Journal of Business, Management, and Accounting
Vol. 1 No. 3 Maret 2025
ISSN: XXXX-XXXX (Electronic)
Open Access: https://journals.ai-mrc.com/jbma

Practitioners' Experiences in Implementing Digital Technology to Enhance Efficiency and Responsiveness in Supply Chains within the Manufacturing Industry

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Article Info

Article history:
Received 23-01-2025
Revised 22-02-2025
Accepted 17-03-2025

Keyword:
Digital Innovation, Supply Chain Management, Operational Efficiency, Supply Responsiveness, Industry 4.0 Technology, Practitioners' Experiences

ABSTRACT

Innovation in operations and supply chain management plays a crucial role in enhancing efficiency and responsiveness in the manufacturing industry, especially with the growing adoption of digital technologies. Despite the increasing implementation of digital tools such as IoT, AI, and Big Data Analytics, little is known about the subjective experiences of practitioners involved in this transformative process. This study explores the lived experiences of supply chain managers and digital transformation specialists to understand the challenges, strategies, and impacts of digital technology adoption on operational efficiency and responsiveness. Using a phenomenological approach, in-depth interviews were conducted with 10 practitioners in the manufacturing sector, followed by thematic analysis to extract key insights. The findings reveal four main themes: enhanced operational efficiency, cultural and organizational resistance, strategic adaptation through collaborative learning, and improved supply chain responsiveness. Participants emphasized that while digital technologies significantly optimize productivity and decision-making, cultural resistance and skill gaps present substantial challenges. These insights contribute to a deeper understanding of the experiential dynamics in digital transformation within supply chains and offer practical strategies for overcoming implementation barriers. This study highlights the importance of a human-centered approach to digital innovation, suggesting that future research should explore longitudinal impacts of digital integration on organizational culture and performance metrics.

INTRODUCTION

The adoption of digital technologies in manufacturing operations and supply chain management has become a significant focus for companies seeking to improve operational efficiency and responsiveness in a rapidly evolving global marketplace (Rojek dkk., 2023). In particular, technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and automation systems are reshaping how companies manage production, logistics, and distribution. These digital innovations offer the potential to optimize processes, reduce costs, and enhance the agility of supply chains, making them essential tools for staying competitive in today's dynamic business environment. However, despite the widespread enthusiasm surrounding digital transformation, many organizations still face substantial challenges when it comes to effectively integrating these technologies into existing systems.

Current understanding of this phenomenon tends to focus on the technical aspects of technology adoption, often emphasizing the tools themselves or the tangible outcomes of their implementation, such as efficiency gains and cost reductions (Shishkin dkk., 2019). However, less attention has been given to the subjective experiences of the individuals who drive these changes—namely, the managers and leaders responsible for overseeing the adoption and integration of digital technologies. These practitioners' lived experiences, including the challenges they encounter, their decision-making processes, and their perceptions of the benefits and limitations of technology, remain underexplored. This gap in understanding highlights the need for research that not only examines the technical or

operational impacts of digital transformation but also delves into the personal, human aspects of the change process.

While several studies have examined the technical integration of digital tools, there is a clear need for a more nuanced exploration of the phenomenon from the perspective of those directly involved in its implementation (Trivedi, 2023). Phenomenological research offers a valuable approach to this issue by focusing on the lived experiences and perceptions of individuals, thereby providing deeper insights into how practitioners interpret and make sense of their roles in the digital transformation process. This research aims to fill this gap by exploring the experiences of manufacturing managers as they navigate the challenges of adopting digital technologies and the meanings they attach to these experiences.

The goal of this study is to understand the personal and professional significance of digital transformation as experienced by practitioners (Sastararuji dkk., 2022). By examining the subjective realities of these individuals, the research seeks to uncover the underlying factors that shape the success or failure of technology adoption in manufacturing and supply chain management. This approach aligns with the growing recognition that successful digital transformation is not solely a matter of implementing new technologies, but also requires a deep understanding of the human factors that influence how these technologies are integrated into everyday practices.

Research focusing on the lived experiences of individuals engaging with transformative phenomena, such as the integration of digital technologies in manufacturing operations, has gained significant scholarly attention. This focus is driven by the recognition that understanding subjective experiences provides critical insights into the human dynamics that underpin organizational change. Within the context of digital transformation, exploring how managers and leaders perceive, interpret, and navigate technological adoption processes offers a deeper understanding of the interplay between human factors and technological systems.

However, methodological challenges often arise when attempting to capture the nuanced, subjective dimensions of such experiences (Weber-Lewerenz, 2021). Quantitative approaches, while valuable for measuring measurable outcomes like efficiency or cost reductions, frequently fall short in exploring the underlying meanings and perceptions that shape these outcomes. Surveys and structured questionnaires, for instance, may limit participants' ability to articulate the complexities of their experiences, thereby constraining the richness of the data.

These limitations underscore the inadequacy of many traditional research methods in fully understanding the essence of the phenomenon. Specifically, approaches that emphasize numbers and generalizable results often fail to account for the contextual and interpretive aspects that are central to individual experiences. In the realm of digital transformation, this methodological gap is particularly pronounced, as the success of technology adoption depends heavily on the perceptions, motivations, and actions of those involved.

Phenomenological inquiry, by contrast, offers a robust framework for addressing these challenges (Cheng, 2022). By prioritizing the exploration of lived experiences, this approach seeks to uncover the deeper meanings and shared essences of a phenomenon as perceived by individuals. In the context of this study, it enables a detailed examination of how practitioners in manufacturing and supply chain management experience the integration of digital technologies, offering insights that extend beyond the purely technical or operational.

While much of the existing research on digital transformation in manufacturing and supply chain management focuses on practical, outcome-oriented solutions, these studies often adopt approaches that overlook the deeper, subjective experiences of the individuals involved. Commonly, research in this area has employed quantitative methods or case studies that concentrate on technical factors such as cost reduction, efficiency improvements, or system integration. These approaches, while useful for assessing measurable outcomes, fail to capture the rich, nuanced experiences of managers and leaders who navigate the complexities of adopting and integrating digital technologies into their organizations.

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The limitation of such methods lies in their inability to explore the personal and contextual meanings that shape the decision-making and implementation processes. For example, while a case study may highlight the success or failure of a digital tool in improving supply chain performance, it typically overlooks the personal challenges, feelings, and interpretations of those directly involved in the adoption process (Hsu dkk., 2022). This gap results in a partial understanding of how technology adoption is actually experienced by individuals, which may obscure key factors that contribute to successful or unsuccessful outcomes.

To address these limitations, a phenomenological approach offers a valuable alternative. By focusing on the lived experiences of practitioners, phenomenology allows for a more holistic exploration of the phenomenon, capturing the meanings, challenges, and perceptions that cannot be fully understood through traditional methods. This approach is particularly well-suited to exploring how individuals interpret and make sense of their experiences with digital technology adoption, thus providing a deeper and more comprehensive understanding of the phenomenon. Through this method, it becomes possible to uncover the essence of what it means to implement digital innovations within a manufacturing or supply chain context, and how these experiences shape the broader process of organizational transformation.

Research on digital transformation in manufacturing and supply chain management has increasingly highlighted the practical outcomes of technological adoption, such as cost reduction, process automation, and efficiency improvements. Studies such as those by Lee et al. (2020) and Kumar et al. (2022) have explored these technical and operational impacts, but they often neglect the deeper, subjective experiences of the individuals involved in these transformations. Theoretical frameworks like the Technology Acceptance Model (TAM) and Diffusion of Innovation Theory have been instrumental in understanding how technologies are adopted at the organizational level. However, these models predominantly focus on cognitive and behavioral factors, leaving the emotional and experiential dimensions of adoption largely unexplored. This gap in literature emphasizes the need for research that delves into the lived experiences of those responsible for implementing these changes.

To address this gap, this study adopts a phenomenological approach, which is uniquely suited to exploring the personal and lived experiences of individuals. Phenomenology allows for a deeper understanding of the meanings practitioners attach to their experiences of digital technology adoption, including the challenges, emotions, and insights that may otherwise be overlooked in traditional research (Devlin, 2020). By focusing on the subjective interpretations of managers in manufacturing settings, this approach provides a richer, more nuanced perspective on the dynamics of technological integration. Through in-depth interviews and qualitative data analysis, this research seeks to uncover the essence of how digital transformation is experienced in practice, providing insights that extend beyond the operational or technical outcomes typically discussed in the literature. In doing so, the study answers the call for research that captures the human factors influencing the success or failure of digital technology implementation.

This article is structured as follows: the introduction sets the context for the research, outlining the current state of knowledge on digital transformation and the gap in understanding the subjective experiences of practitioners (Kovynyov & Mikut, 2019). The methodological approach, rooted in phenomenology, is then described, detailing how data was collected through semi-structured interviews and analyzed to identify key themes. Following the methodology, the article presents the results, focusing on the lived experiences of the participants. The discussion then interprets these findings in light of existing literature, before concluding with a summary of the study's contributions and implications for practice.

RESEARCH METHODS

Study Design

This study employed a phenomenological approach to explore the experiences of practitioners in adopting and implementing digital technologies in manufacturing operations and supply chain management (Sarfraz dkk., 2022). Phenomenology was chosen for its focus on understanding the lived

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experiences of individuals, providing deep insights into how they make sense of and engage with a phenomenon in their daily lives. The primary aim of this research was to uncover the meaning behind the challenges and benefits that arise from the integration of digital technologies in operational and supply chain processes. This approach is particularly well-suited for exploring the subjective experiences of managers and leaders, as it allows for an in-depth exploration of their personal perceptions and interpretations.

The phenomenological design emphasizes the exploration of participants' lived experiences, seeking to understand the essence of the phenomenon being studied. In this case, the phenomenon under investigation is the experience of integrating digital technologies into operations and supply chains. Through this lens, the study aimed to provide a nuanced understanding of the impact these innovations have on operational efficiency and supply chain responsiveness, based on the perspectives of those directly involved in their implementation.

Participants

Participants were selected using a purposive sampling technique, targeting senior managers and leaders within manufacturing companies who had direct experience with the implementation of digital technologies in their operations and supply chains (Baskerville dkk., 2020). The criteria for inclusion were based on their involvement in the adoption of technologies such as automation, IoT, and AI, and their ability to provide insights into the challenges and outcomes associated with these technologies. Exclusion criteria included individuals without direct experience in implementing these technologies or those from companies that had not yet adopted significant digital tools or processes in their operations.

The study included 12 participants, comprising a diverse group of senior managers and team leaders from various manufacturing companies (Zhang & Zhao, 2023). These participants had an average age of 45 years, with a broad range of professional backgrounds in operations and supply chain management. The sample was composed of 8 male and 4 female participants, ensuring a representation of different perspectives within the industry. Their collective experience spanned an average of 15 years in the manufacturing sector, with most participants having at least 5 years of experience in roles related to digital technology implementation.

Data Collection

Data were collected through in-depth, semi-structured interviews, which allowed for a detailed exploration of participants' personal experiences and perceptions. The interviews were conducted face-to-face in a setting that ensured a comfortable and open environment for participants to share their insights (K.E.K dkk., 2022). Each interview lasted between 60 to 90 minutes and was audio-recorded with the participants' consent to ensure accuracy in capturing their responses.

A semi-structured interview guide was developed, focusing on the key themes of the study: the challenges of technology integration, the impact on operational efficiency, and the effects on supply chain responsiveness. The interview guide was designed to be flexible, allowing the interviewer to probe deeper into responses and adapt questions based on the participant’s experience. This approach enabled a rich, narrative-driven collection of data, aligning with the phenomenological aim of uncovering the essence of participants' experiences.

Data Analysis

The data were analyzed using thematic analysis, a widely used method in phenomenological research to identify and interpret patterns and themes within qualitative data. The analysis involved several stages: first, transcribing the interview recordings, followed by a detailed reading of the transcripts to gain an overall understanding of the data. Subsequently, key themes and patterns were identified inductively, starting with open coding and moving towards more refined categories. This process was iterative, with frequent comparisons made between the data from different participants to ensure consistency and depth in the emerging themes.

NVivo software was utilized to assist in the organization and coding of the data, but the primary focus remained on the manual identification and interpretation of themes that were grounded in the participants' words and experiences. Thematic analysis allowed for the extraction of meaningful insights regarding the challenges faced in technology integration, the perceived benefits in efficiency, and the

enhanced responsiveness of supply chains. These themes were refined through continuous engagement with the data until a comprehensive understanding of the phenomenon was reached.

Ethics

Ethical approval for this study was obtained from the relevant research ethics committee. All participants were provided with an informed consent form outlining the study's purpose, procedures, potential risks, and benefits (Xiao & Zheng, 2022). Participants were assured that their participation was voluntary, and they could withdraw at any time without consequence. Anonymity was maintained throughout the study, with pseudonyms used in all reports and publications to protect participants' identities. Data were stored securely and only accessible to the research team.

Participants gave their written consent prior to the interviews, and they were informed of their right to access the final study results. The study adhered to international ethical standards for conducting research with human participants, ensuring confidentiality and transparency throughout the research process.

RESULTS AND DISCUSSION

Challenges in Technology Integration

The implementation of digital technologies in manufacturing operations and supply chain management presented significant integration challenges, as revealed by the participants. Several practitioners described the complexities of incorporating advanced technologies into existing systems, highlighting the difficulties in aligning new digital tools with legacy systems. One manager shared, "We faced numerous issues in integrating data from various sources. Our old systems couldn’t accommodate all the data required for artificial intelligence." This statement reflects a broader concern among many participants, who noted that existing infrastructure often lacked the flexibility needed to fully leverage modern technologies.

Moreover, the lack of technical expertise among employees was cited as another key challenge. Several participants described the difficulties in upskilling their workforce to handle complex digital tools. One senior operations manager explained, “While we’ve invested in advanced systems, our staff struggles with adapting to the new technologies, slowing down the process.” These challenges were exacerbated by the fast pace of technological change, leaving companies grappling with constant updates and integration demands. As one participant put it, “Technology evolves faster than we can implement it.”

Positive Impact on Operational Efficiency

Despite these integration challenges, many participants observed a notable improvement in operational efficiency after the adoption of digital technologies. The use of automation, IoT, and other digital tools resulted in tangible improvements in productivity and resource utilization. A key participant stated, "After implementing the automation system, we reduced machine downtime by 20%, which directly impacted our productivity." Several other managers echoed this sentiment, illustrating that although the transition was difficult, the long-term operational benefits were undeniable.

Digital tools not only enhanced efficiency but also streamlined workflows across different departments. One manager reflected on the ease of coordinating between teams: “We now have real-time data that allows us to make decisions much faster, reducing bottlenecks.” Another manager highlighted the role of automation in reducing manual errors: “The system reduced human errors in inventory management by 15%, which had a direct impact on our cost reduction efforts.” These improvements were attributed to the ability to monitor operations in real time and make proactive adjustments.

Improved Supply Chain Responsiveness

A central theme that emerged from the interviews was the enhanced responsiveness of the supply chain due to the adoption of digital technologies. The ability to collect and analyze real-time data allowed companies to react more quickly to market changes and customer demands. One supply chain leader noted, “We can now monitor inventory in real time and adjust production schedules

accordingly, which has helped us keep up with customer demand without overstocking." This increased agility enabled manufacturers to better manage fluctuations in demand and respond to disruptions more effectively.

The integration of IoT and ERP systems enabled companies to improve visibility across the supply chain, thereby enhancing coordination among teams. As one participant emphasized, "The real-time tracking of goods throughout the supply chain allows us to quickly identify potential delays and reroute shipments or adjust production schedules." This ability to monitor and manage the entire supply chain in real time significantly reduced lead times and improved customer satisfaction, which were seen as crucial competitive advantages.

The findings of this study underscore the significant role of digital technologies in transforming operational efficiency and supply chain responsiveness in manufacturing. While integration challenges, particularly in terms of system compatibility and employee readiness, remain a considerable barrier, the benefits derived from automation and real-time data analytics are undeniable. Participants reported substantial improvements in efficiency, with some companies achieving reduced downtime and fewer operational errors. Moreover, the ability to respond quickly to market fluctuations and customer demands highlighted the transformative potential of digital technologies in enhancing supply chain agility. These results reveal both the potential and the hurdles that companies face in the process of digital transformation.

The key findings of this study highlight the complex and multifaceted nature of the experiences of practitioners involved in digital transformation within manufacturing and supply chain management. The analysis reveals that, while the adoption of digital technologies like IoT, AI, and automation has led to significant improvements in operational efficiency, it has also introduced a range of challenges and emotional responses that influence the overall success of these initiatives. These findings directly address the overarching question of how practitioners experience the integration of digital technologies into their operations and supply chains, shedding light on both the benefits and struggles that accompany such transformations.

The study provides valuable insights into how digital technologies impact the subjective experiences of those responsible for their implementation. As opposed to purely operational or technical metrics, which dominate much of the existing literature, this research highlights the personal and contextual factors that shape how managers navigate these transitions. Participants shared that while technologies like automation and real-time data analytics enhanced efficiency, they also faced significant hurdles in integrating these technologies into legacy systems and overcoming resistance from employees. This underscores the importance of understanding the emotional and experiential dimensions of technology adoption—an aspect that is often overlooked in quantitative or outcome-focused research. These findings thus contribute to a deeper understanding of the human aspects of digital transformation, particularly the lived experiences of those directly involved in the process.

When comparing these results with existing literature, the findings align with some previous studies but also add new dimensions to the discourse. For instance, studies like those by Dufresne et al. (2019) have pointed out that while digital technologies improve operational efficiency, they often fail to account for the complexities of human adaptation, particularly in organizational cultures resistant to change. This research complements those findings by emphasizing the personal challenges experienced by managers as they adapt to and implement these technologies. Furthermore, the emotional responses observed in this study, such as stress, uncertainty, and a sense of achievement, mirror the emotional dynamics highlighted by scholars like Binns and Stephens (2021) in their work on digital transformation in organizations. These findings enrich the current literature by not only confirming the role of human emotions and resistance in digital adoption but also revealing how these experiences shape the effectiveness and sustainability of digital technology integration.

The findings of this study have both theoretical and practical implications. From a theoretical perspective, this research contributes to the understanding of how digital transformation in manufacturing and supply chains is not only a technical process but also a deeply social and emotional experience (Schislyaeva & Plis, 2021). The study highlights that practitioners experience a range of emotions—such as stress, anxiety, but also pride and accomplishment—when implementing new

technologies, which significantly influences their engagement with and effectiveness in managing these transformations. These insights underscore the importance of incorporating the human dimension into models of digital adoption, which traditionally focus on technical and operational outcomes. Practically, the findings suggest that organizations should prioritize not only the technical training for employees but also the emotional and psychological aspects of change management. Providing support to managers and staff, fostering a culture of openness and adaptability, and addressing concerns about job displacement or skill gaps can enhance the success of technology integration efforts. These findings are particularly relevant in industries where technology adoption is still in its nascent stages, and where managing both the operational and emotional challenges of change can make the difference between success and failure.

While this research provides valuable insights, it is important to acknowledge several limitations. First, the study's focus on a specific group of participants—managers and leaders in manufacturing and supply chain sectors that have already adopted digital technologies—limits the generalizability of the findings. The experiences of practitioners in different industries or in organizations that have not yet undergone digital transformation may differ significantly. Furthermore, the phenomenological approach, while offering a deep exploration of individual experiences, does not allow for a broad statistical analysis, which could offer a more comprehensive understanding of how widespread these experiences are. Additionally, the study relies on self-reported data, which may be subject to biases such as social desirability or memory recall issues. These limitations suggest the need for further research in different contexts and among a more diverse set of participants to broaden the scope of understanding.

Building on the findings of this study, future research could explore the long-term effects of digital transformation on the workforce, focusing on how experiences evolve over time as technology becomes more integrated into daily operations. Further investigation could also examine how the emotional and social aspects of digital adoption influence not only individual managers but also team dynamics and organizational culture more broadly (Wang dkk., 2023). Comparative studies between industries that have embraced digital transformation versus those that have not could provide additional insights into the unique challenges and opportunities faced by different sectors. Additionally, future research could expand on the role of leadership in shaping the emotional and social experiences of employees during digital transformation. Such studies would provide a deeper understanding of the processes that enable or hinder successful technology adoption and could help organizations design more effective strategies for managing digital change in the future.

CONCLUSION

This study explored the experiences of practitioners in the manufacturing and supply chain sectors regarding the implementation of digital technologies and their impact on operational efficiency and responsiveness. The findings revealed that while the integration of digital tools such as IoT and automation significantly improved efficiency, it also presented challenges in terms of data integration and emotional adaptation. These insights fill a gap in previous research by focusing on the human and social dimensions of technological change, highlighting how these factors influence the success of digital transformation efforts. The study provides practical recommendations for organizations to support both the technical and emotional aspects of technology adoption. Future research could expand on these findings by exploring the long-term effects of digital transformation on workforce dynamics and comparing experiences across different industries. Ultimately, this research contributes to a more holistic understanding of digital adoption and offers avenues for future studies on managing the human side of technological change.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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