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Presenting a Model for Overcoming Production Barriers Based on Digital Transformations

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Abstract

Given the rapid advancements in the digital world, information and communication technology (ICT) transformations have become a key factor in the structural changes across various industries. In this context, the utilization of modern technologies and digital transformation management has emerged as a strategic approach to addressing challenges and barriers to production. The present study aimed to propose a model for overcoming production barriers based on digital transformations. This research is applied in its objective and qualitative in its methodology. The statistical population consisted of documents related to overcoming production barriers through digital transformations over the past 15 years, from which 35 documents were selected using purposive sampling. Data collection was conducted through note-taking from documents, with validity confirmed via triangulation and reliability assessed using Cohen's kappa coefficient, yielding a reliability score of 86.9%. Data analysis was performed using thematic analysis through three types of coding: open, axial, and selective. The findings identified 116 basic themes, 24 organizing themes, and 9 overarching themes for the model of overcoming production barriers based on digital transformations. These overarching themes included educational leadership based on perception and cognition, planning and goal setting, optimization of digital processes, interactions based on digital transformation, dynamic transformation indicators, characteristics of a digital organization, goal articulation, organizational agility, and the development of digital transformation models. Ultimately, the model for overcoming production barriers based on digital transformations was formulated. The results of this study indicate that digital transformations can serve as a powerful tool for overcoming production barriers. The nine overarching themes identified in this research clearly demonstrate that digital transformations can reduce production barriers and existing challenges in the state banking system by enhancing efficiency, improving services, and optimizing processes.

Keywords: Production barriers, transformation, digital transformation, thematic analysis.

1. Introduction

Focusing on digital transformation in manufacturing opens significant opportunities for growth, improved profitability, and enhanced flexibility (Zighan & Abualqumboz, 2022). To address increasing competition and deliver greater value to customers, industrial companies are developing service-oriented strategies, redefining themselves not merely as sellers of products or services but as providers of integrated solutions that combine both (Le-Dain et al., 2023). These integrated solutions, known as product-service systems, encompass a wide range of value propositions (Shen et al., 2021). The shift

toward this strategy aligns with the increasing adoption of digital technologies and business digitization (Gobble, 2018). In fact, digitization enhances service efficiency by enabling new frameworks and pricing models (Rha & Lee, 2022).

Overcoming production barriers in the industry is highly significant, as it directly impacts the performance and success of an industrial organization (Bahiroh & Imron, 2024). Eliminating production barriers increases the efficiency of production processes. By improving and optimizing production processes, production time is reduced, manufacturing costs decrease, and product quality improves (Li, 2024). This results in increased profitability and competitiveness for the organization, leading to a long-term reduction in production costs. Optimizing production processes also minimizes the likelihood of breakdowns and operational issues, consequently lowering maintenance and repair costs (Kohtamäki et al., 2019; Kohtamäki et al., 2020). Furthermore, enhancing machine efficiency and optimizing production processes reduce material and energy consumption, ultimately leading to cost savings (Liu, 2024).

Overcoming production barriers improves product quality. Enhancing production processes can reduce the need for manual adjustments and frequent modifications, thereby improving product quality. Additionally, advanced technologies such as artificial intelligence and machine learning can be used to identify and resolve quality issues (Thun et al., 2019).

By improving efficiency, reducing costs, and enhancing quality, an organization can effectively compete with top rivals and execute more successful marketing strategies (Poels, 2019). This ultimately contributes to profitability and sustainable organizational growth. Furthermore, this process increases customer satisfaction. By improving quality and ensuring timely product delivery, customers become more satisfied and develop greater trust in the organization (Pomfret et al., 2020). Overcoming production barriers means delivering high-quality products at competitive prices and on time, which can lead to increased sales, repeat orders, and customer acquisition (Lipsmeier et al., 2020).

Enhancing production processes enables an organization to establish a competitive advantage (Sarikasaki et al., 2016). By optimizing production processes, reducing costs, and improving quality, organizations can offer superior products and services that competitors may struggle to match. This competitive advantage helps organizations maintain market sustainability and experience growth and development (Reim et al., 2015).

Digital transformations can significantly contribute to overcoming production barriers and improving manufacturing processes across various industries. The use of automation and robotics in production processes leads to substantial improvements in efficiency and product quality. These technologies automate repetitive and time-consuming tasks while minimizing human errors. As a result, production time decreases, costs are reduced, and product accuracy and quality increase (Annarelli et al., 2020).

Accordingly, the most successful manufacturing industries integrate service strategies with digitization efforts, participating in a digital service strategy (Paschou et al., 2020). Digital service refers to the development of new services or the enhancement of existing ones through digital technologies to implement digital business models, generate knowledge from data, improve operational performance, and enhance competitiveness (Okazaki et al., 2020). Digital service strengthens a company's revenue and profitability by providing competitive advantages and delivering high-quality services to customers. Thanks to digital service, product-service system solutions become more sophisticated by incorporating digital technologies to enhance the intelligence of products, services, or product-service interfaces (Balistri et al., 2020).

These new solutions, referred to as digital transformation strategies, represent an IT-driven business strategy for co-creating value, incorporating various stakeholders as key actors, intelligent systems as infrastructure, smart and connected products as tools, and electronic production processes as fundamental components. The ultimate goal is to continuously meet individual customer needs through sustainable production improvements (Mehrani et al., 2022). Additionally, digital transformation strategies support sustainability by extending product life cycles, increasing resource and energy efficiency, enhancing product utilization, reducing carbon emissions, and minimizing waste (Paiola et al., 2021). Indeed, digital technologies such as the Internet of Things (IoT), cloud platforms, and big data facilitate the implementation of sustainable smart product-service system business models, allowing industries to design and implement more efficient value propositions (Mende et al., 2019).

Digitization enhances the strategic and operational effectiveness of service delivery by enabling innovative services, business models, and pricing frameworks (Kohtamäki et al., 2019; Kohtamäki et al., 2020; Shen et al., 2021). Consequently,

companies pursue a digital service strategy that inherently integrates service provision and digitization. Digital service is considered a transition from pure products and supplementary services to intelligent product-service systems. Digital transformation solutions are understood as the use of digital technologies to create and deliver appropriate value from offered product-service solutions, making digital service an interaction between digitization and service provision (Bouncken et al., 2021).

The barriers to production refer to constraints, challenges, or limiting factors that disrupt the efficiency and quality of manufacturing processes for goods and services. These barriers can be diverse, ranging from technical, managerial, financial, and technological constraints to human-related factors and issues concerning raw material supply and market acceptance (Ackx, 2014). Common production barriers include fluctuations in raw material supply, underutilization of modern technologies, decreased labor productivity, inefficiencies in production process management, supply chain disruptions, low product quality, defects in quality control, market distribution problems, mass production interruptions, and environmental challenges such as product life cycle concerns and industrial waste management (Chowdhury et al., 2018). In the context of Iran, production barriers can be categorized into cultural and economic-political constraints. The primary cultural barriers include negative perceptions of domestic products, brand-oriented consumer behavior, weak commitment to national industry, and socio-cultural transformations (Dashtbani & Mohammadi, 2022). Economic and political barriers encompass poor quality of domestic production, oil-dependent economy, state-controlled economic structures, corruption, smuggling, excessive imports of consumer goods, monopolization, banking system inefficiencies, currency shocks, unfavorable business environments, outward-oriented economic policies, and Western-centric unilateralism (Ebadi et al., 2021). Addressing production barriers is crucial, as overcoming them can lead to improved productivity, reduced resource wastage, enhanced product quality, lower production costs, increased competitiveness, and higher profitability (Coreynen et al., 2017). A key barrier to production is the lack of efficient utilization of modern technologies and automation. To address this, companies must adopt advanced technologies such as robotics, artificial intelligence, and the Internet of Things (IoT) in their production lines to enhance accuracy, speed, and quality (Alizadeh & Khalili Asr, 2023). Additionally, mismanagement of resources and inefficient planning can hinder production, necessitating the implementation of modern management systems and data-driven optimization strategies to improve inventory control, resource allocation, and demand forecasting (Dachs et al., 2013). The shortage of skilled labor also poses a significant barrier to production, requiring investments in workforce training and continuous skill development to enhance employees' capabilities and align them with production demands (Shen et al., 2021). Digital transformations play a critical role in overcoming production barriers, offering companies advanced tools for addressing inefficiencies, enhancing productivity, and optimizing supply chains (Ferreira et al., 2019). The integration of digital technologies such as automation, real-time monitoring, and predictive analytics allows companies to streamline manufacturing processes and minimize human error (Alizadeh & Larijani, 2018). These transformations have had widespread applications in various industries, including manufacturing, finance, healthcare, transportation, and education, improving efficiency, innovation, and user experience (Shen et al., 2021). Digitalization also facilitates seamless communication between production systems, suppliers, and customers through IoT and cloud computing, improving supply chain visibility and operational agility (Kopalle & Lehmann, 2021). Furthermore, predictive analytics and machine learning enable proactive decision-making by identifying patterns in production data, reducing downtime, and enhancing resource utilization (Kim, 2021). The adoption of blockchain technology ensures transparency in supply chain operations, securing transaction records and enhancing product traceability (Grant et al., 2014). Additionally, digital transformations contribute to smart and high-quality manufacturing by employing robotics, automated quality control systems, and real-time data analytics to optimize production efficiency and reduce operational costs (Kamboj et al., 2018). The integration of artificial intelligence and machine learning enables predictive maintenance, reducing unplanned downtimes and increasing production reliability (Ji et al., 2019). Furthermore, digitalization facilitates customer engagement by allowing organizations to collect and analyze customer feedback, improving product customization and service responsiveness (Bleier et al., 2020). Smart product-service systems, driven by digital transformation, integrate connected devices, real-time analytics, and cloud-based services to enhance value creation and service efficiency (Juarez et al., 2021). Digital service provisioning supports industrial sustainability by enabling long-term

relationships with customers, optimizing operational efficiency, and differentiating businesses in competitive markets (Baines & Lightfoot, 2013; Baines et al., 2017). By leveraging digitalization, companies can transition from traditional production models to intelligent and adaptive manufacturing ecosystems, ensuring sustainable growth and competitive advantage in global markets (Frank et al., 2019).

Thus, it can be argued that digital transformations also enable the advancement of product design and development processes. The use of simulations and modeling software allows developers to refine products without the need for immediate physical production, significantly reducing development costs and time. Thus, digital transformations act as a macro-level driver for productivity and quality enhancement across various industries. Consequently, improving product and service delivery processes through digital transformation, based on overcoming production barriers, is of great significance in the industry. This improvement leads to enhanced quality, cost reduction, increased efficiency, and improved organizational competitiveness. Ultimately, it contributes to organizational profitability and sustainable growth while also increasing customer satisfaction. Therefore, this study seeks to answer the following question: How can a model for overcoming production barriers be developed based on digital transformations?

2. Methods and Materials

This study is applied in its objective and qualitative in its execution. The statistical population consisted of documents related to overcoming production barriers based on digital transformations over the past 15 years, from which 35 documents were selected through purposive sampling. Accordingly, this study employed both field and library research. Documents related to overcoming production barriers through digital transformations were selected as samples only if they were deemed relevant by the researchers and had been published within the last 15 years.

To conduct the study and develop a logical framework based on the research objectives, the thematic network approach was utilized. In this process, dimensions, components, and indicators of the model for overcoming production barriers through digital transformations were explored. The literature review and previous studies were examined, and relevant documents were selected as samples. The dimensions, components, and indicators were then extracted and synthesized. To ensure clarity and relevance, redundant items were removed, and similar items were merged. Finally, a model was drawn based on the refined components.

Data collection was conducted using note-taking from documents. Each document was thoroughly examined, and all relevant content and concepts related to overcoming production barriers through digital transformations were documented. Once this process was completed for all selected documents, a synthesis was conducted, redundant items were removed, and similar items were integrated. The validity of the findings was confirmed using the triangulation method. Additionally, beyond validation by the researcher and the supervising and advisory professors, the validity of the findings was reviewed, revised, and approved by three researchers in the field of business and service industries. The reliability of the findings was assessed using Cohen's kappa coefficient, yielding a reliability score of 86.9%.

In this study, data were analyzed using thematic analysis through three types of coding: open coding, axial coding, and selective coding.

3. Findings and Results

In this study, 35 documents related to overcoming production barriers based on digital transformations were analyzed, and the results of the thematic analysis using open, axial, and selective coding are presented in Table 1.

Table 1. Results of Thematic Analysis of Documents Related to Overcoming Production Barriers Based on Digital Transformations

Overarching Themes	Organizing Themes	Basic Themes
Digital transformation leadership based on perception and cognition	Skill development	Employee experience
		Employee interest in diverse digital transformation domains
		Information skills
	In-house training	Educational resources
		Consulting with experts and specialists
		In-service training courses
	Employee motivation	Possibility of tracking activities and progress
	Institutionalizing training	Creating sufficient motivation in employees
		Managerial perspective on training
		Evaluating different perspectives
		Evaluating fundamental beliefs and values
		Enhancing confidence in the transformation process
Planning and goal setting	Digital transformation multimedia resources	User-friendly electronic content
		Increasing speed in training and transformation
		Reducing learning costs
		Increasing motivation
	Existence of a comprehensive digital transformation system	Reducing training costs
		Making training interactive
		Time efficiency
	Educational content	Integration of images, text, audio, and videos
		Conversational-style content
		Content analysis and determination of training methods and tools
Process optimization	Electronic implementation and evaluation	Analysis of collected data
		Support services
		Information usefulness
	New learning and teaching system	Setting educational goals
		Evaluation system analysis
		Linking transformation to employee efficiency and capability
		Optimizing intellectual capital and digital transformation management
Digital transformation interactions	University collaborations	Web-based learning environment
		Linking to university educational programs
		Improving training quality and quantity
	Industry collaboration	Monitoring service industry training programs
		Interaction with industrial and service companies
		Activating research and development units
		Establishing joint research centers with industries
		Developing interdisciplinary industry-university interaction models
		Creating a suitable platform for referring transformation projects to universities
Dynamic transformation indicators	Sustainable transformation	Utilizing creative methods
		Reducing disorder and confusion in the transformation process
		Defining the educational program and setting boundaries
		Aligning employees with virtual classes
	Research-based learning	Building trust
		Educational participation
		Transformation skills
		Employee participation
		Effective communication networks with employees
Characteristics of a digital organization	Structural factors	Implementation approach

		High-speed internet
		Support from senior management and financial backing
		Educational software
		Optimal educational environment
		Suitable hardware
	Environmental barriers	Internal goal orientation
		Information self-efficacy
		Resistance to new conditions
Setting educational goals	Motivation and talent	Stimulating a sense of transformation among employees
		Employee talent assessment and recognition of managerial behavioral traits
		Specialist evaluation based on criteria
		Proper understanding of employee talents
	Identifying educational resources	Recruiting talented employees
		Introducing specialized managers
		The necessity of agility in transformation
		Employee participation in content quality
		Educational branding
		Compatibility of training adaptability with organizational needs
		Educational needs assessment aligned with organizational needs
		Enhancing content quality
	Feasibility assessment for implementation	Aligning training with job requirements
		Educational management consulting for transformation
		Providing consultation to units regarding hybrid transformation
		Support from senior managers
Organizational agility	Superior educational capabilities	Training specialized workforce
		Developing information and communication skills
		Providing new educational opportunities for employees
		Knowledge synergy and creating innovative thought cycles
	Motivation for transformation	Transformation development based on teamwork and participation
		Creating a broad sense of transformation
		Providing equipment and facilities for all
		Human resource motivation
		Continuous transformation
		Flexibility in transformation
	Transformation integration	Increasing creativity and innovation
		Talent evaluation of employees
		Developing desirable knowledge aligned with transformation
		Enhancing individual capabilities and employee productivity
		Reducing organizational risk
		Acquiring new ideas and knowledge for digital transformation
		Agile human resources
		Talent management
		Strengthening employee knowledge
Developing human resource training models	Focus integration	In-house training workshops
		Stimulating specialized expertise
		Comprehensive focus on all aspects of digital transformation development
		Organizational environment
		Specialization
	Organizational productivity	Efficiency in performance and input-output ratio
		Enhancing employee productivity
	Competitive advantage	Retention of key specialists

		Value-added educational assessment
		Generating new digital transformation ideas
		Fair distribution of transformation opportunities
		Identifying, developing, and retaining high-potential individuals
		Increasing commitment to organizational transformation
		Analyzing competitors' models
		Enhancing the value of digital transformation
		New educational thinking
		Fairness in digital transformation processes
		Employee learning capacity
	Transformation assessment and digital environment	Aligning training with transformation
		Strengthening employee engagement in digital transformation
		Reducing transformation costs
		Optimizing training time allocation
		Time savings for transformation
		Perceived training costs
		Maintaining the digital environment

As shown in Table 1, the model for overcoming production barriers based on digital transformations identified 116 basic themes, 24 organizing themes, and 9 overarching themes. Based on the overarching themes, the model for overcoming production barriers based on digital transformations is illustrated in Figure 1.

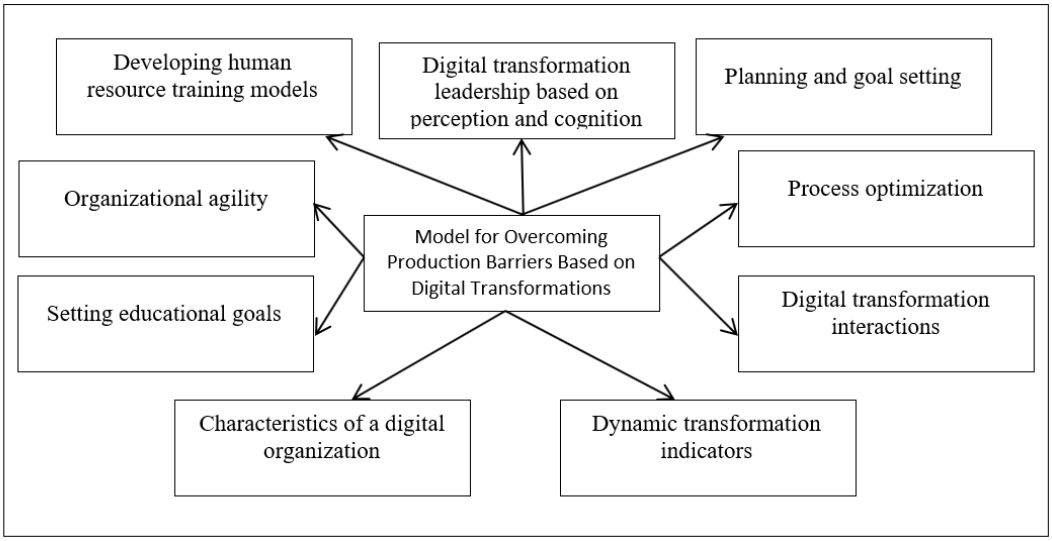

Figure 1. Model for Overcoming Production Barriers Based on Digital Transformations

4. Discussion and Conclusion

The present study aimed to develop a model for overcoming production barriers based on digital transformations. The findings revealed that digital transformation plays a significant role in addressing inefficiencies and obstacles within manufacturing and production systems. The thematic analysis identified 116 basic themes, 24 organizing themes, and 9 overarching themes, which provide a comprehensive framework for understanding how digital transformation can enhance productivity, optimize resource management, and improve the overall efficiency of production systems. The nine overarching themes identified in this study included digital transformation leadership based on perception and cognition, planning and goal setting, optimization of digital processes, interactions based on digital transformation, dynamic transformation indicators, characteristics of a digital organization, goal articulation, organizational agility, and the development of digital transformation

models. These findings indicate that digital transformation provides companies with powerful tools to eliminate inefficiencies, enhance productivity, and improve supply chain coordination.

The results of this study align with previous research, which has consistently emphasized the role of digital transformation in improving industrial efficiency and overcoming production-related challenges. Prior studies have shown that digital technologies, such as artificial intelligence, robotics, and the Internet of Things (IoT), contribute to automation, reduce errors, and enhance process efficiency (Shen et al., 2021). The use of automation and real-time data analytics in production management has been widely acknowledged as an effective approach to increasing accuracy, speed, and cost-effectiveness in manufacturing (Alizadeh & Khalili Asr, 2023). Additionally, digital transformation improves supply chain management by providing real-time tracking and predictive analytics, which help companies optimize raw material procurement and logistics operations (Grant et al., 2014). This is consistent with the findings of the present study, where supply chain coordination and improved operational agility were identified as key benefits of digital transformation.

Another significant finding of the study was the role of digital transformation in enhancing workforce productivity and organizational agility. The study found that digital transformation facilitates knowledge-sharing, promotes continuous skill development, and enables organizations to adapt to changing market conditions more effectively. Previous research has also highlighted the importance of digital transformation in workforce development, indicating that companies that invest in digital training and technological integration experience increased employee efficiency and organizational adaptability (Coreynen et al., 2017). Moreover, digital tools such as cloud computing, machine learning, and data analytics support decision-making processes by providing real-time insights into operational performance (Kim, 2021). These findings underscore the necessity of integrating digital skills into workforce development strategies to ensure that employees can effectively utilize emerging technologies to improve production efficiency.

Furthermore, the study demonstrated that digital transformation enhances quality control and precision in manufacturing processes. The use of automated quality control systems, digital sensors, and real-time monitoring tools allows organizations to detect defects early in the production process and reduce waste. Prior studies have similarly reported that implementing digital quality control measures leads to higher product consistency, reduced defect rates, and improved customer satisfaction (Bleier et al., 2020). The integration of digital tools, such as blockchain and IoT, into production monitoring systems has also been identified as an effective method for increasing transparency and traceability in manufacturing (Kopalle & Lehmann, 2021). These findings further reinforce the notion that digital transformation contributes to the overall improvement of product quality and process efficiency.

The findings of the present study also highlight the importance of organizational agility in the successful implementation of digital transformation strategies. Organizational agility enables companies to quickly respond to market demands, technological advancements, and shifts in consumer preferences. Previous research has emphasized that companies that prioritize agility in their digital transformation initiatives experience greater operational resilience and long-term competitiveness (Chowdhury et al., 2018). This study's findings indicate that digital transformation not only supports process automation and quality control but also fosters a more adaptable and innovative organizational culture.

Additionally, the study identified planning and goal setting as critical factors in the successful implementation of digital transformation initiatives. Strategic planning ensures that digital transformation efforts are aligned with organizational objectives and resource capabilities. Research has consistently shown that organizations with clear digital transformation roadmaps achieve higher success rates in technology adoption and process optimization (Shen et al., 2021). The findings of this study suggest that effective planning and goal setting are essential for maximizing the benefits of digital transformation and overcoming production barriers.

The results also demonstrated that digital transformation contributes to cost reduction by optimizing production processes and minimizing resource wastage. Digital technologies such as predictive analytics, automation, and smart resource management systems enable organizations to reduce operational costs while maintaining high levels of efficiency. Previous studies have reported that companies implementing digital transformation strategies experience significant cost savings through improved process optimization, reduced downtime, and lower labor costs (Kim, 2021). These findings indicate that digital transformation serves as a key enabler of cost-efficient production management.

Finally, the study emphasized the role of digital transformation in enhancing customer engagement and market responsiveness. Digital platforms, data analytics, and customer feedback mechanisms enable organizations to better understand consumer preferences and tailor their production strategies accordingly. Research has indicated that digital transformation facilitates customer-centric business models, allowing companies to develop products that align with market demands and improve customer satisfaction (Baines & Lightfoot, 2013; Baines et al., 2017). The findings of the present study support this perspective, highlighting the importance of leveraging digital tools for market analysis and customer relationship management.

Despite the valuable insights obtained from this study, there are several limitations that should be acknowledged. First, the study relied on document analysis, which may limit the depth of empirical evidence regarding the practical implementation of digital transformation strategies. While the findings provide a strong theoretical foundation, future research could benefit from direct case studies and industry-specific investigations to validate these conclusions. Additionally, the study focused on general production barriers without examining sector-specific challenges in industries such as healthcare, manufacturing, or financial services. A more granular analysis of digital transformation in different industries could provide more targeted insights. Furthermore, the study primarily considered the benefits of digital transformation without extensively addressing the potential risks and challenges associated with its implementation, such as cybersecurity threats, data privacy concerns, and workforce resistance to technological changes.

Future research should explore the empirical validation of the proposed digital transformation model by conducting case studies in various industries. Investigating how different sectors implement digital transformation strategies and the specific challenges they face could provide more comprehensive insights into best practices and industry-specific solutions. Additionally, future studies should focus on the economic impact of digital transformation on production costs, supply chain efficiency, and overall business profitability. Examining the return on investment (ROI) of digital transformation initiatives could help organizations make more informed decisions regarding technology adoption. Moreover, future research should explore the role of digital transformation in sustainability and environmental impact reduction, particularly in areas such as energy-efficient production, waste management, and carbon footprint reduction.

Organizations should prioritize digital transformation as a strategic initiative to overcome production barriers and improve operational efficiency. Companies should invest in workforce training programs to enhance digital literacy and ensure employees can effectively use emerging technologies in production processes. Additionally, organizations should develop clear digital transformation roadmaps that align with their business objectives and resource capabilities. Implementing real-time monitoring and predictive analytics can help companies optimize resource allocation, reduce production costs, and improve quality control. Finally, businesses should leverage digital tools to enhance customer engagement and market responsiveness, ensuring that their products and services align with evolving consumer preferences. By embracing digital transformation, organizations can achieve sustainable growth, enhance competitiveness, and navigate the complexities of modern production environments more effectively.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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