The 1st International Student Conference on Economics and Business Excellence (ISCEBE) 2024
e-ISSN: xxxx-xxxx/Vol.1/SI-DigitalTransformation (2024)

The Impact of Technological Advancements in the Era of the Industrial Revolution 4.0 on Human Resources and Employment in the Labor Market

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Abstract

The dynamics of Human Resources (HR) and employment in the labor market are critical topics as they directly influence economic growth and social stability of a nation. In the current global context, the adaptation and readiness of HR and the labor market to technological advancements determine their competitiveness. However, significant challenges remain, including skill mismatches, job displacement, and the demand for continuous learning. These issues underscore the urgency of addressing the impacts of technological evolution, particularly in the 4.0 Industrial Revolution era.

The 4.0 Industrial Revolution introduces technologies such as automation and artificial intelligence that redefine workplace dynamics and reshape labor market structures (Schwab, 2016). These innovations bring opportunities for creating higher-quality jobs but simultaneously disrupt conventional employment models, posing challenges like skill mismatches and job displacement.

This study examines the multifaceted impacts of technological advancements in the 4.0 Industrial Revolution on HR and the labor market, including their dual effects on traditional and emerging jobs. It also explores how the education and training system needs to transform to meet these new challenges, ensuring workforce readiness and resilience. By addressing these aspects, the research aims to provide actionable insights for sustainable growth in an increasingly digital economy.

Keywords: Human Resources (HR), Employment, Labor Market, Fourth Industrial Revolution, Technology.

Introduction

The Fourth Industrial Revolution, characterized by advanced technologies such as automation, artificial intelligence (AI), and the Internet of Things (IoT), has fundamentally shifted work paradigms. This transformation optimizes business processes and demands significant changes in human resource (HR) management. The importance of this topic lies in technology's dual role as a catalyst for efficiency and innovation, as well as a source of labor market disruption. Agustin et al. (2024) emphasize that Industrial Revolution 4.0 reshapes work dynamics, presenting challenges and opportunities for modern workers.

Deni's (2023) theory of technological change explains how technology drives productivity by automating routine tasks. Automation does not merely replace manual work but also necessitates new skills. Within this context, the theory of technology adaptation highlights the importance of workers' ability to align with technological advancements to remain relevant. This indicates that technology acts not only as a tool but also as a transformational force dictating global economic dynamics.

Technological automation shifts workforce skill demands, with routine manual jobs being replaced by digitalization (Heryana et al., 2023). Conversely, technology creates new opportunities in sectors requiring advanced skills, such as data analysis, software development, and tech-based systems management. This challenge calls for an evolution in education and training systems to integrate tech-oriented curricula aligned with industry needs. In education, Nurhayati & Lahagu's (2024) theory of sustainable skill development underscores the importance of flexible curricula to prepare adaptive workers. Formal education must move beyond conventional methods to adopt tech-based approaches emphasizing proficiency in emerging technologies. Such efforts can be facilitated through collaborations between educational institutions and industries to design relevant and responsive training programs.

Furthermore, the impact of technology is evident in the transformation of service and education sectors. According to Aripin et al. (2023), digitalization has revolutionized customer service and education delivery methods. Automation replaces human roles in customer interactions, while technology enables more flexible learning models through online platforms. Workers in these sectors must master

technological tools to remain competitive in an increasingly complex market. While these transformations bring positive outcomes, they also have negative consequences. Mahardika & Badriyah (2024) warn that workforce reductions in specific sectors may lead to higher unemployment if workers fail to adapt quickly. This necessitates serious attention to government and private sector policies aimed at reskilling affected workers.

Ultimately, the challenge posed by Industrial Revolution 4.0 is creating an ecosystem that fosters synergy between humans and technology. This involves policy shifts, skill development, and innovations in education and training. Thus, Industrial Revolution 4.0 is not just a challenge but also an opportunity to develop a workforce that is more competent, innovative, and adaptable to change. Technology is not only a driver of change but also a strategic instrument in economic development. Further studies are necessary to explore technology's impact on labor market dynamics, educational adaptation strategies, and policies supporting human resource development in the digital era.

Building upon the background outlined earlier, this study aims to address the following key research questions:

1. How do technological advancements in the era of Industrial Revolution 4.0 affect the labor market and human resources?
2. What are the positive and negative effects of the era of Industrial Revolution 4.0 on conventional and emerging jobs?
3. How should education and training be adjusted to address these challenges?

Methods

This research uses a qualitative approach with a literature review method. A qualitative approach allows for an in-depth exploration of complex phenomena through the collection and analysis of non-numeric data. The literature review method is used to examine various written sources such as books, journal articles, research reports, and other documents to build a strong theoretical foundation and understand the impact of technological advancements in the Fourth Industrial Revolution on human resources (HR) and employment in the labor market. Sijal (2024) explains that this method enables researchers to identify existing research gaps and develop new perspectives based on relevant theoretical studies.

Data collection is conducted through a critical review of the literature to explore the impact of technology in transforming the labor market, such as job automation, increased efficiency, and the demand for new skills. Thematic analysis is used, categorizing data from various sources based on specific themes like digital transformation, HR skills, and the impact of technology on traditional jobs. Data validity is ensured through source triangulation, comparing information from relevant articles to confirm consistency and accuracy. This approach enables the research to present an in-depth, data-driven, and contextual analysis of the impact of technology in the era of the Fourth Industrial Revolution.

Results and Discussions

The term "Fourth Industrial Revolution" refers to a major transformation in digital technology, automation, and data connectivity, impacting various business and economic sectors. It encompasses advanced digital technologies such as the Internet of Things (IoT), robotics, big data, cloud computing, and artificial intelligence (AI), which are revolutionizing production, services, and operational management. These changes present new challenges and opportunities in product innovation, business models, and the interaction between companies, consumers, and business partners. Companies across industries are expected to leverage these technologies to enhance efficiency and global competitiveness.

Technological advancements in the Fourth Industrial Revolution, such as automation, AI, and robotics, have significantly reshaped the employment landscape. According to Sudirman (2019), technologies driving this revolution enhance industrial efficiency and productivity but pose threats to human labor, particularly in routine and mechanical tasks. While these technologies offer numerous benefits, their negative implications, especially for unskilled labor, must be addressed.

This research utilizes a systematic review methodology based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA). A systematic review is a method that involves examining, structurally evaluating, classifying, and categorizing existing evidence. This structured approach involves detailed protocols and systematic steps, differentiating it from general literature reviews. The systematic review process includes the following stages:

1. Defining background and objectives.
2. Formulating research questions.
3. Conducting a literature search.

4. Establishing selection criteria.
5. Practical screening.
6. Quality checklists and procedures.
7. Data extraction strategies.
8. Data synthesis strategies.

The study aims to review the literature on the Impact of technological advancements in the era of the Industrial Revolution 4.0, particularly on labor markets and human resources. Using the PRISMA method and the Publish or Perish software version 7, the study gathers relevant data to explore the following research questions:

RQ1: How have technological advancements in the Fourth Industrial Revolution impacted labor markets and human resources?

RQ2: What are the positive and negative effects of the Fourth Industrial Revolution on conventional and emerging jobs?

RQ3: How should education and training adapt to these challenges?

Table 1 Research Data Source and Keyword

Data Source	Keyword
Google Scholar from Perish V.7	Industrial Revolution and Human Resources

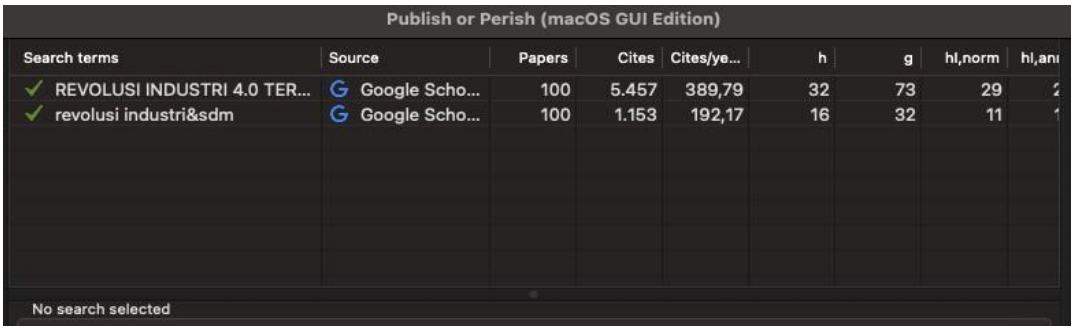

Figure 1
Publish or Perish Interface

A total of 10 sources were selected after undergoing two rounds of screening. The review includes articles and journals evaluated based on their titles and abstracts to ensure they meet the author's inclusion criteria. These 10 sources, comprising both journals and books, were thoroughly analyzed. The findings provide valuable insights and hold significant relevance in the context of the Industrial Revolution era.

e-ISSN: xxxx-xxxx/Vol.1/SI-DigitalTransformation (2024)

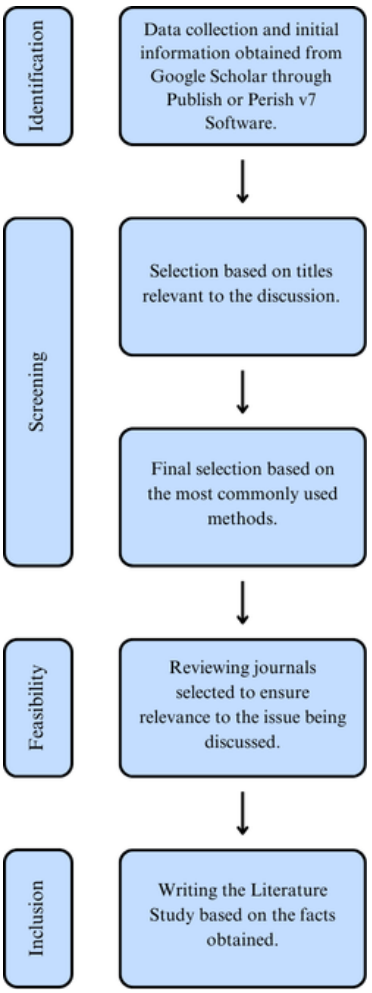

Figure 2
PRISMA Diagram

Table 2 Summary of Previous Research Findings

No.	Researcher Name (Year)	Objective	Research Methodology	Dataset	Research Findings
1	Asmiati, A., Sulastriani, S., & Citta, A. B. (2023)	Developing HR to support maritime transportation transformation	Observation, interviews, literature study	Not mentioned	HR development is crucial to improve port performance as a trade gateway, focusing on training and development to maintain quality and competitiveness.
2	Sudiantini, D., Naiwasha, A., Izzati, A., & Rindiani, C. (2023)	Investigating the impact of technology on HR management in the digital era	Not mentioned	Not mentioned	Technology plays a significant role in increasing productivity, providing a competitive edge, and transforming how companies recruit, train, and

					motivate employees in the digital era.
3	Zahran, R., & Ali, H. (2020)	Analyzing factors influencing information systems in organizations	Not mentioned	Not mentioned	HR quality, business, technology, and methods significantly impact the effectiveness of information systems in organizations. The better the HR quality, the more effective the information delivery.
4	Faiza, N., & Kristina, A. (2021)	Analyzing the role of technology in the competitiveness of small business products	Qualitative phenomenological approach, in-depth interviews	Small embroidery businesses in Bangil, Pasuruan, Indonesia	Technology is essential for improving the competitiveness of small businesses' products, with computerization in embroidery production to meet market demand on time.
5	Novita, T., Hasan, S., & Dewi, R. (2023)	Investigating the impact of HR development and digital culture on employee performance	Descriptive quantitative, multiple regression analysis	Employees of the South Sulawesi Provincial Food Security Service	HR development and digital culture positively impact employee performance, with digital culture as a key supporting factor.
6	Pratama, A. S., Sari, S. M., Hj, M. F., Badwi, M., & Anshori, M. I. (2023)	Investigating the impact of AI, Big Data, and automation on HR performance	Survey, data analysis, case study across industries	Various industries	AI, Big Data, and automation positively impact HR performance, with AI assisting recruitment and training, Big Data supporting data-driven decision-making, and automation reducing repetitive tasks.
7	Nikmah, W., Mukarromah, A., Widyansyah, D., & Anshori, M. I. (2023)	Investigating the impact of technology on HR development	Literature study, secondary data analysis	Various literature sources related to technology and HR	Technology positively impacts HR development by improving efficiency, effectiveness, and HR performance, despite challenges related to organizational

					culture, ethics, and privacy issues.
8	Wahyudi, A., Assyamiri, M. B. T., Al Aluf, W., Fadhillah, M. R., Yolanda, S., & Anshori, M. I. (2023)	Analyzing the impact of digital transformation on HR management	Not mentioned	Not mentioned	Digital transformation affects HR management by demanding the development of digital skills and competency-based approaches to improve productivity and competitiveness.
9	Sinlae, F., Rony, Z. T., & Ali, H. (2024)	Analyzing the impact of technological advancement on IT HR in Indonesia	Systematic literature review (SLR)	Literature data on IT HR in Indonesia	Skills such as data analysis and cybersecurity are in high demand, and there are challenges related to skill gaps and slow technology adaptation among IT HR.
10	Iskandar, R., & Jayanto, N. D. (2022)	Analyzing the impact of technological skills on employee performance	Descriptive qualitative method through literature review	Secondary data from literature review	Employees' ability to operate technology significantly affects their performance, impacting the overall productivity of the company.

RQ1: How does technological change in the era of the Fourth Industrial Revolution impact the labor market and human resources? The development of technology in the era of the Fourth Industrial Revolution has drastically changed the way work is done, increasing efficiency and opening new opportunities in the labor market. Technologies such as artificial intelligence (AI), big data, and automation not only transform production processes but also the way HR is managed. These technologies influence HR development in terms of skills and job quality. For example, the development of digital skills and the utilization of technology in HR management, as explained by Sudiantini et al. (2023), has affected how companies recruit and train employees. This technology enables companies to increase their productivity and competitiveness. Similarly, Sinlae et al. (2024) highlight the importance of information technology skills in the Indonesian labor market, which have become increasingly important with rapid technological development. Therefore, the main impact is the shift in skill requirements in the labor market, which directly affects the quality of HR needed in this digital era (Faiza & Kristina, 2021).

RQ2: What are the positive and negative effects of the Fourth Industrial Revolution on conventional and emerging jobs? The era of the Fourth Industrial Revolution brings both positive and negative effects on conventional and emerging jobs. On the positive side, technology enhances productivity and creates new, higher-quality jobs, particularly in technology- and digital-based sectors (Pratama et al., 2023). However, there are also negative effects, such as the loss of conventional jobs that cannot adapt to technological changes. For example, in small industries like embroidery in Bangil, Pasuruan, Faiza and Kristina (2021) explain that while technology improves product competitiveness, workers must adapt to new technologies such as computerized embroidery machines. This may lead to a reduction in manual jobs. Furthermore, Zahran & Ali (2020) note that although technology enables greater efficiency, it also requires new skills that may be difficult for some older or less skilled workers to access.

RQ3: How should education and training be adjusted to address these challenges? In facing the challenges of the Fourth Industrial Revolution, education and training should focus on the development of digital skills and technological competencies. Nikmah et al. (2023) emphasize that technology should be

e-ISSN: xxxx-xxxx/Vol.1/SI-DigitalTransformation (2024)

used as a tool to enhance HR quality and skills, for example in recruitment, training, and career development processes. Therefore, education needs to adjust its curriculum to match the skills required in the workforce, including data analysis and cybersecurity (Sinlae et al., 2024). Wahyudi et al. (2023) also state that digital skills are crucial, and therefore, competency-based skill development is key to helping HR adapt to the ever-evolving technology. Thus, technology- and digital skills-based education and training will strengthen HR competitiveness in the increasingly competitive labor market.

Based on the above explanation, the researcher can summarize the impact of technological development in the era of Industry 4.0 on human resources and employment in the labor market. The following are the Independent Variable and the Dependent Variable:

1. Independent Variable:
   a) Technological Development
      - Information and communication technology plays a significant role in transforming the world of work, including recruitment processes, training, and human resource management (Sudiantini et al., 2023).
      - Human Resources (HR) are expected to have high digital skills to adapt to the rapidly changing technology (Wahyudi et al., 2023; Iskandar & Jayanto, 2022).
      - The availability of technologies such as Big Data, AI, and automation influences how HR operates and impacts employee performance and competencies (Pratama et al., 2023).
   b) Education and Training
      - Updates in curricula and training programs to enhance digital skills have become crucial in preparing the workforce (Zahran & Ali, 2020).
      - HR training and development focusing on technical and managerial skills are needed to prepare workers for the challenges of digitalization (Nikmah et al., 2023).
2. Dependent Variable: Labor Market and Human Resources
      - The labor market will be greatly influenced by technological changes that may alter the types of jobs available, with some traditional jobs being replaced by automation or new technologies, while new jobs requiring high technical skills are emerging (Asmiati et al., 2023; Faiza & Kristina, 2021).
      - The skills required by HR are also changing, demanding workers to develop new skills in the use of technology (Sinlae et al., 2024).
      - The workforce's ability to adapt to technology and digital culture will affect their competitiveness in the labor market (Novita et al., 2023; Zahran & Ali, 2020).

Referring to the results of previous studies, the variables influencing this are technological development, education, and training systems, while the variables being influenced are the labor market and human resource competencies.

Conclusion

This research reveals that the Fourth Industrial Revolution has brought significant changes to the world of human resources and employment, both positively and negatively. Technological developments, such as artificial intelligence (AI), big data, and automation, have improved efficiency and created new job opportunities in the technology sector. However, technology also threatens jobs that rely on routine and mechanical skills, leading to the loss of conventional jobs. To address these challenges, it is crucial for the workforce to enhance their digital skills and adapt to the latest technologies in order to remain competitive in an increasingly digital and globally connected labor market.

Based on these findings, the implications for the education and training sector are significant. The education and training systems need to be updated to include technology skills that are relevant to the needs of the labor market. Training programs focusing on digital skills and information technology, such as data analysis and cybersecurity, should be introduced to prepare the workforce for the digital era. Additionally, companies need to adjust their recruitment, training, and human resources development methods to meet the evolving technological competence needs, in order to enhance productivity and competitiveness in business.

To mitigate the negative impacts of the Fourth Industrial Revolution, it is recommended that companies and educational institutions collaborate in designing curricula that are more focused on digital and technology skills. Furthermore, continuous training for existing employees is essential to improve their ability to operate new technologies. The government can also play a role in providing policies that support digital transformation and the development of skills that align with the demands of the future labor market. Thus, this revolution can be fully leveraged to create new job opportunities and improve the quality of human resources.

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