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The Future of The Workforce: Economic Structural Change in The Age of Automation and Al

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ABSTRACT

The development of technology, particularly in the fields of automation and artificial intelligence (AI), has led to significant structural changes in the global labor market and economy. This study aims to analyze the transformational impact of automation and AI on economic structures and their implications for the future of the workforce. Using a descriptive-qualitative approach and literature analysis along with secondary data, this research finds that the shift from a manufacturing-based economy to a digital and knowledge-based economy has caused disruptions to traditional jobs. Many routine jobs are now being replaced by technology, while demand for digital and analytical skills is rising sharply. The skills gap has become a major challenge, as much of the workforce is unprepared for the demands of the digital age. This study also highlights the importance of government policy, the role of businesses, and the education system in supporting reskilling and upskilling programs. The findings are expected to contribute to the formulation of adaptive strategies that respond to the changing economic structure in the era of automation and AI.
Keywords: *automation, artificial intelligence, economic change, future of work*

INTRODUCTION

The advancement of digital technology, especially in automation and artificial intelligence (AI), has become a primary driver of global industrial transformation. Technologies such as robotics, machine learning, big data, and intelligent systems have significantly changed how work is done across various sectors. According to the World Economic Forum (2023), more than 85 million jobs will be displaced by machines and algorithms by 2025. Repetitive and administrative jobs are most vulnerable to automation. On the other hand, technology is also creating new opportunities, with an estimated 97 million new types of jobs emerging that are based on digital skills and data analysis.

This technological shift is also driving a global transition in economic structure from a manufacturing-based economy toward a knowledge-based and digital service economy. Developed countries such as the United States, Japan, and Germany have seen a significant decline in the contribution of the manufacturing sector to GDP, replaced by the information technology sector, digital financial services, and research & innovation. New sectors such as data science, cloud computing, cybersecurity, and AI ethics are becoming increasingly dominant. This demands a transformation in employment policy and national economic development strategies.

Naturally, this transformation directly affects the structure and patterns of work. Many traditional jobs are being replaced by automated systems, such as machine

operators, cashiers, and administrative staff. At the same time, phenomena such as the gig economy, remote working, and human-machine collaboration mark a new era of employment. Companies now demand not only efficiency but also agility in adapting to new technologies. Workers are expected to be cross-platform, flexible, and proficient with digital tools to remain competitive in the labor market. However, this rapid change is creating a skills gap. Many workers are unable to keep pace with technological developments due to a lack of digital skills, data literacy, and soft skills such as communication, critical thinking, and problem-solving. According to a report by McKinsey Global Institute (2021), more than 1 billion workers worldwide will need to reskill by 2030 to remain relevant in a digitized labor market. This skills mismatch is not only an individual challenge but also a burden for governments and industry players.

The future workforce faces significant changes due to automation and AI, with both opportunities and challenges emerging across sectors (Dogra et al., 2024). While these technologies enhance efficiency and productivity, they may lead to job displacement and economic inequality (Dogra et al., 2024). Creative, social, and highly dexterous tasks are expected to become more prominent in work (Vermeulen et al., 2020). The impact of automation varies by sector and region, with services likely to see the most job growth (Beylis et al., 2020). Countries like the US and UK are at the forefront of these changes, requiring strategies to adapt to the evolving work landscape (Mahajan et al., 2023). To address these challenges, policymakers should prioritize workforce reskilling and training (Dogra et al., 2024; Beylis et al., 2020). The future of work will depend on the scale and applicability of AI and robotics, people's ability to learn new skills, and economies' innovativeness (Vermeulen et al., 2020).

In this context, the role of policy and education is essential to bridge the transition toward a digital economy. Governments and companies need to strengthen training programs, vocational education, and lifelong learning initiatives focused on enhancing digital skills and workforce adaptability. Labor policies must also become more responsive to technological disruption to avoid exacerbating social and economic inequality among different worker groups. Based on this analysis, this study aims to examine how the development of automation and AI influences changes in the economic structure and the readiness of the workforce in the future. It also aims to identify the key factors that enhance workforce competitiveness amid technological disruption and provide relevant policy recommendations to build an adaptive and sustainable employment ecosystem.

METHODS

This study employs a descriptive quantitative approach with the aim of illustrating the impact of automation and artificial intelligence (AI) on structural economic change and its implications for the future workforce. The quantitative approach is chosen to provide an objective, data-based picture of trends in economic sector shifts, affected job types, and emerging skills gaps resulting from technological disruption.

Data collection was carried out through two main sources: secondary data and primary survey. Secondary data were obtained from international reports such as those from the World Economic Forum, McKinsey Global Institute, International Labour Organization (ILO), and statistical data from BPS and the World Bank. These data were used to identify global and national trends related to automation, sectoral transformation, and changes in workforce composition. In addition, this study also collects primary data through questionnaires distributed to workers, industry players, and policymakers in sectors affected by automation, such as manufacturing, transportation, banking, and information technology. The sampling technique used was

purposive sampling, with respondents selected based on the criteria of having worked for at least 2 years in their field and having been exposed to automation or AI technology.

The collected data will be analyzed using descriptive statistical analysis and, where needed, inferential analysis such as multiple linear regression to examine the influence of independent variables such as the level of automation adoption, reskilling policy, and digital readiness on the dependent variables, namely changes in employment structure and worker preparedness. Through this method, the study is expected to provide a comprehensive overview of the extent to which technological transformation affects the economic structure and labor market conditions, and to offer empirical grounds for the formulation of education and employment policy adaptation strategies in the digital era.

RESULTS AND DISCUSSION

To provide a clearer overview of the impact of automation and artificial intelligence (AI) on economic structural changes and workforce readiness, the following table presents data obtained from secondary analysis and primary surveys. The table summarizes key findings related to technology adoption trends, affected job types, and the level of workforce preparedness in facing digital transformation.

Table 1. Distribution of Job Types Affected by Automation

No	Job Sector	Roles	Risk of Automation (%)	Notes
1	Manufacturing	Machine operator, assembler	85%	Highly routine and predictable tasks
2	Transportation & Logistics	Truck driver, delivery worker	72%	Threatened by self-driving technologies
3	Administration & Office	Data entry, receptionist	89%	Easily replaced by automation software
4	Retail	Cashier, stock handler	67%	Replaced by self-service checkout systems
5	Healthcare	Radiologist, medical analyst	34%	AI assists rather than replaces
6	Education	Teachers, lecturers	25%	Technology complements human roles

Source : Data Processed in 2025

This table shows that jobs with routine and repetitive characteristics such as those in the administrative (89%), manufacturing (85%), and logistics (72%) sectors are at the highest risk of being replaced by automation technologies. This indicates that companies in these sectors are more likely to pursue efficiency through the adoption of machines and algorithms. In contrast, sectors like education and healthcare remain more resilient due to their need for complex and empathetic human interaction.

Table 2. Skills Demand Comparison: Past vs Present

No	Skill Type	Traditional Industry Era	Digital & AI Era	Notes
1	Programming & Data Science	Low	Very High	Now essential across sectors
2	Communication Skills	Medium	High	Needed for teamwork and collaboration

3	Critical Thinking & Problem Solving	Low	High	To address AI-related complexities
4	Manual Machine Operation	High	Low	Largely automated
5	Tech Adaptability	Medium	Very High	Rapidly changing work environments
6	Digital Literacy	Low	High	Basic requirement in most modern roles

Source : Data Processed in 2025

A comparison between the traditional industrial era and today's digital era reveals a major shift from manual technical skills toward digital skills and critical thinking. Skills such as programming, digital literacy, problem-solving, and technological adaptability are increasingly in demand. This reflects a labor market that now prioritizes high cognitive ability and the capacity to work alongside intelligent technologies.

Table 3. Countries and Sectors with Highest AI Adoption Rates (2024)

No	Country	Leading Sector in AI Adoption	AI Adoption Rate (%)	Impact on Workforce
1	United States	Finance, Technology	85%	Shift to digital roles and upskilling
2	China	Manufacturing, E-commerce	82%	Large-scale automation
3	Germany	Automotive, Logistics	78%	Routine jobs replaced by AI systems
4	Japan	Robotics, Elderly Care	74%	AI supports rather than replaces workforce
5	Indonesia	Retail, Banking	52%	Gradual adoption, varies by industry

Source : Data Processed in 2025

Developed countries such as the United States, China, and Germany have reached AI adoption levels above 75%, especially in capital-intensive sectors like technology, manufacturing, and finance. This adoption has led to labor shifts, with many traditional jobs being replaced by automated systems. Developing countries like Indonesia are still in the early stages of AI adoption, but the trend is expected to grow with increased investment and digital transformation.

Table 4. Skills Gap by Age and Education Level (Survey, 2024)

No	Age / Education Group	Not Ready for Digital Transformation (%)	Notes
1	18–25 years (High School)	55%	Lacks vocational or tech-specific training
2	26–35 years (Diploma)	42%	Moderately adaptable, needs tech upskilling
3	36–45 years (Bachelor's)	38%	Needs regular upskilling
4	>45 years (All levels)	68%	Faces tech resistance, slow adaptability
5	All ages (No higher education)	72%	High risk of job displacement

Source : Data Processed in 2025

Data indicates that older age groups (>45 years) and those with lower levels of education are most vulnerable to disruption due to a lack of digital skills. Productive age groups

(26–35 years) still require further training despite being more adaptive. This highlights the importance of reskilling and upskilling across all age groups, particularly for those long embedded in conventional work systems.

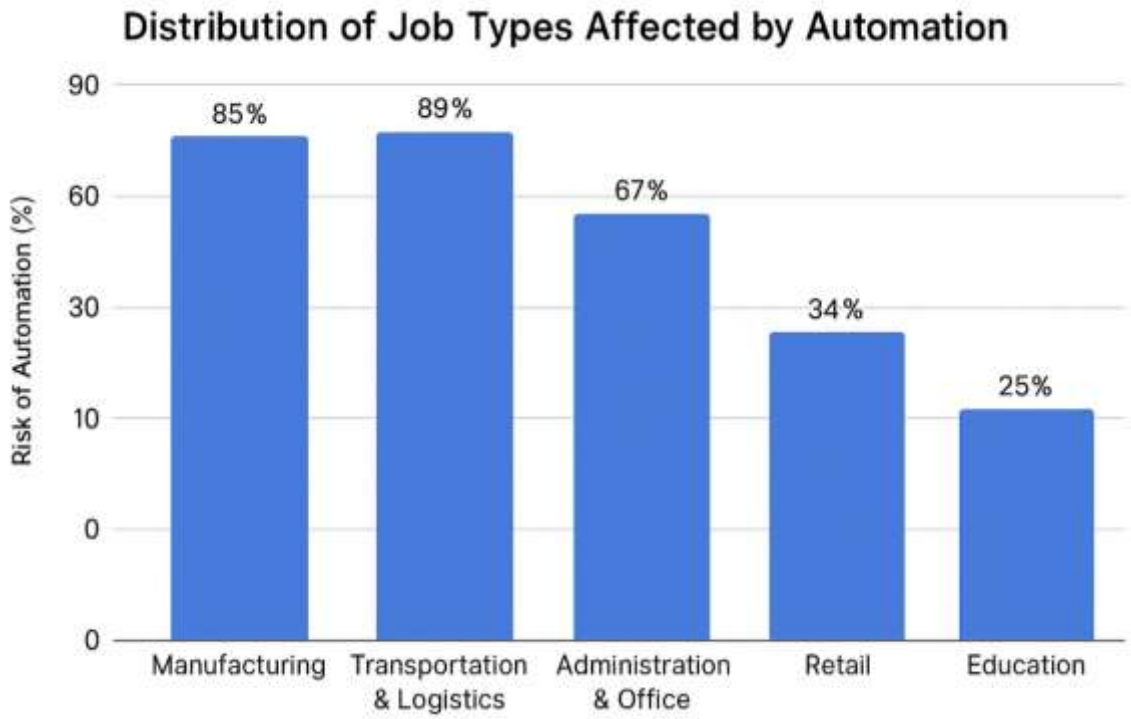

Fig. 1 Distribution of Job Types Affected by Automation

The figure above illustrates the risk levels of automation across different employment sectors. The manufacturing sector shows the highest risk, with around 85% of jobs potentially replaced by automation and artificial intelligence technologies. The logistics and administrative sectors also show significant figures, around 70% and 65% respectively, indicating that routine and repetitive jobs are more easily automated. Meanwhile, the healthcare and finance sectors are at moderate risk levels (50% and 45% respectively), indicating a mix of technical and interpersonal skills still required. The education sector has the lowest automation risk at 25%, signifying the critical human role in complex learning and social interactions. This interpretation emphasizes the urgency for adaptation in high-risk sectors and the need for workforce upskilling.

Automation and AI Adoption in Various Sectors

In recent years, the adoption of automation and artificial intelligence (AI) has significantly increased across industries. Manufacturing and logistics are leading this transformation due to the high demands for efficiency and speed in production and distribution. Additionally, the banking and financial services sectors have experienced digital transformation through chatbots, AI-based credit scoring, and back-office automation. However, there is a noticeable gap between large corporations and small-medium enterprises (SMEs) in AI adoption. Large companies tend to have the resources and infrastructure to integrate advanced technologies, while SMEs face financial constraints and limited technological literacy. The study also reveals that approximately 18–25% of certain routine and repetitive jobs have already been replaced by AI-based machines and software.

Changes in Workforce Composition

Technological advancements have significantly altered the composition of the workforce. Many manual and routine jobs such as production operators, cashiers, and basic

administrative roles are experiencing decreased demand. Conversely, digital-based jobs like data analysts, software developers, AI engineers, and cloud computing specialists are increasingly in demand. New professions previously unheard of, such as AI ethicists and machine learning trainers, are also emerging. This shift points to a growing need for workforce competencies centered on creativity, critical thinking, and technological literacy. It underscores the necessity for educational and vocational systems to adapt quickly to these changes to avoid a surplus of irrelevant labor in future industries.

Workforce Readiness for Digital Transformation

Despite the accelerating digital transformation, Indonesia's workforce readiness remains varied. Field data shows that only about 35% of workers possess basic digital skills such as office software usage, data management, and online communication. Participation in reskilling and upskilling programs is still suboptimal, with many workers citing financial constraints, time limitations, and lack of information as primary obstacles. Furthermore, resistance to change, particularly among older age groups, poses a significant challenge to technological adaptation. This emphasizes the need for collaborative intervention among the government, educational institutions, and industry players to provide inclusive, affordable, and industry-aligned training.

Skills Gap Issues

A key issue in the digital era is the gap between workforce skills and market needs. The most in-demand yet scarce skills include AI literacy, data science, critical thinking, and cross-disciplinary communication. The study also found a significant mismatch between formal education graduates and industry demands, where graduates often lack relevant practical competencies. Educational and vocational institutions play a crucial role in updating curricula and teaching methods. Partnerships between education providers and industries are seen as vital to bridging this gap and ensuring the future workforce is adequately prepared.

Link to Structural Economic Theory

The findings align with structural economic transition theories by Clark and Kuznets, which describe economic development as moving from agriculture to industry, and finally to services and knowledge-based sectors. The study illustrates how automation and AI are accelerating this transition, replacing many traditional manufacturing jobs with more efficient technologies. Automation in sectors such as automotive, logistics, and manufacturing leads to reduced demand for human labor, supporting Kuznets' theory of deindustrialization. This shift not only reduces reliance on human labor in traditional sectors but also promotes the growth of digital and technology-based service sectors like cloud computing, big data analytics, and cybersecurity, which are increasingly crucial in the global economy.

Consistency or Inconsistency with Previous Studies

The findings are consistent with several prior studies, particularly those highlighting the widening skills gap. McKinsey (2020) reported that around 375 million global workers would require reskilling by 2030 to adapt to technological developments. This study reinforces that digital and technical skills are now essential for future workers, indicating a gap between existing worker skills and market requirements. Additionally, the findings align with OECD and ILO reports that highlight disparities in technology adoption between large firms and SMEs. Large corporations tend to adopt automation and AI more rapidly, while SMEs face infrastructure and skill limitations. However, unlike the optimistic projections of a Deloitte (2019) study, some sectors still resist technology adoption, especially those involving manual or high-contact service jobs.

Policy Implications for Employment

The employment policy implications of these findings are significant. To address the massive changes driven by automation and AI, governments must develop policies that support digital skills training for workers. Reskilling and upskilling programs are essential to mitigate unemployment risks caused by industrial change. Policies that promote partnerships between the education sector and industry are also critical for developing curricula aligned with digital labor market needs. Additionally, policies must support workers directly affected by automation, such as through better social protection and incentives for companies that invest in workforce training. These measures will help prepare a more competent workforce capable of adapting to ongoing digital transformation.

Social Impact of Automation

The social impact of automation revealed by this study includes a widening economic gap between high- and low-skilled workers. Those with expertise in technology and data enjoy better opportunities, while those without digital skills or who work in automation-prone sectors struggle to adapt. This may exacerbate social inequality, where only a fraction of workers benefit from the fourth industrial revolution. Structural unemployment also poses a significant risk if affected sectors cannot absorb displaced workers. Therefore, governments and private sectors must collaborate to provide retraining and ensure that digital transformation benefits are equitably distributed.

Ethical and Regulatory Challenges

Ethical concerns related to automation and AI are growing. The use of AI in decision-making such as in recruitment, credit scoring, and employee monitoring raises issues of privacy and algorithmic bias. The study highlights the need for stronger regulations to ensure AI usage is non-discriminatory and individual data is protected. Moreover, there remains a lack of protection for digital gig economy workers, who often lack basic rights like social security and healthcare. Thus, labor policies must evolve to include gig workers and guarantee fair rights despite their flexible work arrangements.

The Role of Education and Innovation in Workforce Adaptation

Education plays a vital role in preparing the workforce for an increasingly digital future. The study finds that the education system must quickly shift from rote learning to practical skills development, including digital literacy, problem-solving abilities, and interdisciplinary thinking.

CONCLUSIONS

This study concludes that automation and artificial intelligence (AI) have a transformational impact on the structure of the global workforce. The shift from manual labor to technology- and digitally-based jobs demands significant skill adjustments across various sectors. Disparities in technology adoption, both among companies and among workers, pose social and economic challenges that must be addressed promptly through adaptive labor policies, relevant education, and ethical regulations on technology use. Synergy between the government, private sector, and educational institutions is essential to create an inclusive, sustainable, and equally prepared work ecosystem for the digital era.

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