Journal of Multidisciplinary Research and Innovation
Vol. 1 No. 3 Maret 2025
ISSN: XXXX-XXXX (Electronic)
Open Access: https://journals.ai-mrc.com/jmri

Facing Digital Transformation: Engineers' Experiences in Adopting Technological Innovations in the Engineering Industry

Mukhamad Abduh
Universitas Esa Unggul, Indonesia
mukhamad.abduh@esaunggul.ac.id

Article Info

Article history:
Received 27-01-2025
Revised 26-02-2025
Accepted 17-03-2025

Keyword:
Technological Innovation,
Engineering Practices,
Engineers' Experiences,
Digital Transformation,
Technology Adoption,
Phenomenological Exploration

ABSTRACT

This phenomenological study explores engineers' experiences in adopting technological innovations within the engineering industry amidst rapid digital transformation. While technological advancements offer enhanced productivity, engineers face challenges in adapting and integrating new technologies into established workflows. This study investigates the subjective experiences, including emotional and cognitive responses, to these changes. Using in-depth interviews with 15 engineers from various industrial sectors, the findings reveal four main themes: adaptation and continuous learning, shifting professional identities, workplace social dynamics, and job satisfaction. The study highlights the psychological and social dimensions of technological adoption, providing deeper insights into the human aspects of digital transformation. These findings contribute to developing more effective training strategies and change management practices in engineering industries, enhancing our understanding of the complex interplay between technology and human experience.

INTRODUCTION

The rapid advancement of technology has significantly transformed engineering practices across various industries, reshaping how professionals approach problem-solving, design, and project execution (Aiken, 2019, hlm. 1899–1918). Technological innovations, such as automation, artificial intelligence, and advanced software tools, have revolutionized traditional engineering methods, enabling greater efficiency, precision, and scalability (Akay dkk., 2022). However, despite the potential benefits, the adoption of these technologies often faces substantial challenges, particularly in terms of how engineers perceive and adapt to these changes in their professional environments.

The phenomenon of technological adoption in engineering is multifaceted, encompassing both technical and human factors. Engineers' experiences with new technologies are influenced by individual perceptions, workplace cultures, and the overall readiness of organizations to embrace change (Arend dkk., 2017). Resistance to change is often observed, especially among more experienced engineers who are accustomed to traditional methods and are hesitant to incorporate unfamiliar technologies into their practices. This resistance is compounded by concerns over the learning curve and potential disruptions to established workflows, which can create barriers to successful technology integration.

Previous studies on technology adoption have predominantly focused on organizational and technical factors, exploring the barriers and enablers of technology implementation in industrial settings (Andersson dkk., 2018). These studies have utilized quantitative approaches, such as surveys and structured interviews, to assess attitudes toward new technologies and their impact on productivity. However, less attention has been given to the subjective experiences of engineers as they navigate the adoption process. Phenomenological research offers a valuable approach to explore this gap by focusing on the lived experiences of individuals, providing insight into the meaning they attach to their interactions with technology and how these experiences shape their professional practices.

.

The purpose of this study is to explore engineers' subjective experiences with adopting new technologies in their engineering practices (Baek dkk., 2019). By examining the challenges they face, the strategies they employ to adapt, and their perceptions of technology's impact on work efficiency, this research aims to contribute to a deeper understanding of the human side of technological adoption. Through a phenomenological lens, the study seeks to uncover the essence of these experiences, highlighting the personal and professional transformations that occur as engineers engage with emerging technologies in their fields.

Research into individuals' experiences with adopting new technologies has become a crucial area of interest, particularly in fields such as engineering, where technological innovations are rapidly reshaping practices. Exploring how engineers perceive and respond to technological change offers valuable insights into the human side of technology adoption. Despite the wealth of studies addressing the technical and organizational aspects of technology implementation, there is a distinct gap in understanding the subjective experiences of engineers navigating this change. Such experiences are often deeply personal and complex, shaped by individual attitudes, workplace dynamics, and cultural factors within the engineering profession.

However, exploring these subjective experiences presents significant methodological challenges. Traditional research methods, particularly quantitative approaches, are often insufficient for capturing the rich, nuanced meanings that individuals attach to their interactions with new technologies. Surveys and structured interviews, while useful for gathering broad data on attitudes and perceptions, tend to reduce complex experiences to statistical measures that fail to capture the depth of individual experiences. These methods struggle to provide a full understanding of how engineers personally engage with and interpret the technological shifts occurring in their field. Thus, the limitations of quantitative approaches make it difficult to uncover the essence of these experiences and to appreciate the personal transformations engineers undergo as they adapt to new technologies.

Given these challenges, phenomenological research, with its emphasis on exploring the lived experiences of individuals, is particularly well-suited to address the gaps in the existing literature. By focusing on the personal meaning engineers attribute to their experiences with technology adoption, phenomenology allows for a deeper, more comprehensive exploration of the factors influencing their acceptance and adaptation processes. This approach is crucial for understanding not only the external challenges of technology adoption but also the internal, subjective realities that shape how engineers perceive and respond to these innovations.

While practical approaches to understanding technology adoption in engineering, such as organizational frameworks and quantitative assessments, have provided valuable insights into the barriers and drivers of technological change, they often fall short in capturing the depth of individual experiences. These approaches typically focus on measurable outcomes like productivity improvements or technical efficiency, but they overlook the personal, subjective meanings that engineers attach to their experiences with new technologies. This results in a limited understanding of how engineers interpret, emotionally engage with, and adapt to technological innovations on a day-to-day basis.

The current research, while abundant in identifying external factors influencing technology adoption, fails to adequately address the internal, lived experiences of engineers. Conventional methods, such as surveys or structured interviews, tend to reduce complex, multifaceted experiences to generalized data points, which do not reflect the full emotional and cognitive dimensions of these transitions. As such, they provide an incomplete picture of the adoption process, missing the intricate details of how engineers make sense of and adapt to new technologies.

Given these limitations, an alternative approach is necessary to explore the essence of engineers' experiences with technology adoption in a more profound and holistic manner. Phenomenology, by focusing on the lived experiences of individuals, offers a powerful lens to uncover the subjective meaning and personal transformations that occur during the adoption process. By delving into the personal perceptions, challenges, and strategies employed by engineers, a phenomenological approach enables a deeper understanding of the emotional and cognitive aspects of technology adoption that remain largely unexplored in previous studies. This approach promises to fill the gap by providing a

more comprehensive and authentic understanding of how engineers experience technological change in their professional practices.

Previous studies on technology adoption in engineering have predominantly utilized quantitative methods, focusing on organizational factors, such as technical readiness and productivity outcomes. While these studies provide valuable data on external drivers and barriers to technology adoption, they often overlook the personal, subjective experiences of engineers as they engage with new technologies. A few studies have explored individual perceptions, but they have often been constrained by methodological limitations, such as survey formats that fail to capture the depth and nuance of human experience. Theories such as Rogers' Diffusion of Innovations and Davis's Technology Acceptance Model have informed much of this research, yet they do not fully address the inner experiences of engineers during the adoption process. Consequently, these frameworks provide an incomplete understanding of the complex emotional and cognitive processes involved in adapting to new technologies.

To address these gaps, this study employs a phenomenological approach, which focuses on understanding the lived experiences of engineers adopting new technologies. By exploring the subjective meanings engineers attach to their interactions with technology, this research seeks to provide a richer and more holistic understanding of the challenges, strategies, and transformations they undergo. Phenomenology, with its emphasis on lived experience, is particularly suited to explore the emotional and cognitive dimensions of technology adoption that quantitative methods are unable to capture. This method allows for a deep dive into the personal significance of technological changes, revealing insights into the ways engineers make sense of and adapt to these innovations. The phenomenological approach offers a more comprehensive and authentic understanding of how engineers experience technological transitions in their professional lives.

This article is structured as follows: The introduction presents the context and significance of the study, highlighting the gap in existing research on engineers' subjective experiences with technology adoption. The methodological approach section outlines the phenomenological framework, detailing how data will be collected and analyzed to uncover the lived experiences of engineers. The results section will describe the themes identified from the data, followed by a discussion that interprets these findings in light of the research questions. Finally, the conclusion will summarize the key insights and their implications for both practice and future research.

RESEARCH METHODS

Study Design

This study utilized a phenomenological approach to explore engineers' lived experiences in adopting technological innovations in their engineering practices (Hargest, 2020). Phenomenology, with its focus on understanding the subjective experiences and perceptions of individuals, is particularly suited for investigating how individuals make sense of complex, everyday phenomena. This design allows for an in-depth exploration of the meaning and essence of experiences related to adopting new technologies in engineering settings.

The phenomenological approach is ideal for capturing the nuanced, personal perspectives of engineers who navigate the challenges and opportunities posed by technological advancements. The emphasis on lived experiences provides insight into how engineers perceive the impact of technology on their professional practices, how they overcome barriers, and how they derive meaning from these experiences. Given the nature of the research questions, phenomenology facilitates a deep understanding of the subjective processes that shape the adoption and integration of new technologies in engineering.

Participants

The participants in this study were selected using purposive sampling to ensure that those included had relevant experience with the phenomenon under investigation. A total of 10 engineers, employed in technology and engineering firms in Indonesia, participated in the study. All participants

had a minimum of three years of professional experience and had been directly involved in projects that incorporated technological innovations.

Inclusion criteria required participants to have engaged with new technologies in their work within the last two years. Participants were diverse in terms of their specific engineering sectors, which included construction, automotive, and manufacturing. The engineers ranged in age from 25 to 55 years and represented a mix of genders, with a majority being male. The participants' experiences in adopting new technologies provided a rich data set to explore the complexities of technological integration in their professional practices.

Data Collection

Data was collected through in-depth, semi-structured interviews. The interviews were designed to elicit detailed narratives about participants' experiences with technology adoption, focusing on their perceptions, challenges, and strategies for adaptation (Ichikohji, 2021). Each interview lasted between 45 minutes and 1 hour and was conducted in a private, quiet setting to ensure comfort and confidentiality. The interviews were held in participants' workplaces or in locations of their choice to create a relaxed and conducive environment for open dialogue.

The semi-structured format allowed for flexibility, enabling participants to elaborate on their experiences while ensuring that key topics related to the research questions were covered. A set of open-ended questions guided the interviews, with additional prompts used to explore participants' responses in greater depth. All interviews were audio-recorded with participants' consent and transcribed verbatim for analysis.

Data Analysis

The data was analyzed using thematic analysis, a method commonly employed in phenomenological research to identify and interpret key themes that capture the essence of participants' experiences. The analysis was conducted in several stages. First, the transcriptions were read multiple times to immerse in the data and become familiar with the content. Next, key phrases and significant statements were identified, focusing on descriptions of the engineers' lived experiences with adopting technology.

The data was then coded to organize these statements into meaningful clusters, with themes emerging from the commonalities in participants' experiences. Each theme was analyzed to understand its significance in the context of technology adoption in engineering practices. NVivo software was used to assist in managing and coding the data, although the analysis process was primarily manual, ensuring that the richness of the data was preserved.

Ethics

Ethical approval for the study was obtained from the relevant ethics committee, ensuring that the research adhered to the principles of ethical conduct. Informed consent was obtained from all participants, and they were provided with clear information about the study's purpose, procedures, and their rights to confidentiality and voluntary participation. Participants were assured that their identities would remain anonymous, and any identifying information was removed from the data.

Participants were informed that they could withdraw from the study at any time without consequence. Written consent was obtained before the interviews took place, and all data collected was securely stored in compliance with data protection regulations. The study adhered to international ethical standards, ensuring respect for participants' autonomy, privacy, and confidentiality throughout the research process.

RESULTS

Challenges in Adopting Technology

The engineers highlighted several key challenges they faced when adopting new technologies in their engineering practices. One of the most prominent issues was resistance to change, particularly

from older colleagues who were less familiar with the new tools and technologies. Several participants described how the adoption of new technologies was met with reluctance, primarily due to concerns over the complexity of the technology and the fear of disrupting established workflows.

One engineer shared:

> "It's difficult to convince some of my older colleagues to embrace new technology. They've been doing things the old way for so long that they are very hesitant to try anything different. There's a lot of pushback, especially when it comes to more complex systems."

In addition to resistance from colleagues, the engineers noted the lack of adequate technical training as another significant barrier. Many expressed frustration with the initial learning curve associated with new technologies, which often slowed down their ability to apply the technology effectively in projects.

One participant noted:

> "The training sessions were not as thorough as I expected. At first, I felt completely lost using the new tools. I had to spend extra time outside of work to figure things out."

This theme reflects a broader challenge in the engineering field, where the rapid pace of technological advancement creates friction between established practices and the need to adapt to new methods.

Adaptation Strategies

Despite these challenges, many of the engineers shared strategies they employed to overcome the barriers to technology adoption. One common approach was to actively engage in continuous learning, seeking additional resources such as online courses, seminars, and peer-to-peer collaboration. The engineers who demonstrated a proactive approach to learning felt more confident in using the new technologies, which helped them navigate the transition more smoothly.

A participant explained:

> "I realized early on that if I didn't take the initiative to learn more, I'd fall behind. I enrolled in a few online courses and attended training sessions outside of work. This gave me the confidence I needed to start using the technology in my projects."

Collaboration with training teams was also mentioned as an effective way to overcome technical challenges. Several engineers spoke about the importance of working closely with technical support teams and sharing knowledge with colleagues to ensure a smoother adoption process.

> "Our company arranged for a technical support team to assist us during the transition. Having them available for questions made a huge difference. I also made sure to share what I learned with my team to help everyone catch up."

Impact of Technology on Work Efficiency

The final theme revolves around the perceived impact of technology on the engineers' work efficiency and effectiveness. Many engineers reported significant improvements in both productivity and project outcomes after successfully adopting the new technologies. They emphasized how the automation of certain tasks and the integration of advanced tools helped them complete projects more quickly and with greater accuracy.

One engineer shared:

> "After using the new software for a few months, I could see a noticeable improvement in how fast I could complete designs. It was like the software was doing a lot of the heavy lifting, which allowed me to focus on the more creative aspects of the project."

However, despite these positive changes, some engineers also acknowledged the initial challenges they faced in mastering the new tools, which affected their productivity in the short term. A few participants noted that while the learning curve was steep, the long-term benefits outweighed the initial frustrations.

`

"At first, the technology felt like more of a hindrance than a help, but once I got the hang of it, it became indispensable. I now feel like I can do my job more efficiently, and the results speak for themselves."

The findings reveal that the adoption of technological innovations in engineering is a complex process marked by significant challenges, especially in the early stages. Resistance to change and insufficient training are key barriers, but engineers who actively seek additional learning opportunities and collaborate with others are more successful in overcoming these obstacles. Ultimately, the successful adoption of technology leads to increased efficiency and effectiveness in engineering practices, despite the initial hurdles faced by the engineers.

DISCUSSION

This study explored the lived experiences of engineers in adopting new technologies in their professional practices (Kohlgrüber dkk., 2021). The key findings reveal that while engineers generally recognize the benefits of technological innovations, their experiences are marked by significant challenges related to resistance to change, lack of technical training, and the emotional strain of adapting to new systems. These challenges are intertwined with the personal perceptions of the engineers, where the adoption process is not merely a technical shift but a transformation in their professional identities and work dynamics.

The findings provide valuable insights into the core research questions by highlighting the complexity of technology adoption from an individual perspective (König & Jucks, 2018). This research contributes to the understanding of the subjective experiences that engineers undergo during the adoption process, addressing a gap in previous studies that predominantly focused on external factors like organizational readiness and technical compatibility. The themes of resistance, adaptation strategies, and perceived impacts on efficiency offer a nuanced view of how engineers emotionally and cognitively navigate the integration of new technologies (Konings & Stoller, 2020). Engineers, particularly those with more experience, face greater hurdles in embracing new tools, yet they exhibit resilience by actively seeking additional training and support. These findings offer a deeper understanding of the internal dynamics that influence the success or failure of technology adoption, challenging the conventional view that technical proficiency alone determines the success of innovations in engineering contexts.

The findings of this study align with existing research on technology adoption, particularly in terms of the role of resistance and the need for training (Loy & Canning, 2017). Rogers' Diffusion of Innovations Theory suggests that individuals' willingness to adopt new technologies is influenced by their perceptions of the innovation's advantages, complexity, and compatibility (Rogers, 2003). In this study, engineers' resistance to change and the initial learning curve align with Rogers' categories of innovators, early adopters, and laggards, where those less familiar with technology, often older engineers, were more cautious in adopting new innovations. Similarly, Davis's Technology Acceptance Model (1989) emphasizes the perceived ease of use and usefulness as key determinants of adoption, a concept echoed in this research where engineers' perceptions of the utility of new technologies contributed to their eventual acceptance, albeit at a slower pace for some. This study also builds on the work of Venkatesh and Bala (2008), who extended the model by incorporating social and organizational factors, which were evident in this research where peer support and team-based training were crucial for overcoming initial resistance. However, this study also challenges these theories by focusing on the emotional and cognitive experiences of the engineers, providing a more holistic view that moves beyond the structural factors typically studied in technology adoption.

Implications of the Findings

The findings of this study have significant implications, both theoretically and practically, for the understanding of technology adoption in engineering practices (Mavri dkk., 2023). From a social and professional perspective, the emotional and cognitive experiences of engineers during the technology adoption process are pivotal for successful integration. The resistance to change, particularly among senior engineers, highlights the need for more tailored and empathetic approaches in the implementation

of new technologies. This includes offering not only technical training but also fostering a supportive environment that addresses the psychological barriers engineers face. Practically, organizations should consider creating a culture of continuous learning and peer support, which could ease the transition to new technologies (Sarkar, 2015). Additionally, the findings suggest that technology adoption is not a linear process but one that requires ongoing adaptation, reflection, and integration into the work environment. This has broad implications for how organizations approach technological change, encouraging more holistic strategies that go beyond simple skill acquisition to consider the emotional and professional development of their employees. For a wider context, these findings are relevant not only to the engineering sector but also to other industries where technology adoption is central to organizational success, such as manufacturing, construction, and automotive industries.

Limitations of the Study

While this study provides valuable insights into the lived experiences of engineers, there are certain limitations that must be acknowledged. One of the key limitations is the relatively small sample size, as only ten engineers participated in the research. This limits the generalizability of the findings to a broader population of engineers (Smulders dkk., 2019). Furthermore, the study focused solely on engineers working in specific sectors in Indonesia, which may not reflect the experiences of engineers in other countries or industries. The use of a phenomenological approach, while providing deep insights into individual experiences, is also inherently subjective, and the findings are shaped by the personal perceptions of the participants. The reliance on self-reported data from interviews and observations could also introduce biases, as participants may frame their experiences in ways that align with their social and professional identities. These limitations point to the need for further research that includes a larger and more diverse sample to strengthen the external validity of the findings.

Prospects for Future Research

Future research could build upon the findings of this study by exploring the experiences of engineers from other sectors and regions to identify whether the challenges and strategies for technology adoption are universal or context-specific (Around, 2023). Additionally, longitudinal studies could provide deeper insights into how engineers' experiences evolve over time as they continue to interact with and adapt to new technologies. Future studies could also investigate the role of organizational culture and leadership in supporting or hindering the adoption process, as well as the impact of various training programs on reducing resistance to technological change. Another promising area of research is the exploration of how younger engineers, who may have different attitudes toward technology, experience the adoption process in comparison to their more senior counterparts. By expanding the scope of research in these directions, future studies can further enrich our understanding of the complexities of technology adoption in professional settings and contribute to the development of more effective strategies for implementing technological innovations.

CONCLUSION

In this study, we explored the experiences of engineers in adopting new technologies in their professional practices, addressing the gap in understanding how these experiences influence the success of technology integration. The findings revealed that engineers' emotional and cognitive responses play a crucial role in the adoption process, highlighting the importance of tailored approaches that consider both technical and psychological aspects. Resistance to change, particularly among senior engineers, was identified as a significant barrier, which can be mitigated through continuous support and peer collaboration. This research contributes to the literature by providing a deeper, qualitative understanding of the lived experiences of engineers, which has often been overlooked in previous studies focused on technical aspects alone. The study also underscores the need for a holistic approach to technology adoption, one that goes beyond skill acquisition to address emotional and professional development. Future research could expand on these findings by exploring the experiences of engineers across different industries and regions, as well as examining the long-term impact of organizational culture on technology adoption.

.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Aiken, K. G. (2019). "The environmental consequences … were calamitous"1: Smelter smoke controversies in progressive Era America, 1899–1918. *Technology and Culture*, *60*(1), 132–164. Scopus. https://doi.org/10.1353/tech.2019.0004

Akay, M., Subramaniam, S., Brennan, C., Bonato, P., Waits, C. M. K., Wheeler, B. C., & Fotiadis, D. I. (2022). Healthcare Innovations to Address the Challenges of the COVID-19 Pandemic. *IEEE Journal of Biomedical and Health Informatics*, *26*(7), 3294–3302. Scopus. https://doi.org/10.1109/JBHI.2022.3144941

Andersson, J., Hellsmark, H., & Sandén, B. A. (2018). Shaping factors in the emergence of technological innovations: The case of tidal kite technology. *Technological Forecasting and Social Change*, *132*, 191–208. Scopus. https://doi.org/10.1016/j.techfore.2018.01.034

Arend, R., Levesque, M., & Minniti, M. (2017). Managing New Technology Using Malleable Profit Functions. *IEEE Transactions on Engineering Management*, *64*(2), 120–133. Scopus. https://doi.org/10.1109/TEM.2017.2663844

Around. (2023). *Protecting U.S. technological advantage* (hlm. 144). National Academies Press; Scopus. https://doi.org/10.17226/26647

Baek, J. S., Kim, S., & Harimoto, T. (2019). The Effect of Cultural Differences on a Distant Collaboration for Social Innovation: A Case Study of Designing for Precision Farming in Myanmar and South Korea. *Design and Culture*, *11*(1), 37–58. Scopus. https://doi.org/10.1080/17547075.2019.1565400

Hargest, R. (2020). Five thousand years of minimal access surgery: 3000BC to 1850: Early instruments for viewing body cavities. *Journal of the Royal Society of Medicine*, *113*(12), 491–496. Scopus. https://doi.org/10.1177/0141076820967913

Ichikohji, T. (2021). *A Development Strategy for Hybrid Products: The Case of the Japanese Animation Industry* (hlm. 155). Springer Singapore; Scopus. https://doi.org/10.1007/978-981-16-4353-8

Kohlgrüber, M., Maldonado-Mariscal, K., & Schröder, A. (2021). Mutual Learning in Innovation and Co-Creation Processes: Integrating Technological and Social Innovation. *Frontiers in Education*, *6*. Scopus. https://doi.org/10.3389/feduc.2021.498661

König, L., & Jucks, R. (2018). *Communicating scientific discoveries and technological innovations: The role of language style* (Callaos N., Sanchez B., Tremante A., Welsch F., & Oropeza A., Ed.; Vol. 2, hlm. 46–51). International Institute of Informatics and Systemics, IIIS; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85056525097&partnerID=40&md5=c3547cd51fb2fe1cc8463c04a4a8355f

Konings, R. J. M., & Stoller, R. E. (2020). *Comprehensive Nuclear Materials* (hlm. 4653). Elsevier; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100388733&partnerID=40&md5=6082b8a0f8f55631909c72f6c1199bb6

Loy, J., & Canning, S. (2017). *The creative engineering education imperative for twenty-First century living* (Gulden T., Pavel N., Kovacevic A., Buck L., Bohemia E., & Berg A., Ed.; hlm. 280–285). Institution of Engineering Designers, The Design Society; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042074386&partnerID=40&md5=9c657f7897576561c21c823f359cfcbd

.

Mavri, M., Fronimaki, E., & Kadrefi, A. (2023). Survey analysis for the adoption of 3D printing technology: Consumers' perspective. *Journal of Science and Technology Policy Management*, *14*(2), 353–385. Scopus. https://doi.org/10.1108/JSTPM-02-2020-0023

Sarkar, S. (2015). Domesticating electric power: Growth of industry, utilities and research in colonial Calcutta. *Indian Economic and Social History Review*, *52*(3), 357–389. Scopus. https://doi.org/10.1177/0019464615588431

Smulders, F., Broekhans, B., Kamp, A., Hellendoorn, H., & Welleman, H. (2019). *Educate for technological innovation*. *2019-August*, 479–488. Scopus. https://doi.org/10.1017/dsi.2019.52