# MIX: Jurnal Ilmiah Manajemen

**Management Scientific Journal**
**ISSN (Online): 2460-5328, ISSN (Print): 2088-1231**
**https://publikasi.mercubuana.ac.id/index.php/jurnal_Mix**


## Assessing the Readiness Index toward Industry 4.0 of the SMEs Leather Industry in Yogyakarta


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***ABSTRACT***

***Objective:*** *This study focuses on create a readiness index measurement model tailored to the transformation of technology in the creative industry for small and medium-sized enterprises (SMEs)measuring the readiness level of leather SMEs as they transition towards Industry 4.0. The indicators developed in INDI 4.0 need to be adjusted again when used to measure the readiness of the creative industry. After developing the measurement model, then proceed with test the model by using it to assess the readiness levels of leather SMEs in Yogyakarta. Based on the results of the readiness index assessment, which indicators need to be improved will be identified and be the basis for formulate recommendations to enhance the readiness levels of leather SMEs.*

***Methodology:*** *The research methodology is divided into Developing Measurement Indicators and Measuring Readiness Index. Developing indicators was conducted through literature review and validated with expert opinion using the Delphi method. Measuring the readiness index was conducted using the multidimensional scaling method and validated using the Monte Carlo method.*

***Finding:*** *The contribution of this research is to develop dimensions and indicators suitable for the creative industry. These additional indicators shed light on digitalization issues in marketing and finance that were not yet fully addressed in INDI 4.0. There is also additional collaboration to strengthen supply chain channels and expand factory operations. The result of measuring the readiness index give a value of 1.92, categorized as Level 1 (initial readiness). The highest value of readiness index is in the product and service dimension and the lowest value is in the technology dimension. The assessment results revealed several points on what the leather creative industry needs to improve to raise the readiness index such as strengthening business management skills, particularly related to digital marketing and financial skills, technology investments, and intensive collaboration with product suppliers and distributors.*



***Keywords****: SMEs; Creative Industries; Readiness Measurement; Industry 4.0.*

Submitted: 16-07-2024 Revised: 31-03-2026 Accepted: 01-04-2026

**Article Doi:**
http://dx.doi.org/10.22441/jurnal_mix.2026.v16i1.016

p-ISSN: 2088-1231
e-ISSN: 2460-5328

## INTRODUCTION

Digital transformation is a major technological revolution closely linked to innovation in business and technology. It creates a new economic paradigm, reshaping industry structures, consumer interactions, and competition rules. Involvement from all actors in the business realm is essential for driving digital transformation and innovation (Reischauer, 2018). Numerous manufacturing companies have adopted Industry 4.0 principles for digital transformation. This transformation involves technological advancements and organizational modifications (Issa et al., 2018). Entrepreneurs have qualified technical skills but lack managerial skills; hence, successful leaders in creative businesses must develop managerial skills and update their knowledge of the creative economy sector (Aisha et al., 2019). Furthermore, a lack of understanding in technology development and improvement, the sources of technology and evaluation in the digital transformation gap in their organizations is the main problem in SMEs (Chonsawat & Sopadang, 2020).

INDI 4.0, designed to prepare Indonesia for the transition to Industry 4.0, has been exclusively applied and evaluated within major corporations, overlooking its potential for small-scale enterprises. The government has utilized the INDI 4.0 framework to assess the readiness of 25 prominent corporations in Indonesia, resulting in preliminary insights tailored to large enterprises. However, extending the utility of the INDI 4.0 framework to encompass SMEs has not been conducted, primarily because it requires customization to accommodate the unique circumstances and requirements of SMEs.

Creative SMEs have significant potential to boost economic growth, foster social development, and nurture cultural expression by creating, producing, and distributing intellectual and artistic goods and services (Rodríguez-Insuasti et al., 2022). Despite the rapid growth of Indonesia's e-commerce sector over the past five years, the creative economy remains untapped (Priambodo et al., 2021). SMEs use innovative marketing strategies to boost profitability (Muluk & Pahurkar, 2023). Assessing a company's digital readiness is crucial for SMEs' transition to Industry 4.0, serving as the cornerstone for effective strategic development in technological and organizational planning (Brozzi et al., 2021).

Industry 4.0 integrates production, information technology, and the internet, integrating cutting-edge communication technologies with conventional industrial processes to boost innovation and efficiency (Matt & Rauch, 2020). The creative sector faces challenges such as fragmented value chains, high production costs, limited distribution channels, inadequate intellectual property protection, and insufficient promotion. These issues hinder growth, particularly in emerging markets, highlighting the need for improved infrastructure, funding, skills development, and institutional support (Zhao et al., 2024).

This research aims to (1) develop a model to measure readiness levels toward Industry 4.0 for leather SMEs in Yogyakarta, (2) test the measurement model by using it to assess the readiness levels of leather SMEs in Yogyakarta, and (3) formulate recommendations to enhance the readiness levels of leather SMEs. This research developed measurement tools to assess the readiness levels of the creative industry, an area that has not been extensively researched in Indonesia. This research also provides an overview of the rise of the creative industry as an expanding area filled by digital technology advancements and the impacts of the COVID-19 pandemic. INDI 4.0 was the primary framework for developing assessment indicators tailored to Indonesia's specific context and requirements. INDI 4.0 is distinguished from other readiness indexes by Indonesia's distinctive cultural and societal characteristics

p-ISSN: 2088-1231
e-ISSN: 2460-5328

This study focuses on measuring the readiness level of batik SMEs as they transition towards Industry 4.0. The indicators developed in INDI 4.0 need to be adjusted again when used to measure the readiness of the creative industry, which has different characteristics and needs from the manufacturing industry in general, which makes mass-produced goods. A creative industry must be adequately equipped to adapt to the fourth industrial revolution, including developing innovative business models. The growth of newcomers in creative industries is being driven by four factors: (1) the support and accessibility of advanced technology, (2) the transfer of knowledge for successful business practices, (3) the efficient process of connecting suppliers and producers online, and (4) the utilization of digital marketing strategies. Disruption replaces outdated markets, sectors, and technologies, giving rise to novel alternatives that are both more efficient and comprehensive (Christensen et al., 2008)

## LITERATURE REVIEW

### *Readiness Index of Industry 4.0 Transformation*

Discussing technology assessment cannot be separated from the initial research, the ATLAS project (United Nations, 1989), which assessed technology using four components of the THIO diagram: Technoware, Humanware, Infoware and Organware (United Nations, 1989). The approach in generating these measurement dimensions is similar to that in INDI 4.0, which also uses the dimensions of organization, people, culture, and technology. Special case for infoware has become connected with technology in hardware and software in factory operations, smart products and services. The Model of INDI 4.0 comprises five dimensions and seventeen indicators, as illustrated in Table 1. These five dimensions are related to technology, both directly and indirectly. The dimensions directly related to technology are technology and factory operations. The dimensions indirectly related to technology are organization, people and culture.

Table 1. Dimensions and indicators of INDI 4.0

| Criteria | Dimention | No | Indicators |
|---|---|---|---|
| Criteria that are not directly related to technology | Organization | 1 | Strategy and leadership |
| | | 2 | Investment toward Industry 4.0 |
| | | 3 | Policy of innovation |
| | People and culture | 4 | Competency development |
| | | 5 | Culture |
| | | 6 | Openness to change |
| | Product and Service | 7 | Data-based services |
| Criteria that are directly related to technology | | 8 | Smart Product |
| | | 9 | Product customization |
| | Technology | 10 | Cyber Security |
| | | 11 | Connectivity |
| | | 12 | Smart Machine |
| | | 13 | Digitalization |
| | Factory Operation | 14 | Data storage and sharing |
| | | 15 | Smart supply chain and Logistics |
| | | 16 | Autonomous process |
| | | 17 | Smart Maintenance system |

The organizational dimension measures the extent of management support in making production systems more efficient with Industry 4.0. People and culture: measuring levels of discipline, willingness to continue learning, and local wisdom. Products and Services

p-ISSN: 2088-1231
e-ISSN: 2460-5328

incorporate technological features, such as an internet-connected interface, data storage (RFID, barcode, etc.), and customization to user preferences. The technology in Industry 4.0 is very diverse, ranging from artificial intelligence to 3D printers, augmented reality and robot collaboration. There must be a system of connectivity between machines and between systems (vertical and horizontal integration). The technological dimension measures this. Factory Operations measures the use of technology within a factory; the measurement includes: the company's supply chain and logistics systems, intelligent machine maintenance/system applications, autonomous/automated production processes, and centralized data storage and control systems. A company's readiness to implement INDI 4.0 is measured on in scale of four levels, from those without management support to those that have implemented it, as shown in Table 2.

Table 2. The Readiness Level

| Level | Status | Description of the company's condition |
|---|---|---|
| Level 0 | Not ready | Management and organizational support are not yet available. |
| Level 1 | Initial Readiness | Management and the organization already have plans to transform to I.4.0. |
| Level 2 | Intermediate readiness | Management and organizations have begun to transform I.4.0. |
| Level 3 | Mature Readiness | Management and organization have already carried out the I.4.0 transformation. |
| Level 4 | Have implemented | Management and organization have implemented I.4.0. |

Three key research areas have emerged within the technological aspects of business organizations: Digital Readiness, Maturity Assessment, and Technology Readiness Assessment (TRA). Digital Readiness gauges the level of preparedness for digital transformation before starting the Smart Manufacturing journey (Pirola et al., 2019). Maturity assessment identifies areas for improvement, measures progress, and guides actions towards higher performance (Mettler, 2011). TRA is crucial for assessing the development and readiness levels of new technologies (Azizian et al., 2011; Machado et al., 2021; Mankins, 2009). Table 3 summarizes Industry 4.0 technological readiness assessment tools from previous studies.

Table 3. Development of Industry 4.0 Readiness Assessment

| Author and Year | Dimension | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Governance | Strategy and Management | People | Awareness | Product | Technology | Operation | Accounting | Marketing |
| (Ansari et al., 2023; Çınar et al., 2021; EDB Singapore, 2017; Lichtblau et al., 2015; Rahamaddulla et al., 2021) | Readiness | Maturity, Readiness, Digital | Readiness | Readiness | Readiness | Digital, Readiness | Maturity and | - | Readiness |
| (Chonsawat & Sopadang, 2020; Gracel & Łebkowski, 2019; Pirola et al., 2019) | - | Maturity and Digital | Readiness | - | - | Maturity and Digital | Readiness | - | - |

p-ISSN: 2088-1231
e-ISSN: 2460-5328

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (Akdil et al., 2018; Ministry of Industry of the Republic of Indonesia, 2018; Mittal et al., 2018) | - | INDI 4.0 and Maturity Readiness | INDI 4.0 and Maturity | - | INDI 4.0 and Maturity | INDI 4.0 & Maturity Readiness | INDI 4.0, Readiness | Maturity | Maturity |
| (Leyh et al., 2016; Schumacher et al., 2016) | Maturity Models | Readiness | Maturity | - | Maturity | Maturity | - | - | - |

The evolution of Industry 4.0 readiness assessment frameworks demonstrates a progressive shift from early models, such as the index by EDB Singapore (2017), towards more contemporary approaches exemplified by the work of Ansari et al. (2023) and Çınar et al. (2021). These authors emphasize various dimensions, including governance, management, organization, technology, factory operations, finance, and marketing. While governance is common, there are differences in the emphasis on factors such as management readiness, technology integration, and operational efficiency. These models also demonstrate notable enhancements to adapt to the evolving digital transformation landscape.

Similar to INDI 4.0, culture is a dimension in other readiness frameworks. However, distinctions emerge, such as integrating dimensions like employee rewards, recognition, leadership, and top management support for Industry 4.0. However, research on readiness measurement often does not consider accounting and marketing dimensions, with few models addressing them, despite marketing's potential to explore customer interaction channels and utilize customer data to better understand customer perspectives (Ansari et al., 2023; Antony et al., 2023). This work introduces a readiness model based on the INDI 4.0 framework, enriched with sub-dimensions from the literature review. It supports Indonesian SMEs in their digital transformation toward Industry 4.0 by identifying key areas for improvement, especially for those with limited innovation resources.

This research differs from existing research because the readiness assessment tool used is designed to use creative industry objects. The creative sector's challenges include (1) Fragmented value chains, which lead to high production costs and limited distribution channels, particularly affecting artists in emerging markets. (2) Inadequate intellectual property protection leads to insufficient coverage and enforcement of institutional frameworks to safeguard creative assets. (3) Lack of public promotion impacts its visibility and recognition. (4) Need for Infrastructure, Financing, and Skills Development. Addressing these deficiencies is crucial for supporting the growth and development of creative industries. Disruptive technologies play a huge role in tackling the challenges faced by the creative sector (UNCTAD, 2024).

## METHOD

This research integrated quantitative and qualitative methods. This research formulated the dimensions and indicators for readiness assessment based on INDI 4.0. Subsequently, these dimensions and indicators were applied to measure the readiness of leather SMEs in Yogyakarta. Finally, this research proposed recommendations to improve readiness levels. Figure 1 presents a flowchart of the methods.

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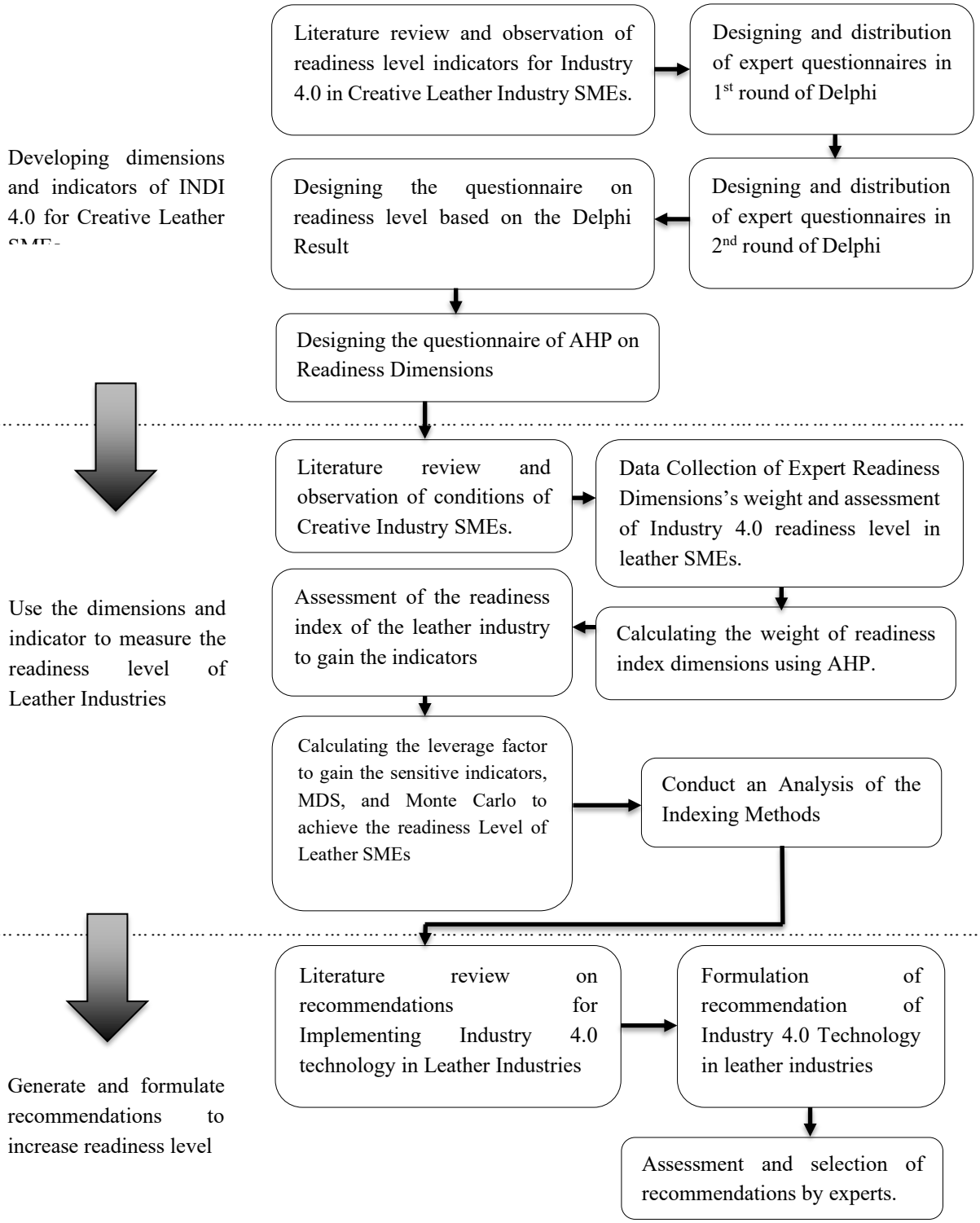
e-ISSN: 2460-5328

Figure 1. Research Methods



p-ISSN: 2088-1231
e-ISSN: 2460-5328

***Developing Measurement Indicators***

The dimensions and indicators of INDI 4.0 as a starting point in developing the measurement tools are presented in Table 4. Experts recommended adjustments to the INDI 4.0 questionnaire to measure the readiness of creative industry SMEs, acknowledging the differences between large enterprises and SMEs.

Table 4. The INDI 4.0 Dimensions, Definition, and Indicators of Measurement

| Dimensions | Sub-Dimensions | Reference | Indicators |
|---|---|---|---|
| Management & Organization | Knowledge and business management | (Mittal et al., 2018; Schumacher et al., 2016) | 1. *Government Permit Ownership*<br>2. *The process of licensing* |
| | | (Schumacher et al., 2016) | 3. *SIINAS Program*<br>4. *E-smart & Online Program*<br>5. *E-Katalog & TKDN* |
| | Strategy and Leadership | (Ministry of Industry of the Republic of Indonesia, 2018; Schumacher et al., 2016) | 6. *Management Support*<br>7. *Strategy* |
| | Investment towards Industry 4.0 | (Ministry of Industry of the Republic of Indonesia, 2018; Schumacher et al., 2016) | 8. *Investment I 4.0* |
| | Innovation Policy | (Ministry of Industry of the Republic of Indonesia, 2018; Schumacher et al., 2016) | 9. *Industry 4.0 Management Department*<br>10. *Innovation I 4.0* |
| People & Culture | Culture | (Gracel & Łebkowski, 2019; Ministry of Industry of the Republic of Indonesia, 2018; Pirola et al., 2019; Schumacher et al., 2016) | 11. *Employee Culture*<br>12. *Work Ethics of Employees* |
| | | (Gracel & Łebkowski, 2019; Ministry of Industry of the Republic of Indonesia, 2018) | 13. *Employee Habits* |
| | Openness to change | (Ministry of Industry of the Republic of Indonesia, 2018) | 14. *Employee Openness* |
| | Competency Development | (Gracel & Łebkowski, 2019; Ministry of Industry of the Republic of Indonesia, 2018; Mittal et al., 2018; Schumacher et al., 2016) | 15. *Industry 4.0 Training* |
| | Technology Utilization Capacity | (Gracel & Łebkowski, 2019) | 16. *Information Technology Skills* |
| | Company Collaboration | (Chonsawat & Sopadang, 2020) | 17. *Collaboration Areas* |
| Products & Services | Data-driven services | (Akdil et al., 2018; Çınar et al., 2021; Lichtblau et al., 2015; Ministry of Industry of the Republic of Indonesia, 2018) | 18. *Customer Data Analysis*<br>19. *Objectives of Data Analysis* |
| | Product Technology | (Akdil et al., 2018; Çınar et al., 2021; Ministry of Industry of the Republic of Indonesia, 2018; Mittal et al., 2018; Pirola et al., 2019; Schumacher et al., 2016) | 20. *Product Technology* |
| | Product Customization | (Chonsawat & Sopadang, 2020; Ministry of Industry of the Republic of Indonesia, 2018) | 21. *Product Customization* |

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| Dimensions | Sub-Dimensions | Reference | Indicators |
|---|---|---|---|
| Technology | Connectivity | (Chonsawat & Sopadang, 2020; Çınar et al., 2021; Gracel & Łebkowski, 2019; Lichtblau et al., 2015; Ministry of Industry of the Republic of Indonesia, 2018) | 22. *System Connectivity* |
| | Machinery Technology | (Akdil et al., 2018; Chonsawat & Sopadang, 2020; Ministry of Industry of the Republic of Indonesia, 2018) | 23. *Production Technology* |
| | Digitalization | (Akdil et al., 2018; Antony et al., 2023; Chonsawat & Sopadang, 2019; Lichtblau et al., 2015; Ministry of Industry of the Republic of Indonesia, 2018) | 24. *Level of Digitalization* |
| Operation | Data storage and sharing | (Chonsawat & Sopadang, 2019; Ministry of Industry of the Republic of Indonesia, 2018) | 25. *Data Storage* |
| | Smart supply chain and logistics | (Chonsawat & Sopadang, 2019; EDB Singapore, 2017; Lichtblau et al., 2015; Ministry of Industry of the Republic of Indonesia, 2018; Mittal et al., 2018) | 26. *Supply Chain and Logistics System* |
| | Autonomous processes | (Akdil et al., 2018a; Chonsawat & Sopadang, 2019a; Çınar et al., 2021; Lichtblau et al., 2015; Ministry of Industry of the Republic of Indonesia, 2018b) | 27. *Level of Automation* |
| | Intelligent maintenance systems | (Gracel & Łebkowski, 2019a; Ministry of Industry of the Republic of Indonesia, 2018b; Mittal et al., 2018a) | 28. *Machine Maintenance System* |
| | *Financial systems* | *(Akdil et al., 2018; Chonsawat & Sopadang, 2020; Mittal et al., 2018)* | 29. *Cash Flow Analysis*<br>30. *Financial System Digitalization*<br>31. *Financial Risk Measurement Analysis*<br>32. *Accounting Applications* |
| | *Marketing systems* | *(Akdil et al., 2018; Chonsawat & Sopadang, 2019)* | 33. *Product Promotion Digitalization*<br>34. *Content Analysis*<br>35. *Sales Channel Integration*<br>36. *Sales Applications* |

Insights from various sources highlight management and organizational dimensions. Schumacher examined the adoption of government policy, while Gracel evaluated the effectiveness of information resources. Barati and Mittal focused on the legal and policy aspects of SMEs. Gruffman identified challenges related to government roles and SMEs, while Khanzode highlighted barriers, including top management's lack of knowledge. Malik's research on Indonesian SMEs identified critical obstacles, including poor collaboration and limited technological expertise, underscoring the need to address them to enhance digital readiness and competitiveness.

p-ISSN: 2088-1231
e-ISSN: 2460-5328

***Measuring Readiness Index***

Data on the leather industry in Yogyakarta is generally grouped under the clothing/crafts category, so estimates are based on sectoral data and industrial centers. There are 401 craft SMEs, and not all of them use leather as raw materials; there are also batik, garment, and wood-based industries (Department of Industry, 2022).

Small industries employ up to 19 workers and have investments of up to 1 billion IDR. In comparison, medium industries employ at least 20 workers and invest between 1 billion and 15 billion IDR (Ministry of Industry of the Republic of Indonesia, 2016). Using Cochran's formula with a sample size of 75 Units has a standard error of 10%, so the confidence level is 90% (Singh & Masuku, 2014). The sample size that represents Leather SMEs in Jogjakarta is calculated to be 43 Units. Respondents are divided into the top, middle, and low management of the SME leather industry. Monte Carlo estimates the effect of errors on the 95% confidence interval. This Monte Carlo index value is compared with the MDS index. Stress values and the coefficient of determination ($R^2$) are used to determine whether additional attributes are needed and to assess the accuracy of the studied dimensions in reflecting the actual situation (Kavanagh & Pitcher, 2004). The assessment results were computed using MDS in Excel. The weighting is based on expert opinions using the AHP method. The weight values for each dimension based on the AHP from the experts are described in Table 5.

Table 5. Dimensions Weight

| Dimensions | Weight |
|---|---|
| Management & Organizations | 25,5% |
| People & Culture | 41,6% |
| Product & Services | 7,78% |
| Technology | 12% |
| Factory Operations | 12,9% |

Subsequently, the readiness level was categorized based on the MDS analysis, as shown in Table 6.

Table 6. The Category of Readiness Level *(Kavanagh & Pitcher, 2004)*

| *Level* | Value Range | Readiness Status |
|---|---|---|
| 0 | 0,0 – 0,50 | Poor (Underprepared) |
| 1 | 0,51 – 1,50 | Insufficient (Less Prepared) |
| 2 | 1,51 – 2,50 | Adequate (Moderately Prepared) |
| 3 | 2,51 – 3,50 | Good (Very Prepared) |

## RESULTS AND DISCUSSION

***INDI 4.0 for the Assessment of Readiness Level for Leather SMEs.***

Expert opinion data for indicator validation were processed and summarized using a questionnaire with a scale of 1 to 5. The processed results, which include the average assessments of five experts for the first and second rounds, are presented in Table 5. The findings in Table 5 indicate that two indicators have relatively low importance. These two indicators were removed to obtain a Kendall's test value above 0.3, which signifies expert agreement. The analysis produced 38 indicators, with a second Kendall coefficient of concordance of 0.4 (Saaty, 1977), indicating consensus among the experts regarding the final

p-ISSN: 2088-1231
e-ISSN: 2460-5328

questionnaire. Table 7 presents the final indicators to be used to evaluate the readiness index of Leather SMEs.

Table 7. The Delphi Result

| INDI 4.0 Indicators | Added Indicators | Mean (Round) 1st | Mean (Round) 2nd | Priority |
|---|---|---|---|---|
| **Dimension: Management and Organization** | | | | |
| | Government Permit Ownership | 4.8 | 5 | Very Important |
| | The process of licensing | 4.6 | 5 | Very Important |
| | SIINAS Program | 4.4 | 4.4 | Important |
| | Program *e-smart* & Online program | 4.4 | 4.6 | Important |
| | E-Katalog & TKDN | 4 | 4.2 | Important |
| Management Support | | 4.6 | 5 | Very Important |
| Strategy | | 4.6 | 5 | Very Important |
| Investment I 4.0 | | 4.8 | 4.8 | Very Important |
| Management Departement | | 4.8 | 5 | Very Important |
| Innovation I 4.0 | | 4.8 | 5 | Very Important |
| **Dimension: People and Culture** | | | | |
| Employee Culture | | 3.1 | 5 | Very Important |
| Work Ethic | | 3.2 | 5 | Very Important |
| Habits | | 3.3 | 4.4 | Very Important |
| Openness | | 3.4 | 4.8 | Very Important |
| Industry 4.0 | | 3.5 | 4.6 | Very Important |
| | Information Technology | 3.6 | 4.6 | Very Important |
| | Collaboration Areas | 3.7 | 4.8 | Very Important |
| **Dimension: Product and Services** | | | | |
| Product Customization | | 5 | 5 | Very Important |
| Customers Data Analysis | | 4.6 | 5 | Very Important |
| Objectives of Data Analysis | | 4.6 | 5 | Very Important |
| Product Technology | | 4.4 | 4.6 | Very Important |
| **Dimension: Technology** | | | | |
| System Connectivity | | 5,3 | 4,6 | Very Important |
| Business Connectivity | | 3 | 2 | Less Important |
| Cyber Security | | 2 | 1,2 | Less Important |
| Production Technology | | 4,91 | 4,91 | Very Important |
| Digitalization | | 4,55 | 4,55 | Very Important |
| **Dimension: Factory Operation** | | | | |
| Data Storage | | 4.6 | 5 | Very Important |
| Supply Chain & Logistics System | | 4.4 | 4.8 | Very Important |
| Level of Automation | | 4.6 | 5 | Very Important |
| Machine Maintenance System | | 4.6 | 5 | Very Important |
| | Cash Flow Analysis | 4.6 | 5 | Very Important |
| | Financial System Digitalization | 4.8 | 5 | Very Important |
| | Financial Risk Measurement Analysis | 4 | 4 | Important |
| | Accounting Applications | 4.6 | 4.4 | Very Important |
| | Product Promotion Digitalization | 4.8 | 5 | Very Important |
| | Content Analysis | 4.8 | 5 | Very Important |
| | Sales Channel Integration | 4.6 | 4.4 | Very Important |
| | Sales Application | 4.8 | 5 | Very Important |

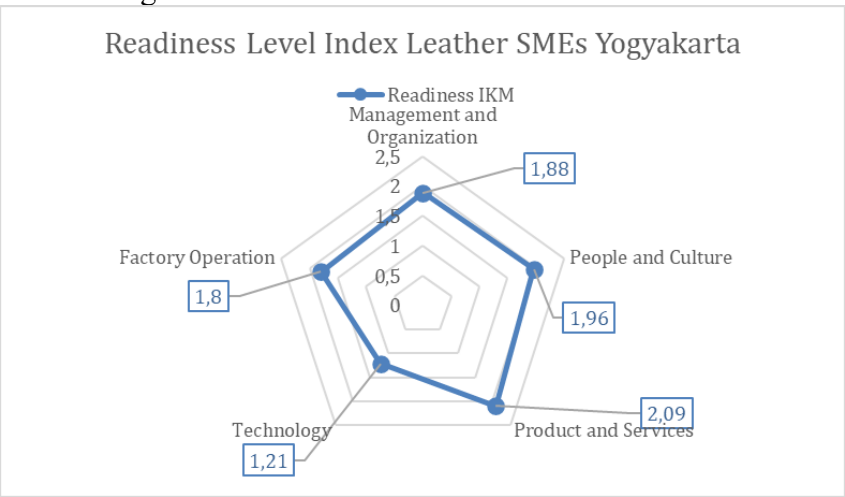
p-ISSN: 2088-1231
e-ISSN: 2460-5328

The contribution of this research is to develop dimensions and indicators suitable for the creative industry. Table 7 shows that the indicators provided by the expert from the open questions, using the Delphi method, yield several additional indicators for the management and organization dimension, the people and culture dimension, and the factory operation dimension. These additional indicators shed light on digitalization issues in marketing and finance that were not yet fully addressed in INDI 4.0. There is also additional collaboration to strengthen supply chain channels and expand factory operations to include inter-enterprise operations.

***Assessment Result of Readiness Level***

The following graph shows the Readiness Level Index for Leather SMEs in Yogyakarta across various dimensions. It assesses the preparedness of these businesses in areas such as Management and Organization, People and Culture, Product and Services, Technology, and Factory Operation. Each dimension has been evaluated to determine the overall readiness, highlighting areas of strength and those requiring improvement. This data is crucial for understanding where efforts should be focused to enhance the digital readiness and operational efficiency of leather SMEs in the region.

Figure 2. Assessment Result of Readiness Level




Measurement by multiplying the weight and rating value is like the weighted scoring method. The readiness index in figure 2, multiplied by a weight as in table 5, gives a value of 1.9, falls into Level 1 (initial readiness). The rating questionnaire uses a scale of 1 to 4 and the total weight is equal to 1. Meanwhile, MDS and Monte Carlo calculations use a scale of 100. The comparison of the values between the assessment results with MDS with Monte Carlo which is not too far or less than 5% shows that the assessment results are valid.

These findings align with those of other studies (Ekawati & Rahayu, 2021). Different calculation methods generated similar results, highlighting the multidimensional uniqueness of each SME. The Singapore Smart Industry Readiness Index for the textile industry in West Java showed identical outcomes, whereas SMEs in Riau demonstrated below-average digital readiness (Okfalisa et al., 2022). These disparities in findings may stem from differences in the dimensions of digital measurements used to assess the digital business's success. Thus, suggestions for improvement across all aspects are necessary (Utomo & Setiastuti, 2019). Research on SMEs' readiness for INDI 4.0 is scarce, focusing mainly on developing INDI 4.0 dimensions or indicators rather than on calculating readiness-level indices. Some studies

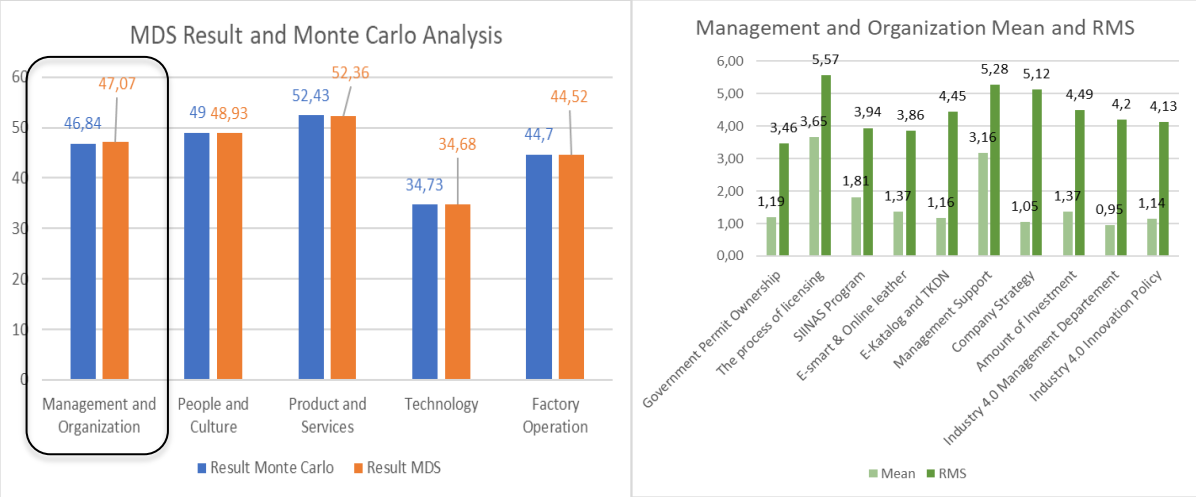
p-ISSN: 2088-1231
e-ISSN: 2460-5328

examine socio-economic factors, assessment tools, and the weaknesses of INDI 4.0. However, there is still a need for readiness level index measurements tailored specifically for SMEs (Araliz et al., 2024; Hasbullah et al., 2021; Prakosa et al., 2024).

**MDS on Management and Organization Dimension**

The MDS analysis reveals an average readiness index of 47.07 in the management and organizational dimensions for Leather SMEs in Yogyakarta, indicating a lower level of preparedness (25.01-50.00). Those classified as underprepared and less prepared are in the initial stages of planning for legalization, underutilizing government programs, and recognizing the necessity of an Industry 4.0 strategy and business requirements. Conversely, the moderate and very prepared have already completed legalization, fully utilized government programs, and are actively addressing strategy and business needs for Industry 4.0. The MDS result and the Monte Carlo are shown in Figure 3. Slight Monte Carlo difference (<5%) suggests minimal scoring errors relative to score (Kavanagh & Pitcher, 2004).

Figure 3. MDS Management & Organisation and Monte Carlo Analysis




The highest average scores were given to the knowledge of licensing processes indicator, while the lowest was for the Industry 4.0 department indicator. A significant gap between the average and leverage values was observed in the Strategy for Industry 4.0 indicator, which had the third-highest leverage. Many SMEs have not yet implemented this, highlighting the need for attention. Sensitivity to strategy can lead to ideas such as investment and Industry 4.0 management. This aligns with other findings indicating that only 5% of 57 automotive SME owners have implemented Industry 4.0 strategies due to limited access to information, ongoing guidance, training, and support (Tama et al., 2021).

**MDS on People and Culture**

The MDS analysis indicated an average readiness index of 48.93, positioning Leather SMEs in Jogjakarta as less prepared (50.01-75.00). This status is attributed to a gap in employee work ethic and a lack of readiness for Industry 4.0 transformation. Despite a desire to adopt advancements, actual implementation is lacking. Collaboration with other sectors remains underdeveloped. However, the slight Monte Carlo difference (below 5%) indicates minimal scoring errors. The MDS results for the people and culture dimension are described in Figure 4.

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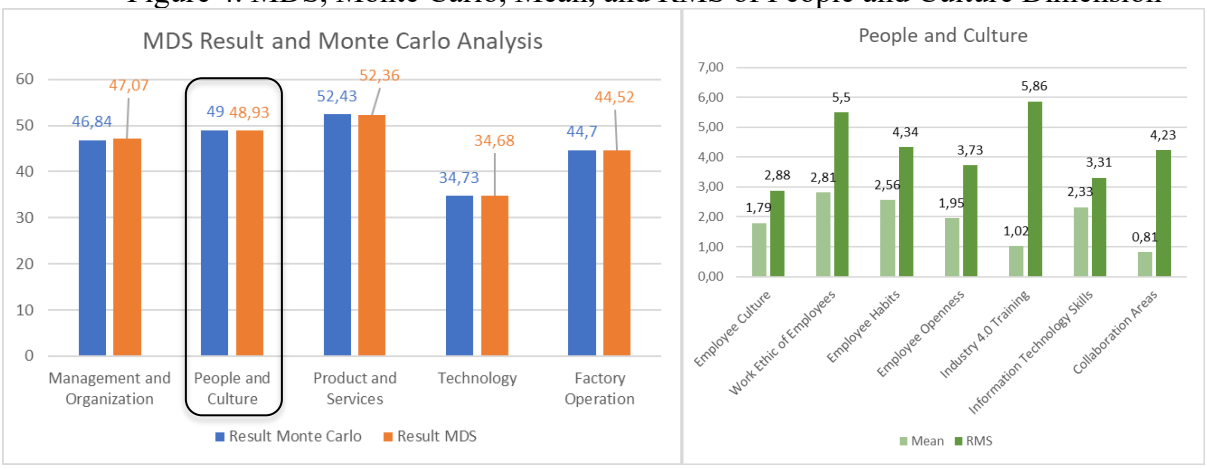
Figure 4. MDS, Monte Carlo, Mean, and RMS of People and Culture Dimension

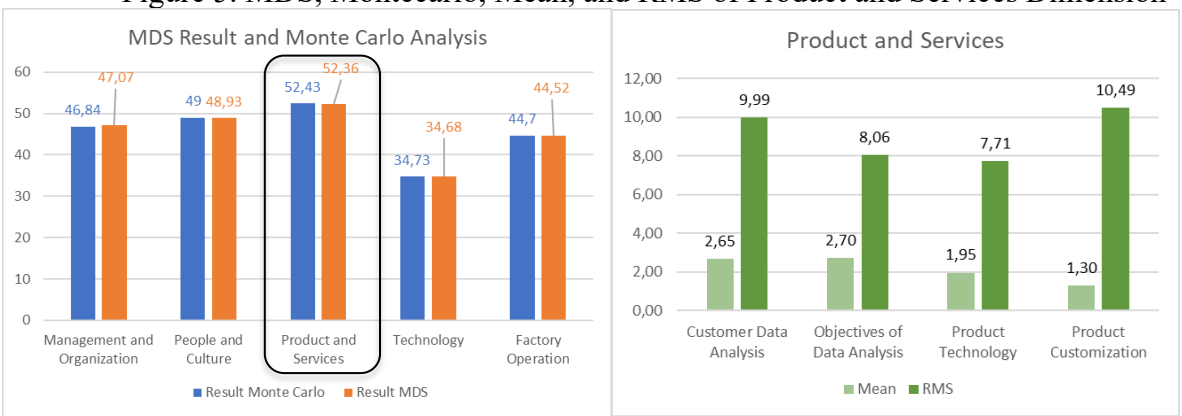



The analysis of sensitive indicators for Industry 4.0 readiness highlights that Industry 4.0 training and work ethics are crucial. These indicators, with the highest RMS values in the environmental dimension, underscore the need to invest in training and reinforce work ethics among SMEs. Training is vital because of rapid technological advancements, which require a skilled workforce proficient in IoT, AI, and automation. Improved work ethics ensure that employees are adaptive, innovative, and results-oriented. Focusing on these areas provides a strong foundation for strategies to address readiness gaps, enhance competitiveness, and accelerate adaptation to industrial transformation.

**MDS on Product and Services**

The MDS analysis revealed a readiness index of 52.36 in the Product and Service dimension describe in Figure 5,, indicating a moderately prepared status between 50.01-and 75.00, with about 61% of SMEs falling within this range, influenced by well-executed readiness indicators among Leather SMEs in Yogyakarta; SMEs with good readiness effectively utilize customer data for business purposes like preferred design research, essential for understanding market interests, and employ technology such as barcodes for sales tracking, with minimal errors in scoring indicated by a Monte Carlo simulation difference below 5% (Kavanagh & Pitcher, 2004).

Figure 5. MDS, Montecarlo, Mean, and RMS of Product and Services Dimension



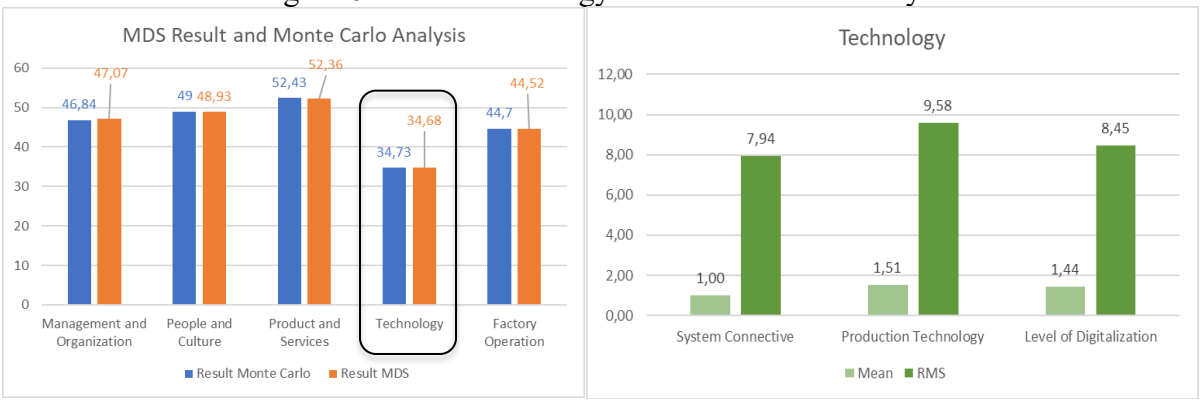
p-ISSN: 2088-1231
e-ISSN: 2460-5328

The customer data analysis indicator has the highest average scores, while the lowest was for product technology. Product technology had high leverage, enabling tracking of sold products, conducting market research to boost sales, and reaching diverse customers. Connecting products to the internet can accelerate sales, making this indicator crucial. Therefore, SMEs must enhance their product technology readiness to improve and expand their market reach.

**MDS on Technology**

Based on the MDS analysis in the Technology dimension, an average readiness index of 30.30 was obtained, indicating a lower level of preparedness, as it falls between 25.01 and 50.00. The table above shows that 87% of SMEs are classified as unprepared or less prepared in the Industry 4.0 technology dimension. This percentage needs to be a significant concern for SMEs. The smaller the business, the greater the benefits from implementing technology in its operations (Arendt, 2008). The slight difference in Monte Carlo, in this case below 5%, indicates minimal scoring errors relative to the variation in scores across indicators (Kavanagh & Pitcher, 2004). Figure 6 shows the results of MDS for the Technology dimension.

Figure 6. MDS Technology and Monte Carlo Analysis




Smaller businesses can achieve greater profit by implementing technology. Digital readiness assessments indicate that technology use remains low among SMEs, especially in eastern regions where traditional methods prevail (Fathian et al., 2008). In contrast, Western SMEs often use daily technology. Research on creative industry readiness in Central Java reveals that SMEs are often skeptical of technology, which complicates their work (Winarsih & Hendar, 2019). However, two out of four readiness assessments indicate high technological readiness, primarily in medium manufacturing companies planning to automate (Agusti et al., 2023). Thus, increased digitalization and technological advancements will enhance SME readiness.

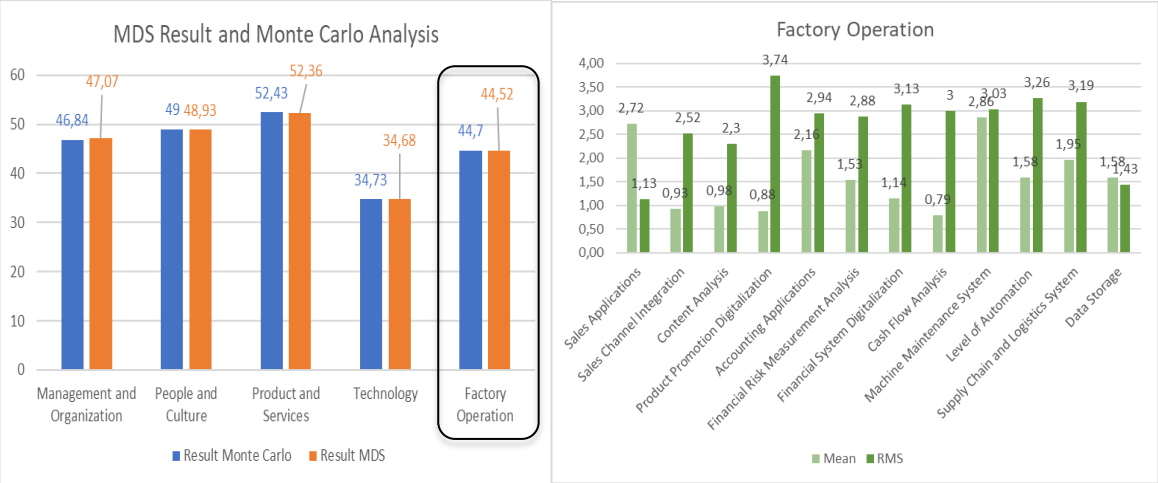
**MDS on Factory Operation**

The poor readiness at 56% of SMEs, only a few have already implemented company data storage because most companies already have internet access, supply chain and logistics systems, company automation processes, machine maintenance systems, flow analysis, digitalization of financial systems, financial risk measurement analysis, accounting applications, marketing team support level, content analysts, company sales channels, product sales applications. In contrast, the SMEs in good readiness have already implemented all of the

p-ISSN: 2088-1231
e-ISSN: 2460-5328

above. The slight difference in Monte Carlo, in this case below 5%, indicates minimal scoring errors relative to the variation in scores across indicators *(Kavanagh & Pitcher, 2004)*. Figure 7 describes the results of MDS for the factory operation dimension.

Figure 7. MDS Factory Operation




The largest gap between the mean and RMS is in the digitalization of product promotion. SMEs can boost exposure by using digital marketing to attract consumers and enhance online accessibility. Furthermore, digital marketing positively impacts financial performance (Zhang et al., 2025). Leverage analysis reveals how sensitive indicators influence readiness indexes; higher RMS values indicate a greater impact. Enhancing specific readiness dimensions involves adjusting these sensitive indicators, with the top leverage factors in operations being automation levels and digital promotion.

The assessment results for the INDI 4.0 implementation readiness, by dimension, revealed several points on what the leather creative industry needs to improve to raise the readiness index. In the management and organization dimension, management support needs improvement, particularly in strengthening business management skills. In the people and culture dimension, training is needed, particularly related to digital marketing and financial skills. In the product and service dimension, online services need improvement, so technology investments are made to stay connected to the online market. In the factory operation dimension, more intensive collaboration with product suppliers and distributors is needed.

## CONCLUSION

In conclusion, the readiness level for Industry 4.0 transformation in Leather SMEs in Yogyakarta, based on the INDI 4.0 model, reveals an overall index of 1.9, indicating level 1 readiness or initial readiness. The lowest readiness lies in technology connectivity, indicating the need for improvement. Investing in technology and infrastructure is vital. SMEs must focus on acquiring the necessary digital skills and tools to remain competitive. This includes adopting e-commerce and continuous learning about digital transformation. Improvements are needed in product technology and the industry 4.0 strategy. Digital marketing and product customization using technology can significantly enhance market reach and efficiency. SMEs need to embrace digital tools for product promotion and operations, although the highest, the people and culture dimension requires better system connectivity. Developing a solid work ethic and innovative culture is crucial. Training programs and continuous development are essential for employees

p-ISSN: 2088-1231
e-ISSN: 2460-5328

to adapt to Industry 4.0 technologies. Given its significant weight, enhancing this dimension will notably boost overall readiness. Recommendations include providing employee technology training and fostering more robust collaboration networks with related industries.

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