention to the balance between work and personal life, as well as providing the psychological support needed to overcome work stress.

6. CONCLUSION

This research explores the influence of Industry 4.0 on work behavior and employee productivity in start-up technology companies using the Systematic Literature Review (SLR) method. Based on the literature analysis that has been carried out.

The adoption of advanced technology in the Industry 4.0 era has caused significant changes in employee work behavior. Employees are required to be more flexible, adaptive and have adequate digital skills. Work flexibility and adaptation to new technology are the main keys to maintaining productivity and efficiency in a dynamic work environment.

Training and developing employee skills, especially in digital and technological aspects, is very important to face the challenges of Industry 4.0. Ongoing training programs help employees continue to develop and adapt to changing technology, ultimately increasing productivity and innovation in the workplace.

Transformational leadership has a positive impact on employee motivation and performance. Leaders who are able to encourage innovation and support technological adaptation create a more productive and innovative work environment. Effective leadership is critical to managing change and ensuring employees feel supported in facing new challenges.

HR management strategies that focus on improving digital skills and adapting to technology are very important to improve company performance and productivity. Good HR management includes continuous training, skills development, and creating a work environment that supports employee welfare.

In addition to increasing productivity, it is important for companies to pay attention to employee welfare. Excessive use of technology without proper management can cause stress and burnout. Therefore, balance between work and personal life and psychological support are essential to ensure continued productivity.

Overall, Industry 4.0 brings many opportunities to increase productivity and efficiency in the workplace, but also demands significant changes in work behavior and HR management. Start-up technology companies need to invest in training and skills development, implement transformational leadership, and ensure employee well-being to maximize the benefits of this transformation. This research provides useful insights for companies that want to optimize employee productivity in this digital era.

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