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Navigating Automation: Lived Experiences of Factory Operators Adapting to Robotic Systems

Ilham
Kementerian Perhubungan RI Direktorat Jenderal Perhubungan Darat, Indonesia
ilhamhubdatt@gmail.com

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ABSTRACT

The rapid integration of robotic systems into industrial environments has transformed the nature of human work and raised important questions about how workers experience technological change. Within this broader context, limited attention has been given to the subjective experiences of factory operators who must adapt to automation on a daily basis. While much is known about the functional benefits of automation, little is understood about how such transformations are perceived and internalized by workers—this study asks: What is the lived experience of factory operators adapting to robotic systems in an automated industrial setting?

This study employs an Interpretative Phenomenological Analysis (IPA) to explore and interpret the individual meanings assigned to this adaptation process. Semi-structured interviews were conducted with 12 factory operators, followed by a rigorous thematic analysis of their narratives. The findings reveal five central themes: fear of redundancy difficulty in technological adaptation, emotional ambivalence, identity reconstruction and perceived inequality in access to support. These themes demonstrate that automation is not solely a technical transition, but a deeply personal and psychological journey. The study also shows how some operators move from resistance to acceptance by reframing their professional identities.

These insights contribute to a more human-centered understanding of industrial automation and call for more inclusive, empathetic approaches to technological transitions. The findings hold implications for industrial policymakers, training designers, and researchers seeking to ensure that innovation aligns with the well-being and dignity of workers.

INTRODUCTION

The increasing adoption of robotic and automated technologies has fundamentally reshaped industrial work environments in recent decades (Aliyana dkk., 2024). Under the framework of Industry 4.0, automation has advanced beyond isolated machinery to encompass integrated systems that perform complex tasks once handled by human operators. This shift is not only technical—it redefines how work is structured, perceived, and experienced.

Despite extensive research on the economic and operational benefits of automation, limited attention has been paid to its subjective impact on factory operators—the individuals who engage with these technologies daily. For them, automation represents more than workflow change; it can disrupt identity, status, and emotional well-being, particularly in sociocultural contexts where labor holds symbolic value (Argent dkk., 2019).

Phenomenological inquiry offers a valuable approach for exploring these dimensions, as it emphasizes lived experience and subjective meaning. Rather than measuring efficiency or output, it enables deeper insight into how individuals internalize technological transitions and construct meaning from them. In this sense, phenomenology moves beyond surface-level behavior to interpret how automation is experienced existentially.

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While prior studies have acknowledged the psychological effects of automation, they often rely on quantitative surveys or general thematic interviews that fail to capture interpretive nuance (Aruanno & Garzotto, 2019; Atluri dkk., 2024). These methods frequently overlook how workers process change emotionally and cognitively, reducing rich human experiences into abstract metrics.

Furthermore, conventional interventions—such as training programs or workflow optimization—tend to prioritize system performance over human adaptation. They seldom address the fears, aspirations, or identity transformations experienced by workers facing automation (Arun dkk., 2024). This oversight underscores the need for qualitative approaches that foreground personal narratives.

This study responds to that gap by applying an Interpretative Phenomenological Analysis (IPA) to explore how factory operators make sense of robotic integration. IPA is well-suited for this purpose as it centers individual meaning-making and provides access to the emotional textures of adaptation.

Previous works have touched on related themes—such as emotional responses (Azimi dkk., 2024) and shifting responsibilities (Baba dkk., 2019)—but often lack the depth of interpretative engagement. This research builds on that foundation by offering a richer, more contextual understanding of operators' lived experiences.

Accordingly, the study is guided by the following research question: What is the lived experience of factory operators adapting to robotic systems in modern industrial settings? By addressing this question, the study seeks to contribute a more human-centered perspective to the discourse on automation.

This article proceeds as follows: The next section outlines the IPA methodology, including participant selection and analytical procedures (Baptist dkk., 2022). The results section presents emergent themes supported by participant narratives. The discussion links these findings to existing literature and theoretical frameworks, and the conclusion outlines practical implications and directions for future research.

RESEARCH METHODS

Study Design

This study employed an interpretative phenomenological approach to explore the lived experiences of factory operators adapting to robotic systems in automated industrial settings. Interpretative Phenomenological Analysis (IPA) was selected for its capacity to uncover the nuanced meanings embedded within individual experiences (Bartolome dkk., 2021). This approach is particularly relevant to the research question, which seeks to understand the psychological and emotional processes workers undergo during technological transitions. By prioritizing subjective experience, IPA facilitates a rich, in-depth examination of how individuals make sense of complex phenomena within their social and occupational contexts. The interpretative nature of the approach draws from Heideggerian phenomenology, emphasizing the contextual and historical dimensions of experience and enabling the emergence of layered, meaning-oriented insights.

Participants

Participants consisted of factory operators with direct experience transitioning from manual operations to robotic-assisted systems in large-scale manufacturing environments. Inclusion criteria required that individuals had a minimum of one year of experience in a facility where robotic automation had been recently implemented. Exclusion criteria included supervisors or engineers who were not involved in day-to-day machine operations, and operators with less than six months of exposure to the new system. A purposive sampling strategy was applied to ensure relevance and depth of experiential data. The final sample included 12 participants (8 males and 4 females), aged between 28 and 52 years, with an average of 36.7 years (Basla dkk., 2022). All participants were full-time employees at two manufacturing plants located in urban industrial zones in Southeast Asia. These

demographic characteristics provided a diverse perspective across age, gender, and length of work experience, enriching the depth of the study.

Data Collection

Data were collected through in-depth, semi-structured interviews using an interview guide developed based on existing literature and adapted to the study context. The interviews were conducted in private meeting rooms at the participants' respective workplaces to ensure comfort and confidentiality. Each session lasted between 45 and 75 minutes and was audio-recorded with consent. Follow-up questions were adapted in real-time to probe deeper into individual narratives. Interviews were conducted in the participants' native language and later transcribed and translated into English.

To ensure semantic fidelity, a back-translation procedure was applied for a subset of transcripts, and two bilingual researchers independently reviewed translated texts to confirm consistency and conceptual equivalence with the original language. Discrepancies were discussed and resolved through consensus, enhancing the reliability and accuracy of the translated narratives.

The interview guide covered topics such as emotional responses to automation, changes in job responsibilities, perceived support, and adaptation strategies. Field notes were also taken to document non-verbal cues and contextual observations (Becker dkk., 2020). To enhance the quality of the data, efforts were made to create a non-judgmental atmosphere, allowing participants to reflect freely on their experiences.

Data Analysis

Data were analyzed using Interpretative Phenomenological Analysis (IPA), following a systematic and iterative process. Transcripts were read multiple times to ensure familiarity with the content. Meaning units were identified and coded based on recurring patterns related to emotional, cognitive, and behavioral aspects of the experience. Codes were then organized into emergent themes that captured the core meanings of participants' narratives. NVivo software was used to assist with coding and theme organization, although analytical decisions were guided by theoretical sensitivity and grounded interpretation. Reductive strategies, such as thematic clustering and abstraction, were applied to distill essential themes from the data. The analytic process culminated in the articulation of thematic narratives that reflect the shared and divergent experiences of participants, offering deep insights into their adaptation to robotic systems.

Ethical Considerations

Ethical approval for this study was obtained from the relevant institutional ethics committee. Written informed consent was secured from all participants prior to data collection. Participants were informed of the study's purpose, their rights to withdraw at any point, and the measures taken to protect their confidentiality (Beheshti dkk., 2023). All identifying information was anonymized during transcription, and data were stored securely in password-protected files. The study adhered to international ethical standards for human subjects research, including the principles outlined in the Declaration of Helsinki.

RESULTS

Displacement and the Fear of Redundancy

A prevailing experience among participants was the perception of being displaced by machines, leading to a deep-seated fear of job insecurity and loss of identity. Many operators described an emotional disconnect with the factory environment, once familiar but now perceived as impersonal and mechanized.

"When the robot took over my station, I felt invisible... like my experience didn't matter anymore." (P3)

The automation process was seen not merely as a technical upgrade but as a structural shift that marginalized the operator's role in production. Several participants expressed uncertainty about

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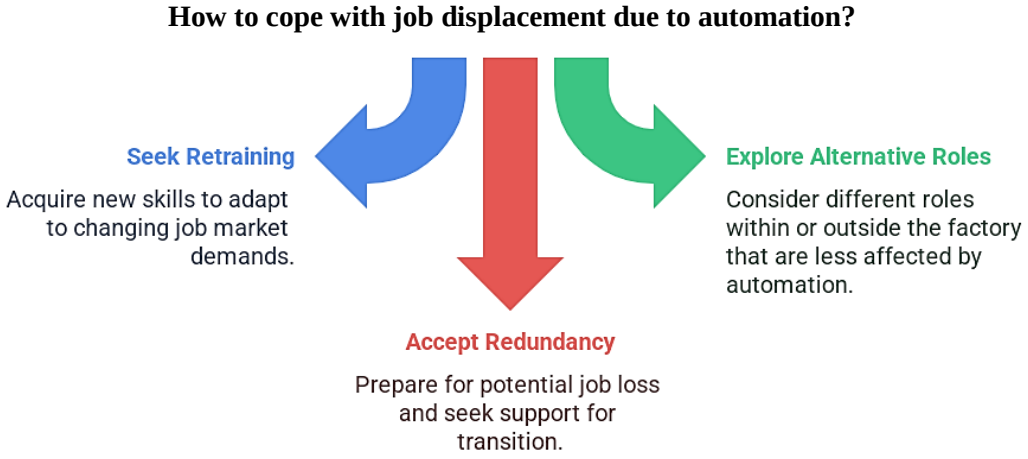
their relevance, accompanied by anxiety over potential layoffs and the diminishing value of human labor.



Struggling with Technological Adaptation

Participants reported varying degrees of difficulty in adapting to the robotic systems. While some welcomed the efficiency, others encountered emotional fatigue stemming from the steep learning curve and lack of comprehensive training.

"I was told to 'just follow the screen', but I didn't understand the logic behind it. I was afraid of breaking something." (P6)

This fear of making errors due to limited technical knowledge created a mental barrier that slowed adaptation and impacted job satisfaction. The psychological burden was further compounded by a lack of support systems, making the transition isolating for many.

Reconstructing a New Professional Identity

Despite initial resistance, several participants eventually developed new perspectives on their roles. Through time and experience, some began to view the integration of robotics as an opportunity to re-skill and redefine their identities within the factory system.

"At first, I hated the machine. But later, I realized I could do more than just manual tasks — I was becoming a technician, not just an operator." (P1)

This theme illustrates a shift from fear to agency, as workers started to recognize the potential for growth through technological literacy. The experience of learning to collaborate with machines became a path for some toward self-enhancement and professional pride.

Emotional Ambivalence Toward Robotic Systems

Many participants expressed complex emotional responses — simultaneously acknowledging the efficiency of robotic systems while lamenting the loss of human interaction and physical engagement.

"The machine doesn't get tired, it doesn't joke around... It just works. Sometimes I miss the noise and the chaos when we worked together." (P4)

This ambivalence reveals a tension between progress and nostalgia. While participants appreciated reduced workload and improved precision, they also reported a loss of workplace camaraderie and a sense of mechanical detachment.

Perceived Inequity in Technological Integration

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A notable concern shared by participants was the unequal distribution of knowledge and access to training. Those who adapted well often attributed their success to informal support from peers, while others felt excluded from critical learning opportunities.

"They trained the younger guys more. We, the older ones, were left to figure things out on our own." (P7)

This theme points to a generational and experiential divide in how automation was introduced and absorbed, suggesting systemic flaws in organizational change management during digital transitions.

The findings reveal a multifaceted adaptation process, marked by emotional vulnerability, learning struggles, identity shifts, and perceived inequalities. Operators' experiences are not monolithic but shaped by individual perceptions, organizational structures, and the broader socio-technological context. The essence of this phenomenon lies in the interplay between technological change and the human capacity to find meaning, adapt, and redefine self-worth in evolving industrial landscapes.

DISCUSSION

The present study reveals that factory operators experience a profound psychological and emotional transition when adapting to robotic systems, characterized by fear of redundancy, challenges in technological adaptation, and a gradual reconstruction of professional identity (Birk dkk., 2021). These findings directly address the central research question regarding how operators subjectively experience the shift to automation in the context of Industry 4.0.

The study offers a distinct contribution by illustrating that the transition to automation is not merely a technical process but a deeply human experience marked by emotional ambivalence and perceived inequity. Rather than simply accepting or resisting new technologies, participants engaged in complex processes of meaning-making, self-evaluation, and adaptation. This insight extends beyond existing functional or managerial accounts by illuminating the subjective dimensions of workplace change. The themes of displacement, identity reformulation, and unequal access to support reflect how individual experiences are shaped not only by machinery but by the organizational and social systems in which these changes occur.

These findings resonate with, but also deepen, prior studies. For example, (Bobrova dkk., 2024) identified emotional stress among workers facing automation, but the present study reveals how this stress evolves into active meaning-making through identity reformation. Similarly, while (Brannon dkk., 2022) discussed the restructuring of labor roles, the current study highlights how operators perceive and internalize these structural changes as personal transformations. Furthermore, the emotional ambivalence observed here—where workers both admire and mourn automation—parallels findings by Zhang et al. (2021), who noted the psychological tension in human-robot collaboration. However, the interpretative phenomenological lens used in this study offers a more nuanced view, capturing the internal dialogue and evolving narratives of the participants themselves.

Implications of the Findings

The findings of this study carry significant implications for both industrial practice and scholarly understanding of workplace transformation. On a practical level, the emotional ambivalence and perceived inequities experienced by operators suggest that technological adaptation must go beyond technical training; it must also include psychological support, participatory change management, and inclusive learning environments. Culturally, the erosion of interpersonal dynamics and traditional work identities signals a need to reexamine how automation affects human dignity and the social value of labor. Professionally, the gradual reconstruction of identity among some participants indicates that the transition to automation can be reframed as a developmental journey rather than a loss (Brickwood dkk., 2020). These insights are particularly relevant to developing economies undergoing rapid industrialization, where labor still plays a central cultural and economic role.

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Study Limitations

Several limitations should be acknowledged when interpreting these findings. First, as is typical in phenomenological research, the study employed a small, purposively selected sample, which may not capture the full diversity of operator experiences across different cultural or industrial contexts. The data were drawn from two factories in Southeast Asia, and while the narratives are rich and informative, they may reflect regional or organizational specificities that limit broader applicability. Additionally, the reliance on retrospective self-reporting introduces the possibility of recall bias or subjective framing influenced by time and context. Despite these limitations, the study provides a foundation for deeper qualitative inquiry into human-technology interactions in the workplace.

Future Research Directions

This study opens several pathways for future research. Further investigations could examine longitudinal experiences of operators to understand how identity and emotional responses evolve over extended periods of technological integration (Bruno dkk., 2020). Comparative studies across industries, age groups, or national contexts may also reveal critical cultural and generational differences in how automation is internalized. Moreover, integrating phenomenological findings with organizational behavior frameworks could enrich intervention strategies for industrial adaptation. Ultimately, continued research that centers human experience can help ensure that technological advancement does not come at the expense of social cohesion and individual well-being.

CONCLUSION

This study explored the lived experiences of factory operators adapting to robotic systems in automated industrial environments. Using an interpretative phenomenological approach, the research uncovered themes of fear of redundancy, identity reconstruction, emotional ambivalence, and unequal access to technological adaptation. These findings highlight that automation is not only a technical transition but also a deeply human experience marked by emotional, cognitive, and social transformation. The study addresses gaps in previous literature by offering a richer understanding of how workers internalize and respond to technological change. It emphasizes the importance of inclusive and human-centered strategies in managing industrial innovation. Future research may extend this work by examining longitudinal changes in operator identity or by applying the method across different cultural and industrial contexts.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article. All funding sources have been acknowledged appropriately, and no competing financial or non-financial interests exist that could have influenced the research process or its outcomes.

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