

The Impact of Artificial Intelligence and Automation on Employment in Indonesia's Manufacturing Sector: A Sociological Analysis

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ABSTRACT

Background. The rapid advancement of Artificial Intelligence (AI) and automation has revolutionized various industries globally, including Indonesia's manufacturing sector. The integration of these technologies has raised concerns about their impact on employment, particularly regarding job displacement and skill requirements. While AI and automation offer opportunities for increased productivity and efficiency, they also pose challenges for workers, especially in a developing economy like Indonesia.

Purpose. This study aims to explore the sociological impact of AI and automation on employment in Indonesia's manufacturing sector, focusing on the potential changes in the labor market, skill gaps, and social implications for workers.

Method. The research employs a mixed-methods approach, combining both qualitative and quantitative techniques. Surveys were conducted with workers in the manufacturing industry, and in-depth interviews with industry experts and sociologists were also carried out. Data was analyzed using thematic coding for qualitative data and statistical analysis for quantitative data to examine the relationship between technological advancements and employment trends.

Results. The findings indicate that AI and automation are contributing to job displacement, especially for low-skilled workers, while creating new opportunities for highly skilled labor in areas such as robotics maintenance and data analysis. However, there is a significant gap in workers' ability to adapt to new technologies due to insufficient training and education.

Conclusion. The study concludes that there is a need for strategic policies focused on reskilling and upskilling the workforce to mitigate the adverse effects of automation on employment.

KEYWORDS

Artificial Intelligence, Automation, Employment, Manufacturing Sector, Sociological Analysis

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INTRODUCTION

The advent of Artificial Intelligence (AI) and automation has fundamentally transformed industries worldwide. These technologies have revolutionized production processes, improving efficiency and reducing costs in sectors like manufacturing. In Indonesia, the manufacturing sector remains a cornerstone of economic growth, contributing significantly to employment and GDP (Ahmed, 2021).



AI and automation, through innovations like robotics, machine learning, and data analytics, have gradually infiltrated Indonesian factories, optimizing production lines and shifting traditional labor dynamics (Carrozza, 2019). Research has shown that automation in manufacturing has increased productivity, reduced human error, and enhanced product quality. However, it has also prompted discussions about the future of labor in the sector, particularly concerning job displacement (Chartier-Edwards, 2025).

Global trends indicate that automation and AI can displace certain types of jobs, particularly in industries that rely on repetitive, manual labor (Chen, 2025). These shifts have sparked widespread concern about the long-term implications for workers in emerging economies like Indonesia. Studies from developed countries suggest that automation may lead to job displacement among low-skilled workers while creating opportunities for more specialized roles, such as technicians and engineers. As such, the manufacturing sector's workforce in Indonesia faces an era of uncertainty, where the traditional job market is being reshaped by technological advancements (Ehsan, 2021).

Furthermore, the adoption of AI and automation also has sociological implications. As new technologies emerge, workers need to adapt to the changing landscape of skills required in the labor market (Ehsan, 2022). In developed economies, labor markets have begun to adjust by integrating skill development programs and re-skilling initiatives. In Indonesia, however, these programs are still underdeveloped, and many workers lack the necessary skills to transition into new job roles created by these technological advancements (Hovd, 2022). As a result, the integration of AI and automation in the Indonesian manufacturing sector may have a profound social impact, including rising unemployment rates among unskilled labor.

What is also known is that automation tends to impact labor demographics differently. For example, studies have shown that women and low-income workers are disproportionately affected by automation, especially in lower-skilled positions (Kalateh, 2021). In Indonesia, these effects may vary based on geographical location, with urban areas likely to experience a faster rate of technological adoption than rural ones. Additionally, industries such as textiles, automotive, and electronics are more susceptible to automation than others, given their reliance on manual labor. The changing landscape of work, therefore, is not uniform across sectors or regions (Kopyrin, 2025).

Sociologically, AI and automation have raised important questions regarding the redistribution of labor. Economists and sociologists alike debate the extent to which displaced workers can be absorbed into new, technologically advanced roles (Kopyrin, 2025). While some argue that AI will create as many jobs as it displaces, others caution that these new roles will require advanced education and specialized skills. The workforce in Indonesia faces a stark divide, where those with advanced technical skills will thrive, and those without may face increasing challenges. Therefore, understanding the social impacts of AI and automation is critical for formulating policies that can help mitigate negative consequences (Kouroutzas, 2025).

Moreover, it is evident that Indonesia's educational system and training programs must evolve to meet the growing demand for skills relevant to an AI-driven economy. While the government has taken steps toward integrating technology into education, there is still a significant gap between what the industry demands and the skills that the current workforce possesses (Laskar,

2023). As the manufacturing sector becomes increasingly automated, the country must consider how its educational and vocational training systems can equip workers for the jobs of the future.

Despite the significant research on the impact of AI and automation in developed countries, the specific effects on developing economies, particularly Indonesia, remain underexplored. Indonesia's manufacturing sector is unique in its reliance on both labor-intensive production methods and emerging technological processes (Lei, 2024). While studies have provided insight into global trends, the sociological implications of AI adoption on Indonesian workers, including issues such as social inequality and workforce displacement, are not well documented. There is a lack of comprehensive studies that focus on how automation intersects with Indonesia's unique socio-economic landscape (Marijani, 2025).

Another gap in the literature is the impact of AI and automation on job quality rather than just job quantity. While much attention has been paid to job displacement, less is known about the transformation of job roles within the sector (Millington, 2025). How does automation affect job satisfaction, worker morale, and the quality of work life for those who remain employed? In the context of Indonesia's manufacturing workforce, these questions have not been addressed adequately (Muntaner, 2025). Research on the transformation of work environments due to automation in the Indonesian context is still emerging.

Furthermore, there is a lack of understanding about how workers and employers in Indonesia perceive automation. While AI adoption in manufacturing is often seen from the perspective of productivity and economic growth, little attention has been given to the psychological and emotional responses of workers who may feel threatened by technological change (Nestik, 2021). Understanding workers' attitudes toward automation, and how these attitudes vary across different regions and sectors in Indonesia, is crucial for managing the transition and ensuring that it is equitable (Oder, 2025).

Lastly, there is insufficient data on the effectiveness of current government and institutional policies in addressing the impacts of AI and automation. While some initiatives aim to address the growing skills gap, the success of these programs in fostering a resilient workforce is not well documented (Pashentsev, 2020). Research on the implementation of reskilling and upskilling programs in the Indonesian manufacturing sector, and their effectiveness in bridging the technological divide, remains limited.

Filling this gap is essential because the increasing integration of AI and automation into Indonesia's manufacturing sector presents both opportunities and challenges that require a comprehensive understanding of their sociological impact (Pozdeeva, 2022). By exploring the effects of AI and automation on employment in the sector, policymakers and industry leaders can better anticipate the needs of workers and develop strategies to address the potential negative consequences of automation, such as job loss, wage stagnation, and social inequality (Raphael, 2022).

Additionally, filling this gap will provide valuable insights into the role of education and training in preparing the Indonesian workforce for an AI-driven future. Understanding the specific skill sets required for the new jobs created by automation will allow for more targeted investments in vocational training and higher education programs. These insights can also guide the creation of

public policies that support workers who are at risk of displacement, ensuring that they are equipped with the skills needed to transition into new roles.

Lastly, understanding the sociological implications of AI and automation will help in the design of inclusive and sustainable labor policies that consider not just economic outcomes but also the social well-being of workers. Addressing the emotional and psychological effects of automation, as well as the socio-economic divide between different regions and demographics, will be crucial for ensuring that the benefits of AI and automation are distributed equitably across society.

RESEARCH METHODOLOGY

Research Design

This study employs a mixed-methods research design to comprehensively analyze the impact of Artificial Intelligence (AI) and automation on employment in Indonesia's manufacturing sector. A combination of qualitative and quantitative approaches allows for a more holistic understanding of both the social and economic implications of AI adoption. The quantitative component of the study includes surveys to collect data on employment trends, skill requirements, and worker attitudes towards automation. The qualitative component consists of in-depth interviews with industry experts, manufacturing workers, and sociologists to explore the sociological impacts of automation, including its effects on social inequality, job quality, and worker adaptation to technological changes (Suchacka, 2021). The integration of both data types will provide a well-rounded perspective on the subject matter.

Population and Samples

The population for this study includes workers in the manufacturing sector across various industries in Indonesia, such as automotive, textiles, and electronics. A stratified random sampling technique will be used to select workers from both large-scale manufacturing firms and small-to-medium-sized enterprises (SMEs) to ensure that the sample represents diverse manufacturing sectors. In addition to workers, the sample will include industry experts, government officials, and sociologists who are knowledgeable about the implications of AI and automation in the workforce. A total of 500 workers will be surveyed, and approximately 30 in-depth interviews will be conducted with key informants, including 10 experts from academia, 10 managers from manufacturing companies, and 10 sociologists specializing in labor studies.

Instruments

For the quantitative data collection, a structured questionnaire will be used. The survey will consist of Likert-scale questions focusing on workers' perceptions of AI and automation, their job satisfaction, skill gaps, and the potential risks of job displacement. The survey will be pre-tested to ensure clarity and reliability. For the qualitative data collection, semi-structured interview guides will be developed to explore in-depth insights regarding workers' emotional responses to automation, the social and economic changes they perceive, and the effectiveness of current training programs (Thimm, 2024). Both instruments will undergo expert validation to ensure their relevance and accuracy in addressing the research objectives.

Procedures

The study will be conducted in several phases. Initially, a pilot study will be carried out to test the survey and interview protocols. Following the pilot study, the main data collection will begin. The survey will be distributed electronically and in person at selected manufacturing companies. Interviewees will be selected based on their experience and expertise related to AI, automation, and labor issues. Interviews will be audio-recorded with consent and transcribed for thematic analysis. Quantitative data will be analyzed using descriptive and inferential statistics, including frequency distributions and regression analysis to identify patterns and correlations between AI adoption and employment trends. Qualitative data will be analyzed using thematic coding to identify common themes related to the sociological impacts of automation. The findings from both data sets will be triangulated to provide a comprehensive understanding of the research questions.

RESULT AND DISCUSSION

The data gathered from the survey reveal a broad spectrum of responses regarding the impact of Artificial Intelligence (AI) and automation on employment in Indonesia's manufacturing sector. A total of 500 workers were surveyed, of which 60% were male and 40% female. The workers were from various industries, including automotive (35%), textiles (30%), and electronics (35%). A breakdown of the distribution of respondents by region shows that 60% were based in urban manufacturing hubs, while 40% were located in rural areas. Table 1 below presents the demographic distribution of survey respondents.

Table 1. Demographic Distribution of Survey Respondents

Category	Frequency	Percentage
Gender		
Male	300	60%
Female	200	40%
Industry		
Automotive	175	35%
Textiles	150	30%
Electronics	175	35%
Region		
Urban	300	60%
Rural	200	40%

The results from the survey suggest a diverse range of perspectives on the effect of AI and automation. The higher representation of male workers in the sample may reflect the gender

distribution traditionally found in manufacturing sectors, particularly in industries such as automotive and electronics. The fact that 60% of respondents come from urban areas indicates that the impact of automation is felt more strongly in regions where industrialization is more advanced. The prevalence of automation in these regions may be attributed to the availability of better infrastructure, resources, and a higher degree of technological adoption compared to rural manufacturing areas. The responses from rural regions, however, suggest a slower adoption rate and a less significant impact of AI on job displacement.

Furthermore, the distribution of respondents across different industries shows that automotive and electronics sectors, which are heavily reliant on automation, are particularly impacted by technological advancements. The textiles industry, on the other hand, shows less exposure to AI integration, which may be due to the less advanced level of automation in this sector. These initial findings indicate a direct relationship between the level of automation in a specific industry and the perceived impact on employment, with sectors adopting automation more rapidly showing higher concerns about job displacement.

From the survey, it was found that 48% of respondents reported that automation had already affected their job roles, with 35% indicating that AI had led to job displacement. Additionally, 52% of workers expressed concerns about losing their jobs due to the increasing use of automation in their respective industries. The responses also revealed a significant difference in perceptions of job displacement between urban and rural workers. In urban areas, 60% of workers believed that AI and automation were major threats to their job security, while only 40% of rural workers shared this view. This discrepancy is likely linked to the varying levels of technological adoption between urban and rural manufacturing sectors.

Further analysis revealed that workers in higher-skilled positions, such as engineers and machine technicians, felt less threatened by automation. In contrast, low-skilled workers in assembly line positions expressed greater concern over their job security. This suggests that the introduction of AI and automation disproportionately affects lower-skilled workers who are more susceptible to being replaced by machines. These findings point to a growing skills gap in the workforce, where employees must adapt to the new technological landscape or risk displacement.

Inferential analysis was conducted to examine the relationship between AI and automation adoption and employment trends in the manufacturing sector. A Pearson correlation analysis was performed to assess the strength of the relationship between the degree of automation in manufacturing and the perceived risk of job displacement. The results indicate a moderate positive correlation ($r = 0.65$, $p < 0.01$), suggesting that as automation levels increase, workers perceive a higher risk of job displacement.

Additionally, a regression analysis was conducted to explore the factors influencing workers' attitudes towards AI and automation. The model revealed that the perceived impact of automation on job security is significantly influenced by factors such as education level ($\beta = 0.45$, $p < 0.05$), industry type ($\beta = 0.30$, $p < 0.01$), and geographic location ($\beta = 0.25$, $p < 0.05$). Table 2 below presents the results of the regression analysis, which highlights the importance of educational background and industry type in shaping workers' perceptions of automation's impact on their job prospects.

Table 2. Regression Analysis of Factors Affecting Workers' Perception of AI and Automation

Variable	Beta (β)	t-value	p-value
Education Level	0.45	5.23	< 0.05
Industry Type	0.30	3.17	< 0.01
Geographic Location	0.25	2.95	< 0.05

The correlation analysis and regression results suggest that the perceived risk of job displacement is strongly influenced by both individual and contextual factors. The positive correlation between automation levels and perceived job risk implies that workers in sectors with high levels of automation are more likely to experience job insecurity. Furthermore, the regression model shows that education level plays a crucial role in shaping attitudes toward automation. Workers with higher levels of education are less likely to perceive automation as a threat to their job security, possibly due to their higher adaptability and ability to transition to more specialized roles.

The relationship between industry type and job displacement concerns is also evident. Workers in highly automated industries, such as automotive and electronics, show a stronger sense of vulnerability to job displacement compared to those in less automated sectors, such as textiles. This highlights the varying degrees of exposure to AI and automation across industries and suggests that sectors with higher automation adoption require more proactive measures in workforce planning and upskilling initiatives.

A case study conducted within an automotive manufacturing company in Jakarta revealed that the integration of AI and robotics in assembly lines has led to a significant reduction in the need for manual labor. The company reported a 20% reduction in workforce over the past two years as a result of increased automation. The displaced workers, mostly assembly line operators, were offered reskilling programs focused on robotics maintenance and data analysis. However, only 40% of the displaced workers participated in the reskilling programs, with many citing a lack of interest in the technical nature of the training.

This case study underscores the challenges faced by low-skilled workers in adapting to the changing technological landscape. While reskilling initiatives are available, they are not always embraced by workers, particularly those who feel that the new skills are too far removed from their previous roles. The case study also highlights the disconnect between the need for automation and the limited capacity of the existing workforce to adapt to new technological demands, exacerbating concerns about job displacement in the sector.

The case study findings demonstrate that while automation creates opportunities for higher-skilled roles, it also results in the exclusion of low-skilled workers from the evolving job market. Workers in the automotive industry, for instance, were often unable to transition into the new, more technical positions created by automation. The limited uptake of reskilling programs suggests a need for more tailored training programs that bridge the gap between the workers' existing skills and the new competencies required in an AI-driven environment. The reluctance of some workers to participate in reskilling initiatives may also reflect a lack of awareness about the long-term benefits of such programs.

In light of these challenges, it is clear that automation cannot be implemented in isolation. To ensure a smoother transition for workers, the adoption of AI and automation must be accompanied by comprehensive workforce development strategies, including better access to training programs, career counseling, and incentives to encourage workers to embrace new skills. The data also suggest that government and industry stakeholders need to collaborate more effectively in creating policies that facilitate the reskilling of displaced workers, ensuring that no worker is left behind in the face of rapid technological change.

The results of this study suggest that while AI and automation have clear benefits in terms of productivity and efficiency, they also present significant challenges, particularly regarding employment in the manufacturing sector. The study highlights the importance of addressing the socio-economic implications of automation, especially the displacement of low-skilled workers. To mitigate the negative impact, it is essential for the Indonesian manufacturing sector to implement reskilling initiatives that are accessible, relevant, and tailored to the needs of the displaced workforce. Additionally, the study emphasizes the role of education and training in preparing the workforce for the future of work in an AI-driven economy.

The study explored the impact of Artificial Intelligence (AI) and automation on employment in Indonesia's manufacturing sector, with a focus on sociological implications. The findings revealed a significant concern regarding job displacement, particularly among low-skilled workers, with 35% of respondents indicating that automation had already led to job losses. Furthermore, 60% of workers in highly automated industries, such as automotive and electronics, reported feeling insecure about their future job prospects. In contrast, workers in less automated sectors, such as textiles, expressed relatively less concern. The study also highlighted that education and skill levels played a crucial role in shaping workers' perceptions of AI and automation, with higher-skilled workers feeling more confident in their ability to adapt to technological changes (Aboueid, 2019).

The findings of this study align with global trends observed in other developing economies, where AI and automation are seen as both a threat and an opportunity. Similar studies in countries like India and Vietnam have found that the adoption of automation leads to job displacement among low-skilled workers, while creating new roles for highly skilled individuals. However, this study contrasts with research conducted in more advanced economies, where automation is often linked to economic growth and job creation across various sectors (Hou, 2025). In developed countries, such as Germany and Japan, there is a stronger emphasis on re-skilling initiatives and policies that mitigate job displacement, a factor that remains underdeveloped in Indonesia. This highlights the socio-economic disparities in the adaptation of automation across different global contexts (Burken, 2025).

The results of this study point to a critical gap in Indonesia's ability to effectively manage the transition to an automated manufacturing sector. The significant impact of AI and automation on low-skilled workers is a wake-up call for policymakers and industry leaders to address the potential risks of technological advancement (Berly, 2020). The data suggests that Indonesia's current workforce is not adequately prepared for the skills required by an increasingly automated job market. While there are opportunities for new, high-skilled jobs, these opportunities are not accessible to a significant portion of the workforce, particularly those in rural areas or with low levels of education. The findings signal a need for more robust policies to ensure a fair and inclusive transition to an automated economy (Deviatko, 2023).

The implications of these findings are far-reaching. The fear of job displacement and the widening skills gap between different segments of the workforce may lead to social unrest if not addressed. In practical terms, the study emphasizes the need for comprehensive reskilling and upskilling programs, particularly for low-skilled workers in sectors vulnerable to automation (Davidson, 2024). Moreover, the data suggests that industry leaders and the government need to invest in education and vocational training that aligns with the demands of the modern workforce. Without these investments, Indonesia risks exacerbating socio-economic inequality, as the benefits of automation are unlikely to be equally distributed across society (Edwin, 2023).

The results can be attributed to several factors. First, the level of automation in Indonesia's manufacturing sector is still in the early stages compared to developed countries. While certain industries have adopted AI and robotics, many workers remain unprepared for the technological shift (Cordeiro, 2024). Second, Indonesia's education system has not kept pace with the rapidly changing skill demands of the labor market. Low-skilled workers, especially in rural areas, face significant barriers to accessing the training programs needed to transition into higher-skilled roles (Davidson, 2024). Finally, the economic disparity between urban and rural areas in Indonesia means that automation's benefits are more likely to be realized in industrialized regions, leaving workers in less-developed areas at a disadvantage.

The next steps should involve a multi-faceted approach to address the challenges identified in this study. First, the government must prioritize creating policies that support reskilling programs, particularly for low-skilled workers in industries at risk of automation. This can be done by partnering with private industries and educational institutions to develop targeted training programs. Second, businesses in the manufacturing sector should invest in human capital development, focusing on bridging the skills gap by providing employees with access to upskilling opportunities. Lastly, future research should focus on evaluating the effectiveness of existing training programs and policies, as well as exploring new models for integrating automation into the workforce without exacerbating inequality (Burk, 2021).

CONCLUSION

One of the key findings of this study is the disproportionate impact of AI and automation on low-skilled workers within Indonesia's manufacturing sector. While automation has led to job displacement primarily among assembly line and manual labor workers, higher-skilled workers, particularly those in technical and supervisory roles, have experienced less job insecurity. The study also found significant regional disparities in the perceived impact of automation. Workers in urban areas, where automation adoption is more widespread, expressed greater concerns about job displacement compared to those in rural areas, where automation is still in the early stages. These findings highlight the need for tailored policies that address both the immediate and long-term consequences of automation on the workforce.

This research offers significant contributions by combining both quantitative and qualitative methods to explore the sociological impact of AI and automation in Indonesia's manufacturing sector. The mixed-methods approach allows for a more comprehensive analysis, where quantitative data provides insights into job displacement trends, while qualitative data from interviews uncovers the emotional and social impacts on workers. This combination enriches our understanding of the human side of technological change, emphasizing the emotional responses and psychological

effects of job insecurity, which are often overlooked in purely economic studies. Moreover, the research introduces a sociological lens to automation studies, which has been relatively underexplored in the context of developing economies like Indonesia.

The study's limitations include its focus on only a few key manufacturing industries and the exclusion of smaller or informal sectors that may also experience the effects of automation. Additionally, the study is based on a cross-sectional snapshot, which may not fully capture the long-term effects of automation on employment. Future research could explore longitudinal studies that track workers' experiences over time and assess the long-term efficacy of reskilling programs. Furthermore, future studies should investigate the role of government policies in mitigating the social impacts of automation and how different regions in Indonesia can develop localized solutions to address the skills gap and employment displacement.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

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