Productivity *Analysis*

Unlocking Productivity and Growth Potential: Digital Adoption in Indonesia's Manufacturing MSEs

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UNLOCKING PRODUCTIVITY AND GROWTH POTENTIAL: DIGITAL ADOPTION IN INDONESIA'S MANUFACTURING MSEs

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PRODUCTIVITY ANALYSIS
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I would also like to thank the team that has worked hard in completing this report. Special thanks to my colleague at the APO, Santi Setiawati, for her dedication, collaboration, and outstanding contributions during the process of preparing this report. We hope the insights provided in this report will serve as a valuable resource in enhancing the productivity of Indonesia's micro and small enterprises (MSEs) and fostering sustainable growth in the future.

Jakarta, November 2024

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EXECUTIVE SUMMARY

Digitalization is essential for enhancing the productivity and competitiveness of MSEs within Indonesia's manufacturing sector. This report aims to use the impact of digital technology adoption on total factor productivity (TFP), labor productivity, and capital productivity in MSEs, as well as to spread the level of digital skills possessed by the workforce. Using data from the Annual Micro and Small Industry Survey (VIMK) and the National Labor Force Survey (SAKERNAS) from 2019 to 2020, this report provides insights into how digitalization affects the efficiency and performance of MSEs.

TFP analysis shows that despite the increase in digital technology adoption during the COVID-19 pandemic, MSE productivity has not increased uniformly. Microenterprises showed stability and even a slight increase in TFP, while small businesses experienced a decline in productivity. During the COVID-19 pandemic, forced digital adoption accelerated digital transformation but also revealed uneven unpreparedness, especially among the small businesses that faced resource constraints and were less adaptable than microenterprises. These problems were and continue to be exacerbated by the low digital literacy of the Indonesian workforce in general. Therefore, joint efforts are needed to improve digital literacy and provide technical support so that digital transformation can be more inclusive and effective.

The findings revealed that most MSEs' workforce has basic digital skills. Low levels of digital skills hinder the effective adoption of technology, which ultimately affects productivity. This skills gap needs to be addressed through better education and training focused on technical skills and the use of digital tools to improve efficiency.

This report's conclusions affirm that improving digital literacy and access to technology are critical to accelerating inclusive digital transformation. Key recommendations include increasing basic education to at least nine years to

provide a better foundation for digital literacy, providing digital-specific training relevant to the needs of MSEs, and supporting infrastructure and finance to expand technology adoption. Implementing these measures is expected to increase productivity, strengthen resilience, and drive sustainable economic growth in Indonesia.

INTRODUCTION

Micro, small, and medium enterprises (MSMEs) make a significant contribution to the global economy, serving as a primary engine of economic growth and job creation (Madgavkar et al., 2024; Hamilton, 2023). MSMEs represent about 90% of total businesses worldwide, create over 70% of jobs, and contribute approximately 50% to the global GDP (WTO, 2022; Hamilton, 2023). In many developing countries, MSMEs not only generate employment but also spur economic development (WTO, 2022). For instance, in Kenya, MSMEs account for around 60% of the country's GDP and contribute approximately 96% of total employment (Madgavkar et al., 2024).

In the context of Indonesia, MSMEs play a crucial role in economic growth: in 2019 their numbers dominate the total business units in Indonesia, totaling 65.4 million, or about 99% of all business units (Ministry of Cooperatives and Small and Medium-sized Enterprises of the Republic of Indonesia, 2023). Additionally, Indonesian MSMEs contribute more than 60% of the country's GDP and provide 96% of total employment (Ministry of Cooperatives and Small and Medium-sized Enterprises of the Republic of Indonesia, 2023).

In various developing countries, MSEs also dominate, both in terms of employment absorption and as drivers of economic development. They represent 90% of all businesses and over 50% of employment globally. Formal MSEs contribute up to 40% of the GDP in developing countries (World Bank, 2019). Additionally, in countries such as India, Kenya, and Nigeria, microenterprises employ more than 90% of the MSE workforce, with most being self-employed individuals and contributing family members (Madgavkar et al., 2024). This pattern underscores the reliance on microenterprises for job creation and economic stability in these regions.

Government Regulation Number 7 of 2021 (Database Peraturan) and Law Number 11 of 2020 were issued by the Indonesian government. Under these

regulations, small and medium-sized enterprises (SMEs) are classified based on business capital criteria or annual sales. According to these provisions, a microenterprise with capital of up to IDR1 billion, excluding land and buildings for business premises, is defined as a business. Meanwhile, a small enterprise is one with business capital of more than IDR1 billion but not exceeding IDR5 billion, also excluding land and buildings for business premises.

According to Statistics Indonesia (*Badan Pusat Statistik*), microenterprises typically employ between one and four people and operate at the community level, so they are often shaped by local demand and resource availability. Examples include small grocery stores, family-owned eateries, or repair shops. This small scale means that owners play dual roles as entrepreneurs and integral community members, fostering interdependent economic relationships. Meanwhile, small enterprises employ five to 19 workers and run more structured operations than microenterprises. Together, they contribute to job creation and bolster the local economy, especially in regions with limited employment opportunities. This study will use the definitions of MSEs as provided by Statistics Indonesia.

TABLE 1

THE AVERAGE REVENUE AND SHARE OF MICRO, SMALL, MEDIUM, AND LARGE ENTERPRISES.

Business Category	% Business Units (2019)	% Contribution to GDP (2018)	% Contribution to Employment (2018)
Micro	98.67%	37.4%	89.03%
Small	1.22%	9.5%	4.83%
Medium	0.10%	13.6%	3.13%
Large	0.01%	39.5%	3.00%
Total	100%	100%	

Source: Ministry of Cooperatives and Small and Medium-sized Enterprises (2023), Katadata (2023), Haryanti (2024).

A similar pattern to that seen globally and in some developing countries is observed in Indonesia (Berry et al., 2001), where MSEs also serve as the backbone of the economy by providing employment for 93% of the total workforce, with over 89% comprising microenterprises (Table 1). This scale of presence also makes a substantial contribution to the GDP; in 2019, MSEs accounted for about 47% of the total GDP (Table 1).

Despite the critical role of MSEs in the economy, their sustainability and growth potential heavily depend on productivity levels. Business and labor productivity play crucial roles across various economic levels (Azis, 2024; International Labour Organization, 2015). Productivity, measured by the output-to-input ratio, not only reflects resource utilization efficiency but also illustrates the contribution of inputs to the generation of greater output (Balk, 2001). For business entities, productivity improvements support profit increases, open investment opportunities, and allow them to remain competitive by offering higher wages and better returns. For workers, higher productivity provides the potential for wage increases and improved working conditions. At the macro level, productivity growth is key to economic resilience and job creation, as strong productivity strengthens a country's ability to recover from crises and face long-term challenges such as climate change and an aging population.

However, MSEs often experience low productivity, impacting their economic contribution (International Labour Organization, 2019). Small manufacturing enterprises' productivity is typically only about half that of large firms, especially in developing countries, with the gap continuing to widen despite various efforts to support MSEs. A primary cause of this productivity disparity is the scale of MSEs themselves; they face limitations in size, resources, and access to advanced technology (Nuryakin et al., 2024). If MSEs' productivity could be raised to reach the top quartile, their contribution could increase GDP by up to 5% in developed countries and 10% in developing countries (Madgavkar et al., 2024). MSEs' productivity also varies significantly across countries and sectors, indicating substantial room for improvement. For instance, manufacturing MSEs in Japan exhibit higher productivity than their counterparts in other developed countries, benefiting from strong collaborative networks and a willingness to learn from larger firms (Madgavkar et al., 2023). This support has proven to strengthen the competitiveness and productivity of Japanese MSEs, offering a model for MSEs in other countries.

Additionally, one of the sectors with the most widespread economic output and contributing the largest share of GDP through increased MSE productivity is manufacturing. Manufacturing has historically been recognized as an engine of economic growth, especially in developing countries. Empirical studies suggest that an increase in the manufacturing sector's share of GDP correlates positively with overall economic growth (United Nations, 2016). Therefore,

MSEs' productivity must be encouraged to support economic growth, particularly in the manufacturing sector.

However, the *OECD Compendium of Productivity Indicators report* (OECD, 2024) indicates that productivity among MSEs in the manufacturing sector remains low. This is evident in the productivity gap between micro and large enterprises within this sector, which is larger than in other economic sectors overall. This gap results from the economies of scale enjoyed by large companies, leading to greater efficiency and higher productivity than smaller enterprises. One source of increased efficiency in scaling up MSEs is innovation (Nuryakin et al., 2024). Nevertheless, many MSEs face challenges in fostering a culture of innovation due to limited resources and support, which often hinders their capacity to enhance productivity. A commitment to innovation can not only facilitate productivity improvements but also support MSEs in expanding their business size.

Digitalization is considered the foundation of the Fourth Industrial Revolution, where technology is transforming various aspects of life, including business practices (Das et al., 2016). Digital technology opens up opportunities for companies to transform their production processes and business models while supporting development in multiple ways (World Bank, 2016). The internet enables automation and coordination to enhance efficiency; streamlines communication and collaboration to foster innovation; and creates market effects through expanded trade, job creation, and improved access to public services, thereby strengthening social and economic inclusion. MSEs can leverage the digital economy to acquire new skills and improve production efficiency through the internet, ultimately supporting their productivity growth. Additionally, Azis (2024) emphasizes that digital technology can significantly drive MSE productivity by increasing their visibility to lenders, improving financial records, and enabling better credit risk assessments. Enhanced digital presence makes it easier for MSEs to access credit facilities, such as *Kredit Usaha Rakyat* (People's Business Credit).

According to Statistics Indonesia, manufacturing MSEs employed 9.42 million people in 2022. Despite their growing role in employment, MSEs' ability to enhance competitiveness remains constrained. In developing countries, the labor market is dominated by the informal sector (Lambert et al., 2020). This sector acts as a cushion for job seekers unable to secure employment in the

formal sector or those pushed out by more qualified candidates in the formal job market. As a result, many individuals with a low level of education enter the informal sector. Educational attainment also impacts a person's digital skills (Eurostat, 2024). This is evident in EU countries, where a digital skill gap of 46% exists between individuals with higher education and those with little or no formal education.

Although awareness of the importance of technology is rising, many MSEs still lack the skills to effectively adopt digital technology, leading to a slow digitalization process (Zahoor et al., 2023). Many MSEs struggle to transition from offline to online operations and often cannot fully utilize digital technology (Kurniawati et al., 2021; Economic Research Institute for ASEAN and East Asia, 2019). By 2020, around 70% of MSEs had increasingly adopted digital technology due to COVID-19. However, the gap between MSEs and large companies remains significant, with digital technology use by MSEs being only half that of large companies (OECD, 2021). This low adoption is mainly due to limited technological literacy and inadequate support facilities (Redjeki & Affandi, 2021).

In the manufacturing context, digitalization offers great potential for boosting productivity, yet its implementation often presents various barriers (OECD, 2021). Studies show that while digitalization can provide substantial benefits, the application of digital technology does not automatically increase productivity and rarely occurs without friction (Horvat et al., 2019). Many manufacturing companies still face cultural and organizational challenges, as well as a lack of knowledge of how to adapt their business models to align with new technology.

This study focused on the years 2019 and 2020, a period during which digitalization saw a sharp increase, especially during the COVID-19 pandemic in 2020. In developed countries, digitalization rose by an average of 6% in 2021 compared to 2020 when the COVID-19 pandemic was still ongoing (Jaumotte et al., 2023). The increased proportion of workers using computers also reflects a rise in digitalization, which has wide-ranging and long-term implications for productivity. Although digitalization was expected to boost productivity, productivity levels actually declined in 2020. According to a Statistics Indonesia publication (2021), in 2020, MSE production growth dropped sharply to negative from January to June. In the second quarter, it

reached its lowest point since 2011, of -21.31%. However, in the third and fourth quarters of 2020, production growth increased but still experienced contraction. Gaglio et al. (2022) conducted research examining the relationship between digital communication, technology use, innovation performance, and productivity in MSEs in middle-income countries using an expanded version of the Crepon-Duguet-Mairesse (1998) model. Gaglio et al.'s study sampled MSEs in South Africa, focusing on how digital technology can enhance productivity through improved innovation performance. On the other hand, prior research by Falentina et al. (2021) examined the impact of internet use, as a form of digitalization, on the performance of MSEs in Yogyakarta province, Indonesia. While both studies provide valuable insights into the role of digitalization in MSEs, there is still a research gap regarding MSEs in the manufacturing sector, particularly in Indonesia, which needs to be addressed.

This study will examine the relationship between digitalization and productivity in MSEs within Indonesia's manufacturing sector. By examining data from VIMK and the National Labor Force Statistics Survey (SAKERNAS) 2019–2020, this research aims to analyze the role of digitalization in enhancing productivity and digital skills in MSEs in the manufacturing sector. Digital transformation is considered crucial as it provides opportunities for MSEs to adapt to modern economic developments and compete with other businesses in broader markets, both nationally and globally.

DIGITALIZATION AND TOTAL FACTOR PRODUCTIVITY IN MANUFACTURING

Total Factor Productivity of Manufacturing Micro and Small Enterprises in Indonesia before and during COVID-19

Business productivity can be measured in various ways, such as by measuring labor productivity and capital productivity, which each highlight a different aspect of a firm's inputs. One way to holistically understand these productivity dynamics is through the lens of total factor productivity (TFP), which offers a broad view of efficiency. It captures the full scope of how well enterprises (including micro and small manufacturing enterprises) combine all their inputs, including labor, capital, and even technological innovations, to generate output. In this sense, TFP looks beyond just the amount of labor or capital invested. It assesses how effectively these inputs are transformed into outputs, capturing improvements from smarter resource use rather than simply adding more inputs. TFP measures the portion of output not directly explained by labor or capital, reflecting gains from innovation, technology, efficiency, and other factors unrelated to input quantity alone. Box 1 provides the detailed calculation of TFP we used in this study.

Figure 1 exhibits the dynamics of TFP in 2019–2020. Interestingly, despite the severe disruptions caused by the COVID-19 pandemic, the aggregate TFP of manufacturing MSEs reveals an upward trend. At first glance, the increase in TFP suggests that, contrary to expectations of declining productivity during a crisis, the pandemic may have prompted certain efficiencies or shifts in operational strategies among these enterprises that allowed them to sustain or even improve productivity levels despite the challenging situation. However,

BOX 1

MEASURING PRODUCTIVITY USING TOTAL FACTOR PRODUCTIVITY.

Economists define TFP as the residual, representing unexplained variations in output and production. TFP is calculated by dividing the total output by the weighted geometric average of labor input. Following is the formula used to calculate TFP.

$$Y = AK^{\beta 1} L^{\beta 2} M^{\beta 3}$$

Y is total production, *A* is TFP, *K* is total capital input, *L* is total labor hours, *M* is total material input, and β is parameters for capital, labor, and raw material, describing output elasticity of capital, labor, and raw material. These variables were gathered from the VIMK.

To measure TFP in this study, we adapted the method of Nuryakin et al. (2017). We transformed the above formula into a natural logarithmic form to linearize it, allowing for easier estimation of elasticity coefficients. The natural logarithmic form is specified as follows:

$$lnY = lnA + \beta 1\ lnK\ + \beta 2\ lnL\ + \beta 3\ lnM\ + u$$

The total of β1, β2, and β3 shows the return to scale, describing how the output responds to a proportional change in all inputs, while *u* denotes an error term. Because the VIMK data cannot be structured as a panel (it lacks data points over multiple time periods for the same firms), this study used ordinary least squares (OLS) regression. TFP was derived as the exponentiated residuals from the OLS regression, converting the log-form residuals to TFP levels. In estimating the production function, we used output as the dependent variable (*Y*), although value added could also be used. Labor input (*L*) was measured in labor hours, capital (*K*) by assets, and raw materials (*M*) by the input expenses. All nominal figures were adjusted to real values.

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We acknowledge that the VIMK dataset may introduce potential unobserved heterogeneity, as firm-specific factors like management quality or company culture, though not directly observed, could impact productivity. Addressing this unobserved heterogeneity would ideally require panel data structure, but VIMK cannot be structured as a panel dataset. Nonetheless, VIMK remains one of the most comprehensive datasets available for analyzing productivity among small manufacturing enterprises in Indonesia, and we proceeded with this data for our analysis.

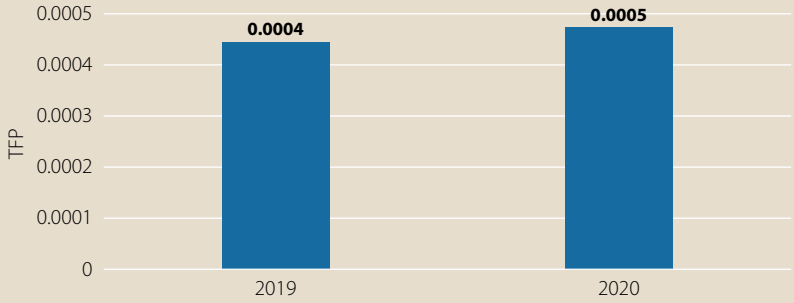
closer examination reveals a more complex picture when broken down by enterprise size: TFP for small enterprises actually declined, while that of microenterprises remained relatively stagnant with a modest increase (Figure 2). It is important to consider that the number of microenterprises far exceeds that of small enterprises (Ministry of Cooperatives and SMEs, 2022). Thus, this aggregate TFP increase seems to be largely driven by the substantial number of microenterprises, whose slight gains offset the decline in small enterprises. In Figure 2, we see that while the mean TFP for small enterprises (yellow) decreased significantly, the TFP for microenterprises (black) showed a modest increase, with their greater numbers contributing to the overall upward trend in aggregate TFP. The difference between microenterprises and small enterprises could be partially explained by government support initiatives specifically aimed at microenterprises, such as *Banpres Produktif Pelaku Usaha Mikro* (Productive Cash Assistance for Micro Business Actors). This program delivered essential financial aid and resources directly to microenterprises, providing a crucial buffer against the challenging market conditions. This assistance likely bolstered the resilience of microenterprises to maintain operations and navigate financial pressures more effectively than small enterprises, which did not receive the support.

Another possible explanation of why micro manufacturing enterprises appear relatively stable is their scale and nature making them "too small to fail." They typically operate with simple structures and lower operational costs. As noted by Civelek et al. (2016), the simple business structure of microenterprises allows them

to pivot their activities and even shift sectors with relative ease. This flexibility is a key factor in their resilience during challenging times, such as the pandemic. Their simple operational models enable rapid adaptation, whether by altering the products or services they offer, targeting new customer segments, or adopting informal, low-cost strategies to remain viable. This allows them to continue functioning even during periods of reduced demand or restricted activities.

FIGURE 1

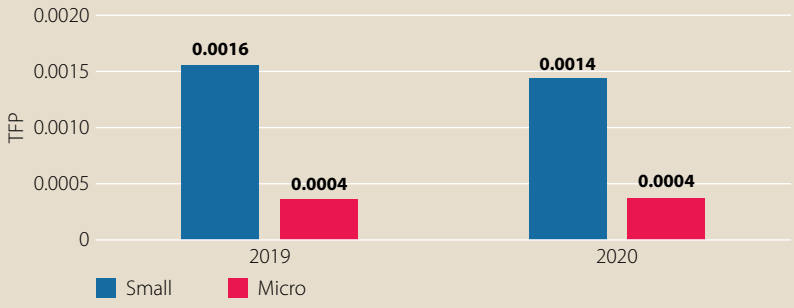
COMBINED TOTAL FACTOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES, 2019 AND 2020.



Note: TFP, total factor productivity.
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

FIGURE 2

TOTAL FACTOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES (BY SIZE), 2019 AND 2020.



Note: TFP, total factor productivity.
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

Internet Usage Effect on Productivity

As the internet weaves deeper into modern business, its role in reshaping business processes becomes ever more pronounced. Internet adoption alters how companies operate, access information, and connect with customers in today's digital economy. In this section, we will take a closer look at the conditions in Indonesia's manufacturing MSEs and how digital adoption, particularly of the internet, affects their productivity.

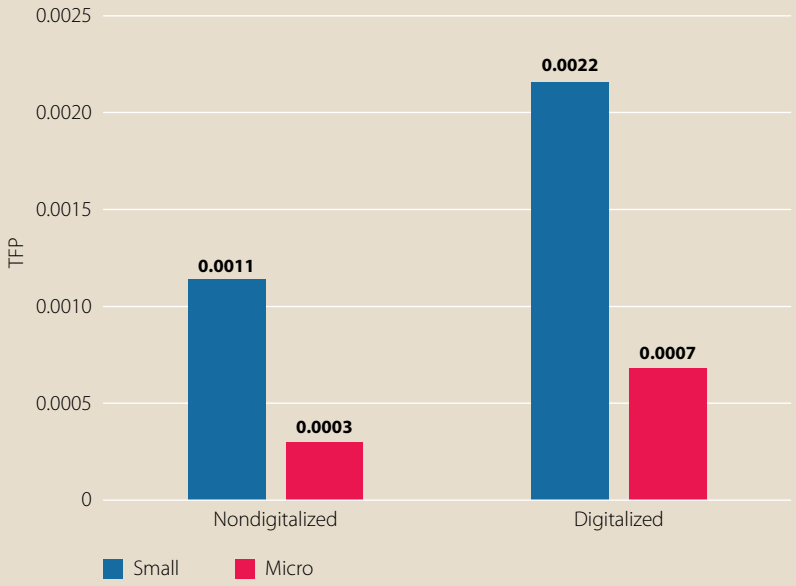
For the purposes of this study, we have defined manufacturing MSEs as "digitalized" if they use the internet to conduct business activities. That is, if they integrate online tools and platforms into their daily workflows, which might include sales, marketing activities, or procurement. In the VIMK survey, respondents provided insights into their use of the internet across various business activities. In VIMK 2019, respondents were required to confirm what activities they used the internet for in their business. Thus, we classified businesses as "digitalized" if they selected at least one activity and did not explicitly indicate an absence of internet usage. However, some variables in VIMK 2020 were different to those in VIMK 2019. VIMK 2020 included a question that explicitly asked whether businesses used the internet for their operation in general, followed by yes or no questions on whether they used the internet for specific activities. Hence, when using VIMK 2020 data, we classified manufacturing MSEs as "digitalized" if they said "yes" in answer to the question of whether they used the internet for their business in general.

A quick comparison of TFP in small and micro manufacturing enterprises that use digital technologies and those that don't reveals that businesses that have adopted digital tools tend to experience higher productivity. Figure 3 shows the average TFP of MSEs in the manufacturing sector, averaged over 2019 and 2020. These findings are in line with previous studies, suggesting that technological progress can create opportunities for productivity gains. Digital transformation is anticipated to enhance productivity and efficiency (Bartel et al., 2007) as the integration of digital technologies leads to a substantial reduction in costs across various domains and drives innovation in production processes and business models, thereby enhancing organizational flexibility (Goldfarb & Tucker, 2019). Azis (2024) also argues that digital technologies can significantly boost productivity among MSEs. For example, improving their digital presence can help them to

secure financial resources by making them more visible to lenders. This enhances their recordkeeping and allows for better credit risk assessments. This improved visibility helps address the persistent issue of limited capital access that has been lingering among the manufacturing MSE sector (Statistics Indonesia, 2024). Through digital integration, MSEs gain access to credit facilities, such as *Kredit Usaha Rakyat* (People's Business Credit), that offer financial support and create opportunities for expansion and productivity growth.

FIGURE 3

TOTAL FACTOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE AND DIGITAL ADOPTION FOR 2019 AND 2020 COMBINED.



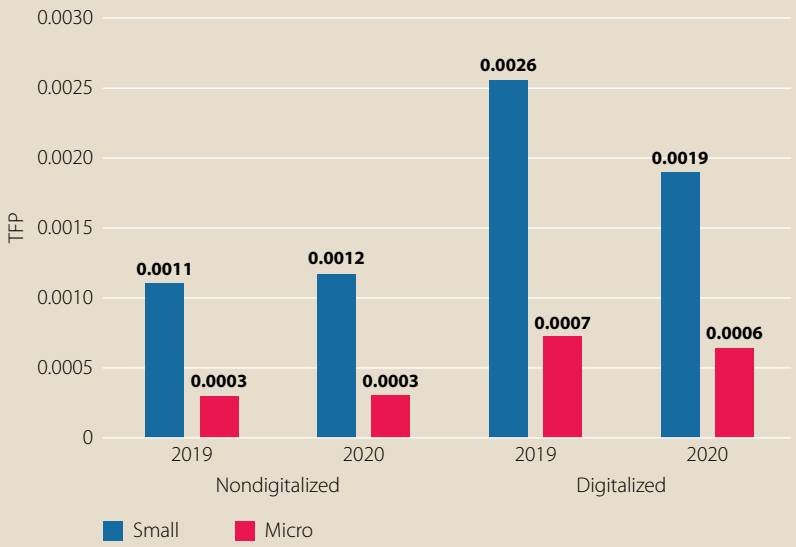
Note: TFP, total factor productivity.
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

Even though the findings in Figure 3 confirm that digitalized manufacturing MSEs exhibit higher TFP than their nondigitalized counterparts, an intriguing trend emerges when we separate the data by year. Year-by-year analysis, shown in Figure 4, reveals an interesting pattern: although the digitalized manufacturing

MSEs had higher TFP in both years, they faced a notable decline in TFP from 2019 to 2020. However, the TFP of nondigitalized manufacturing MSEs increased slightly in 2020 compared to 2019. The decline of digitalized MSEs' TFP may be rooted in the sudden surge in digital adoption during 2020, a year marked by the unprecedented pressures of the COVID-19 pandemic. Faced with the need to operate remotely and respond to rapidly changing market conditions, many enterprises pivoted to adopt digital tools, hoping to sustain productivity and remain competitive. Yet for many, this shift to digital was abrupt and often not prepared for due to the unexpectedness of the conditions during the COVID-19 pandemic.

FIGURE 4

TOTAL FACTOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE AND DIGITAL ADOPTION, 2019 AND 2020.



Note: TFP, total factor productivity.
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

The COVID-19 pandemic serves as a revealing test case for the role of the internet in ensuring business continuity and resilience. Manufacturing MSEs that used the internet for marketing (Figure 5a) managed to improve TFP

during this turbulent period, with small enterprises experiencing a far higher increase compared to microenterprises. Adopting digital tools for marketing activities allows MSEs to extend their market reach through social media and online platforms, overcoming geographical limitations and accessing distant markets. Small businesses, compared to microenterprises, are particularly well-positioned to benefit from digital tools due to their access to relatively more resources, such as capital, technology, and skilled staff, which allow for a smoother transition to digital practices.

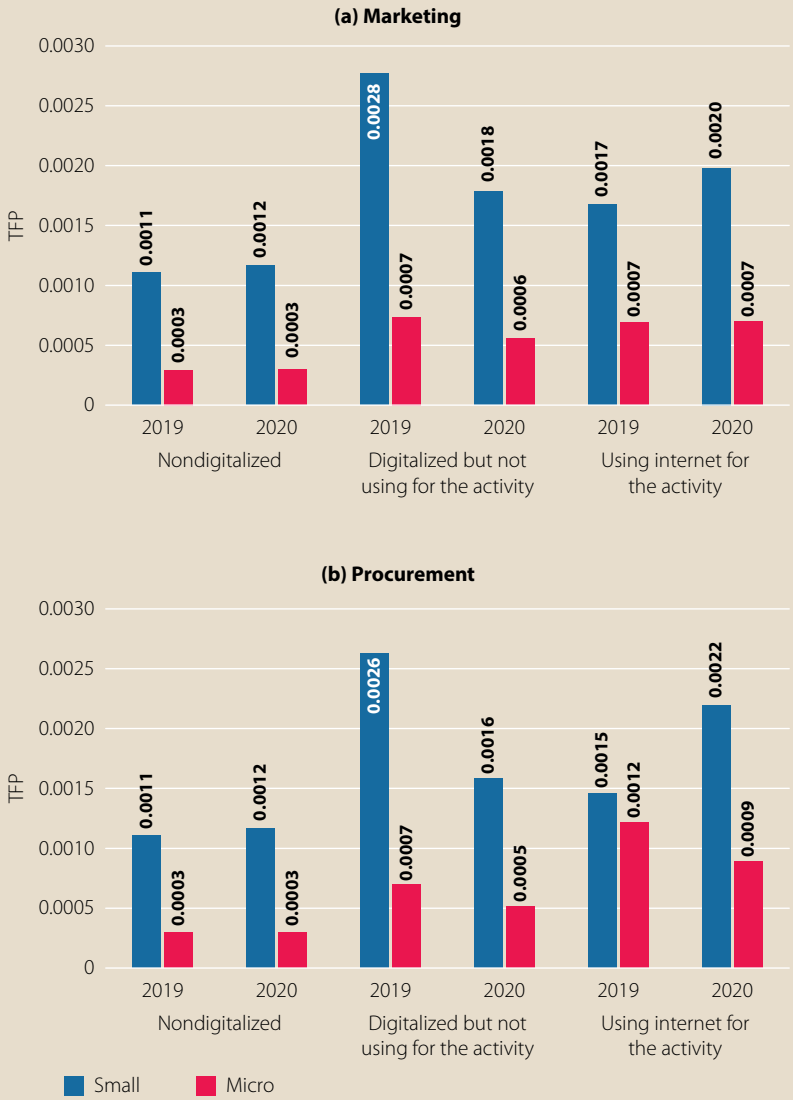
Shifting our attention to digital adoption in sales activities (Figure 5c), it's clear that enterprises using digital tools for sales generally achieve higher TFP compared to those that are either fully nondigitalized or those that use digital tools but not specifically for sales. This trend highlights the distinct advantage that digital sales strategies can offer, allowing businesses to optimize sales processes in ways that drive productivity. Sales optimization through internet-driven channels may boost productivity by increasing revenue, which can then be funneled back into the business. This revenue growth allows companies to acquire better resources, whether advanced technology, skilled staff, or infrastructure improvements. Previous studies also suggest that online sales activities positively influence productivity across business sectors (Bertschek et al., 2006; Yu et al., 2023). Yet when we divided our analysis by business size, small manufacturing enterprises witnessed a striking decline in TFP from 2019 to 2020 that was even more severe than that of those not using digital tools for sales. On the other hand, the TFP of micro manufacturing enterprises remained relatively stagnant.

Our analysis of digital adoption for procurement activities and TFP shows a mixed result (Figure 5b). Small manufacturing enterprises that used digital tools for procurement saw an increase in TFP from 2019 to 2020. In contrast, microenterprises experienced a notable decline in TFP during the same period despite using digital tools for procurement.

Similar to the findings in digitalized sales activities, using digital tools for information gathering resulted in higher TFP in general, but still showed a decline from 2019–2020 (Figure 5d). However, the decline was modest compared to digitalized enterprises who do not use digital tools to look for information.

FIGURE 5

TOTAL FACTOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY DIGITAL ADOPTION FOR SPECIFIC ACTIVITIES, 2019 AND 2020.



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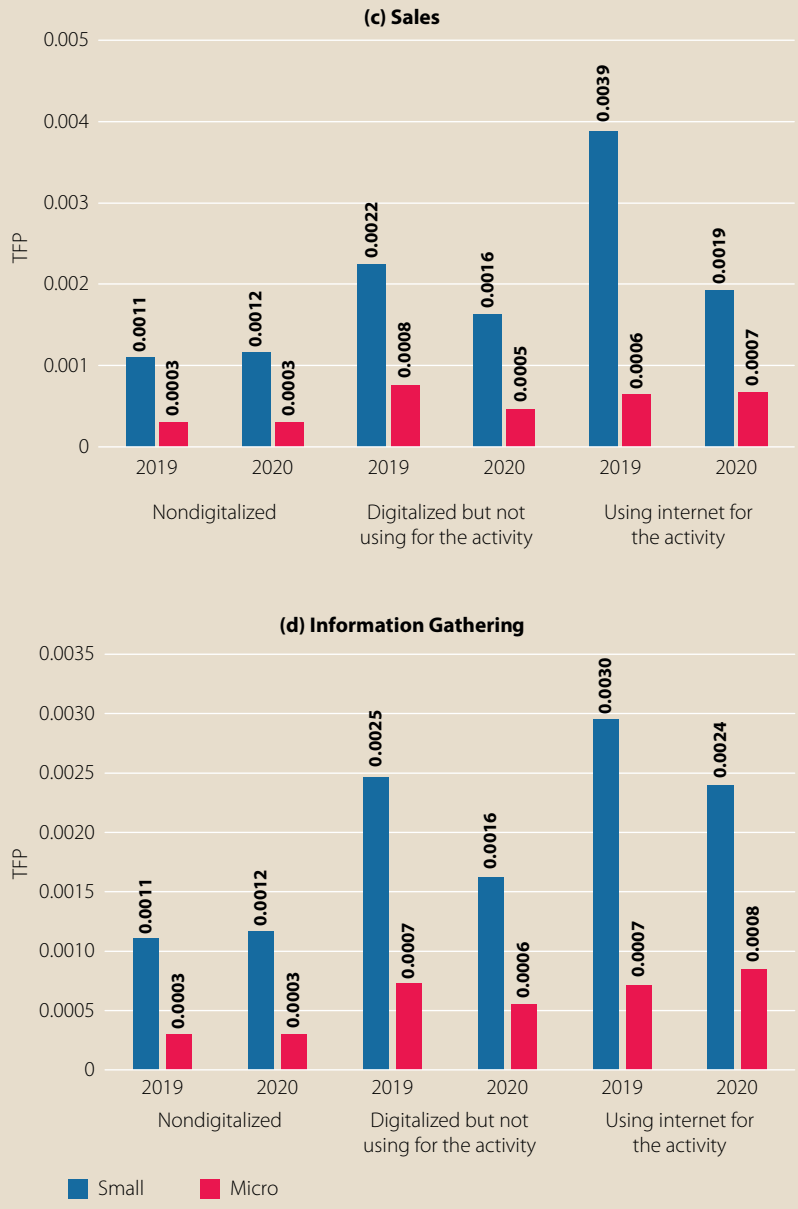


Note: TFP, total factor productivity.
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

LABOR AND CAPITAL PRODUCTIVITY AND DIGITALIZATION

Labor Productivity and Digitalization

While TFP highlights the broader efficiency with which inputs are transformed into output, labor productivity takes a more focused look at how effectively the workforce itself is utilized. By shifting the focus from overall input-output efficiency to worker-level performance, the examination of labor productivity provides a complementary perspective on how these firms manage their resources, especially in a time of fluctuating economic pressures.

Labor productivity is a measure of how much output, such as goods or services, is produced for each unit of labor input. It is a measure of partial factor productivity, which focuses on only one input factor: labor. Although easier to measure, labor productivity only provides a partial picture because it does not take into account the contribution of capital or other factors. In this study, we measured labor productivity using the following formula:

$$Labor\ productivity = \frac{Total\ output}{Total\ hours\ worked}$$

Changes in labor productivity can be influenced by a number of factors, including improvements in worker skills, investment in technology, and improvements in management processes. Therefore, increases in labor productivity do not necessarily reflect improvements in labor efficiency alone, but can also occur due to improvements in areas such as higher skilled labor and better use of technology (Mose, 2017; Kekezi, 2021; Nguyen & Nguyen, 2021; Chavira, 2021).

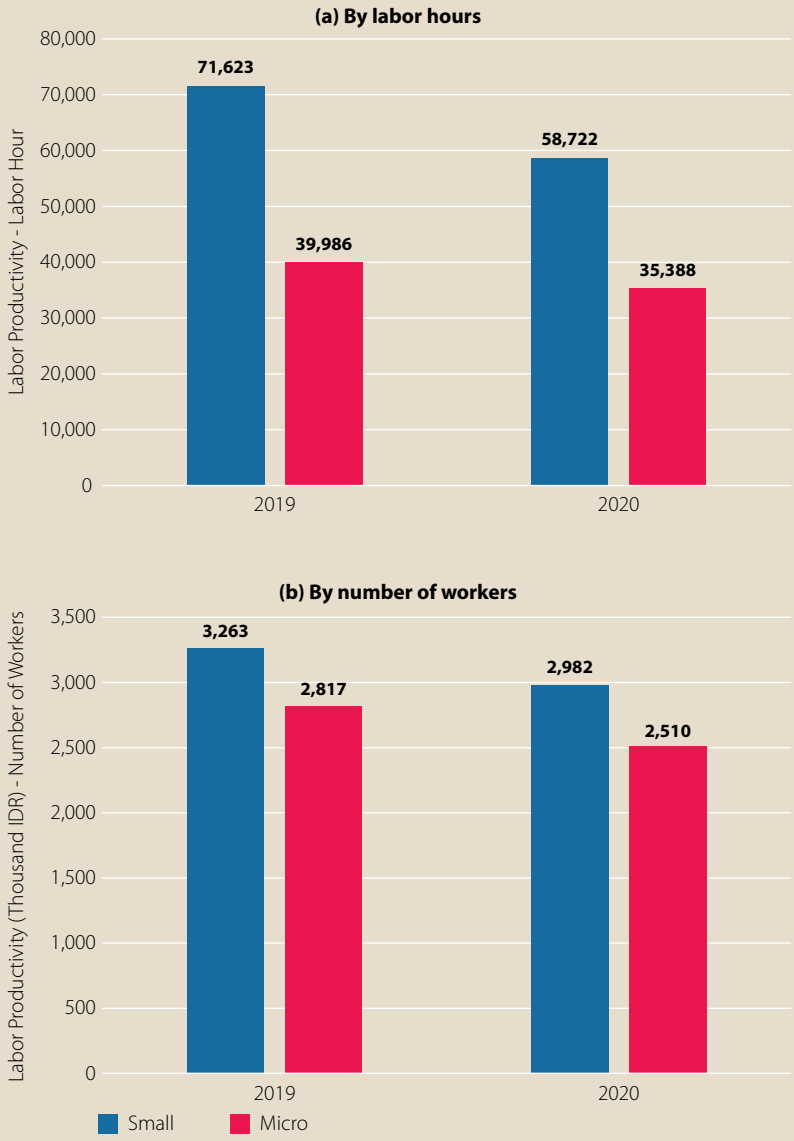
Labor productivity often reflects how efficiently businesses utilize their available capital. In manufacturing, for instance, the use of advanced machinery and technology can significantly enhance productivity by enabling workers to produce more with fewer resources. These investments enable workers to produce more with less effort, illustrating the critical role that capital plays in enhancing efficiency and output. Technological advancements and strategic capital investments, therefore, become essential drivers of labor productivity growth (Kebede & Heshmati, 2020). However, MSEs tend to have limited access to capital and resources (Statistics Indonesia, 2024), which prevents them from making the necessary investments to expand their operations. Our findings on labor productivity in 2019 and 2020 suggest that there was a decline in productivity levels for both groups (Figure 6a and 6b). Another insight was that small manufacturing enterprises consistently outperform microenterprises. Considering the importance of capital in labor productivity, it may be that better resources and greater access to capital strengthen the position of small enterprises, helping them maintain labor productivity better than microenterprises.

When labor productivity is calculated without accounting for business size, digitalized MSEs outperform their nondigitalized counterparts both when examining by labor hours and by number of workers for 2019 and 2020 combined (Figure 7a and 7b). However, a more complex insight was found when we divided the observations into small and micro manufacturing enterprises (Figure 7c and 7d). When we calculated labor productivity based on labor hours, small enterprises with digital adoption had lower labor hour productivity. For microenterprises, digitalization appeared to improve productivity per labor hour. On the other hand, when we calculated labor productivity using the number of workers, digitalized MSEs consistently demonstrated higher efficiency compared to nondigitalized, both in micro and small enterprises. However, the magnitude of this efficiency gain varies by business size. For microenterprises, digitalization yielded only a slight increase in productivity per worker. This suggests that while digital tools may streamline operations, they do not substantially boost overall output per employee in microenterprises. In contrast, small enterprises show a more pronounced increase in productivity per worker from digitalization.

The different findings for labor hours and number of workers in small manufacturing enterprises indicates that digitalization reduces the number

FIGURE 6

LABOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE, 2019 AND 2020.

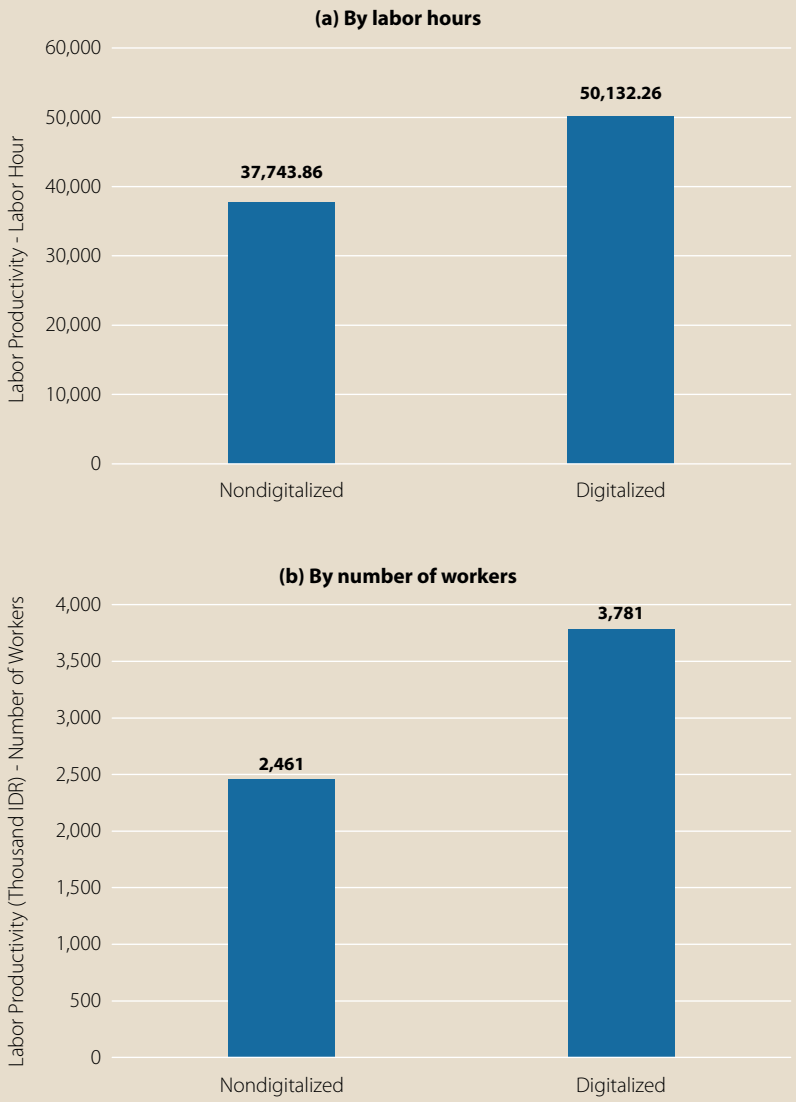


Source: Author's Calculation based on Annual Micro and Small Industry Survey (VIMK), 2024.

of workers required to produce the same amount of output, indicating efficiency gains in terms of workforce size. However, it simultaneously increases the hours of work needed. This pattern implies that while digitalization optimizes the number of workers by streamlining certain tasks (Zhang, 2023), it may also demand longer working hours from the remaining workforce. This phenomenon can be attributed to the adaptation process that follows the adoption of digital technology. Digital adoption might create short-term setbacks before yielding long-term benefits due to investment cost and adaptation challenges (Li et al., 2024). Figure 7a–d comprises the average labor productivity of manufacturing MSEs in 2019 and 2020 combined, and the observations in 2020 accounted for nearly half of the overall observations. It is important to consider the sudden and unexpected shock of COVID-19 in 2020 that forced businesses to operate digitally (Ministry of Cooperatives and SMEs, 2022). This required rapid adaptation. The digitalized category in 2020 likely included many newly digitalized firms that had just started using digital technology, requiring them to quickly restructure processes and learn to effectively use digital technologies. This process takes time, so the initial challenges may have led to lower productivity at the start of the adoption process. In short, many firms in the digitalized category in 2020 were likely in the early phase of adapting to digital technology, which could have temporarily lowered their productivity. These challenges could partially explain the observed gap between the labor hour efficiency of digitalized and nondigitalized small manufacturing enterprises (Figure 7c). On the other hand, microenterprises did not exhibit a similar trend in this analysis. Digitalized microenterprises had higher labor productivity than the nondigitalized in both metrics. The difference of the findings could be attributed to their size and simpler organizational structures. These characteristics enable microenterprises to adapt more quickly and flexibly to such disruptions, as discussed in the previous section. The absence of a complex organizational structure among microenterprises (Alves & Carvalho, 2022; Herrero et al., 2018) allows them to adjust quickly in response to market demands or external pressures, maintaining labor efficiency despite challenging situations. Therefore, the newly digitalized manufacturing MSEs in 2020 may have been able to easily adapt to new digital systems without facing significant challenges, enabling their business operations to run effectively. In this case, they might have gained the benefits of adopting digital technology quicker than small enterprises.

FIGURE 7

LABOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE AND DIGITAL ADOPTION, 2019 AND 2020 COMBINED.



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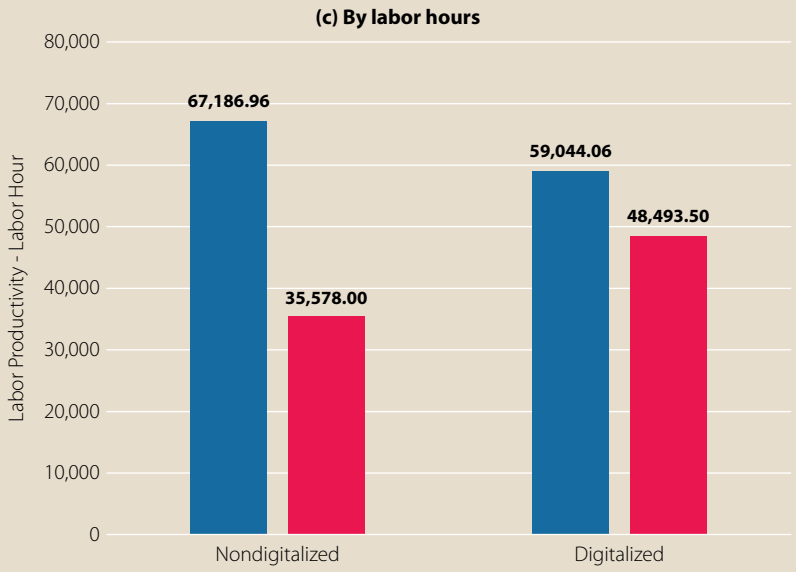
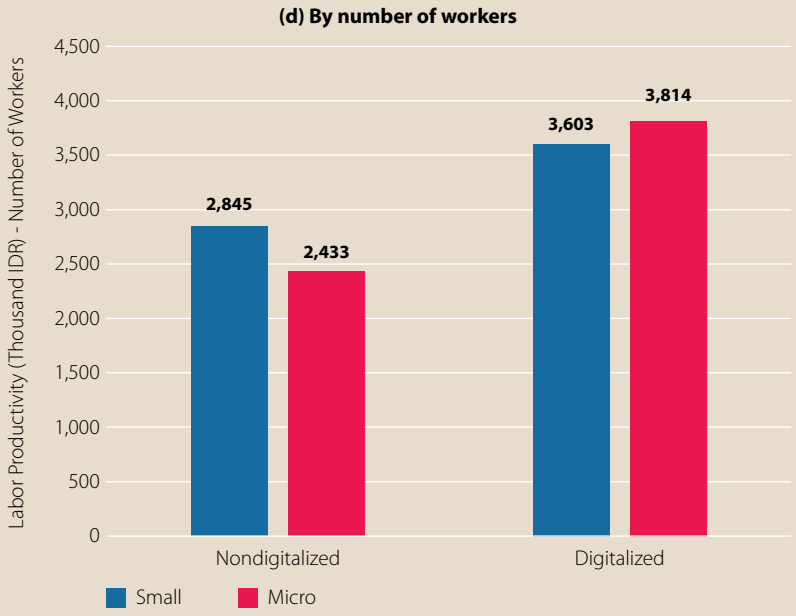




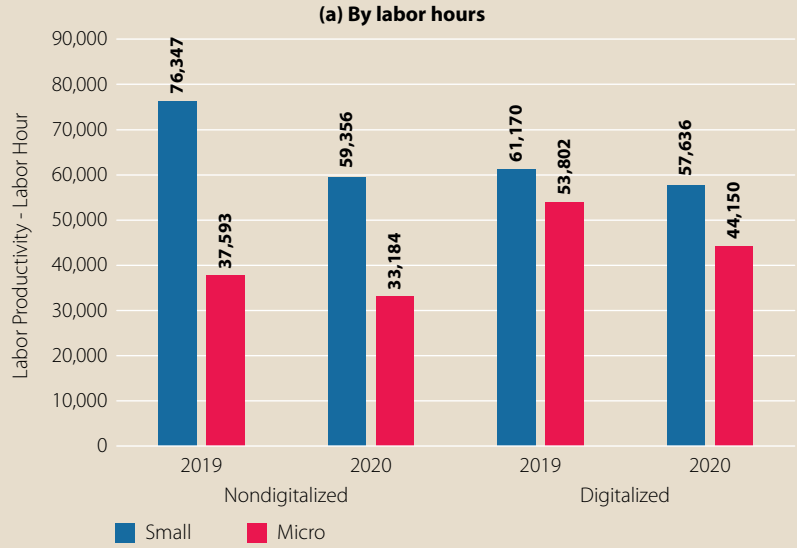
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

In terms of labor hour productivity, nondigitalized small enterprises showed significantly higher productivity than nondigitalized microenterprises in 2019 (Figure 8a). Both small and micro nondigitalized enterprises experienced a productivity decline in 2020, with small enterprises experiencing a steeper decline. In contrast, digitalized enterprises charted a steadier course. Their labor productivity per hour experienced a less significant decline, remaining relatively stable across both years and revealing an underlying resilience. Digital adoption seemed to act as a stabilizing force that allowed these businesses to weather fluctuations and hold productivity steady.

Similar findings were found in small enterprises when we assessed labor productivity per worker (Figure 8b): small digitalized manufacturing enterprises seemed to successfully maintain their productivity level with a minimal decline compared to their nondigitalized counterparts. The productivity level of micro digitalized manufacturing enterprises, on the other hand, exceeded that of small digitalized enterprises in 2019 but fell short in 2020.

FIGURE 8

LABOR PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE AND DIGITAL ADOPTION, 2019 AND 2020.



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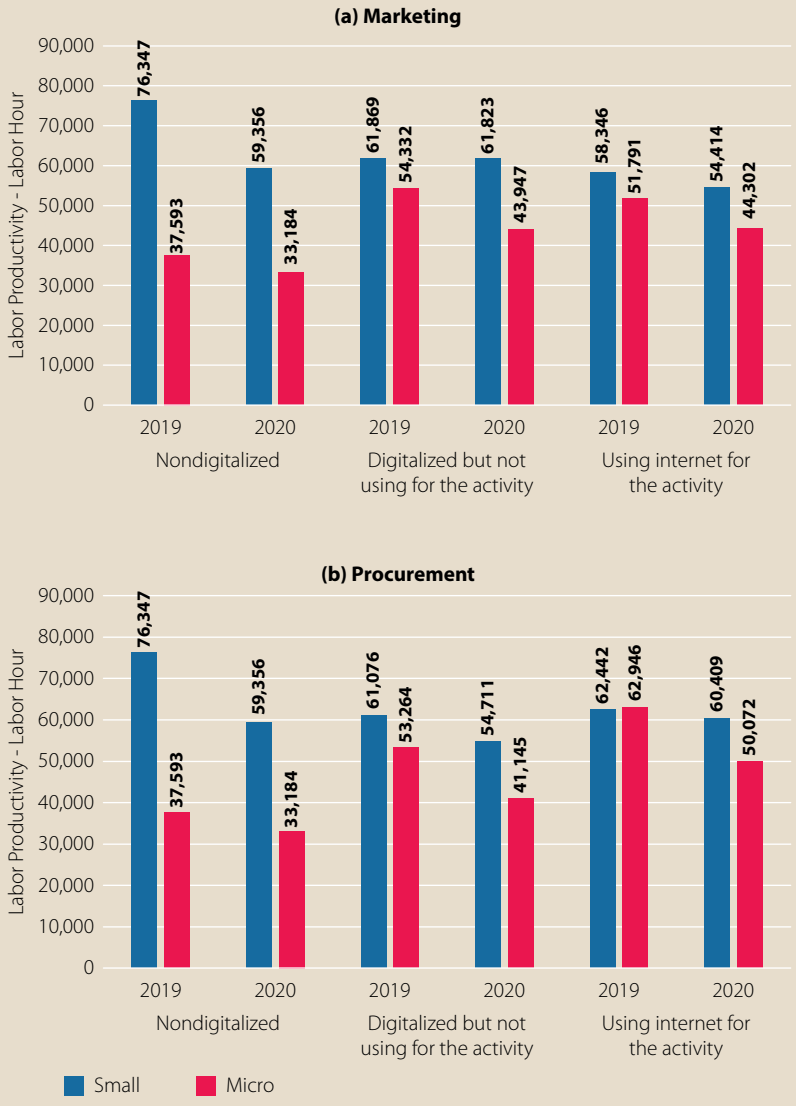
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

Figure 9a to 9d illustrate a less apparent link between labor productivity digitalization and specific activities. In all aspects observed (marketing, sales, procurement, and information gathering) there was little difference between labor productivity in digitalized and nondigitalized enterprises. The lack of a clear connection between digitalization and labor productivity in these activities could be attributed to how the internet is used. First, the internet may not be fully integrated or utilized in ways that directly influence labor productivity outcomes. In some cases, digitalization might be more about automating routine tasks or improving efficiency in these aspects without leading to significant changes in overall labor productivity. In this case, digitalization may improve efficiency or reduce time spent on tasks, but the direct output-per-worker may not change significantly. The trend remains similar when labor productivity is measured in terms of number of workers, as shown in Figures 10a to 10d.

FIGURE 9

LABOR PRODUCTIVITY (BY LABOR HOURS) BY DIGITAL ADOPTION FOR SPECIFIC ACTIVITIES, 2019 AND 2020.



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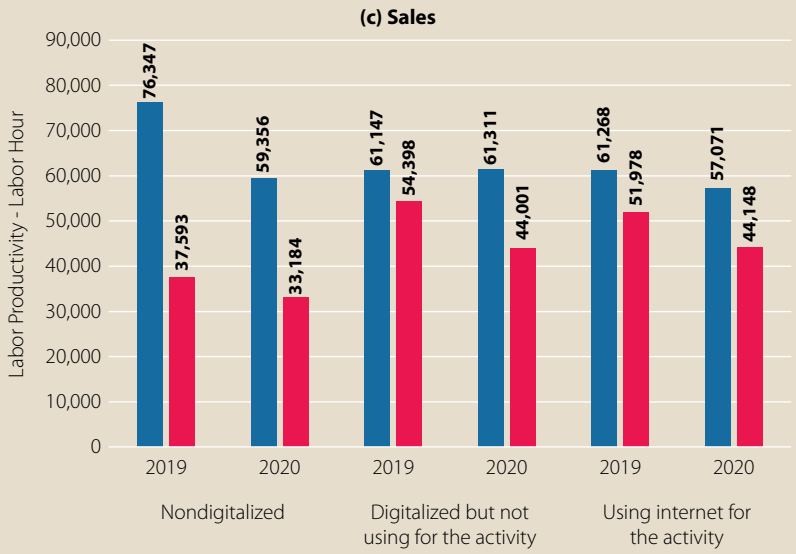
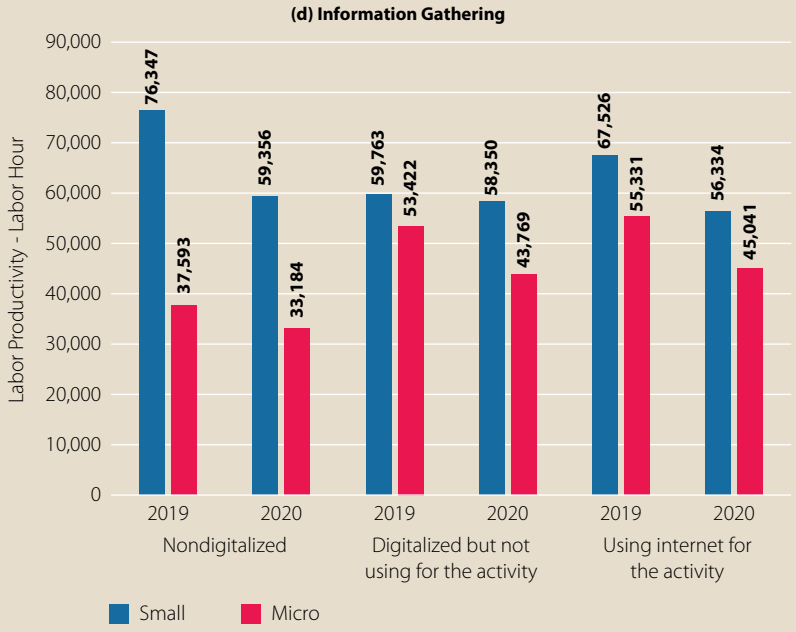
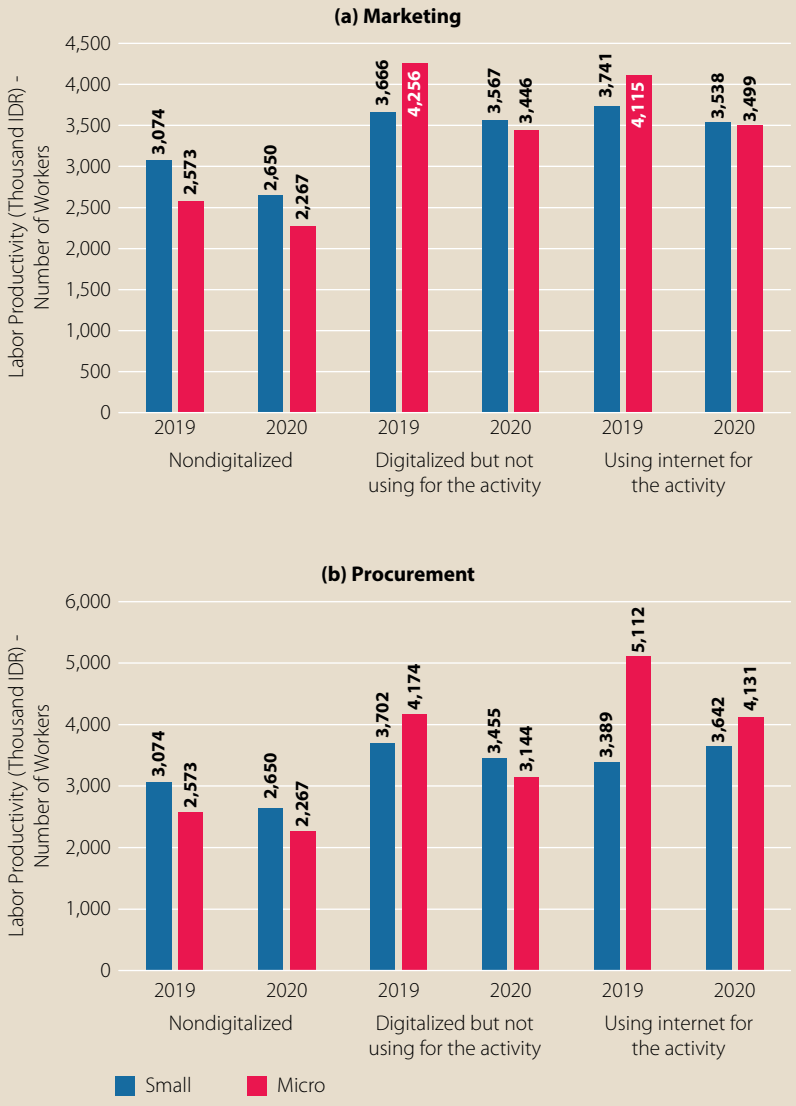




Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

FIGURE 10

LABOR PRODUCTIVITY (BY NUMBER OF WORKERS) BY DIGITAL ADOPTION FOR SPECIFIC ACTIVITIES, 2019 AND 2020.



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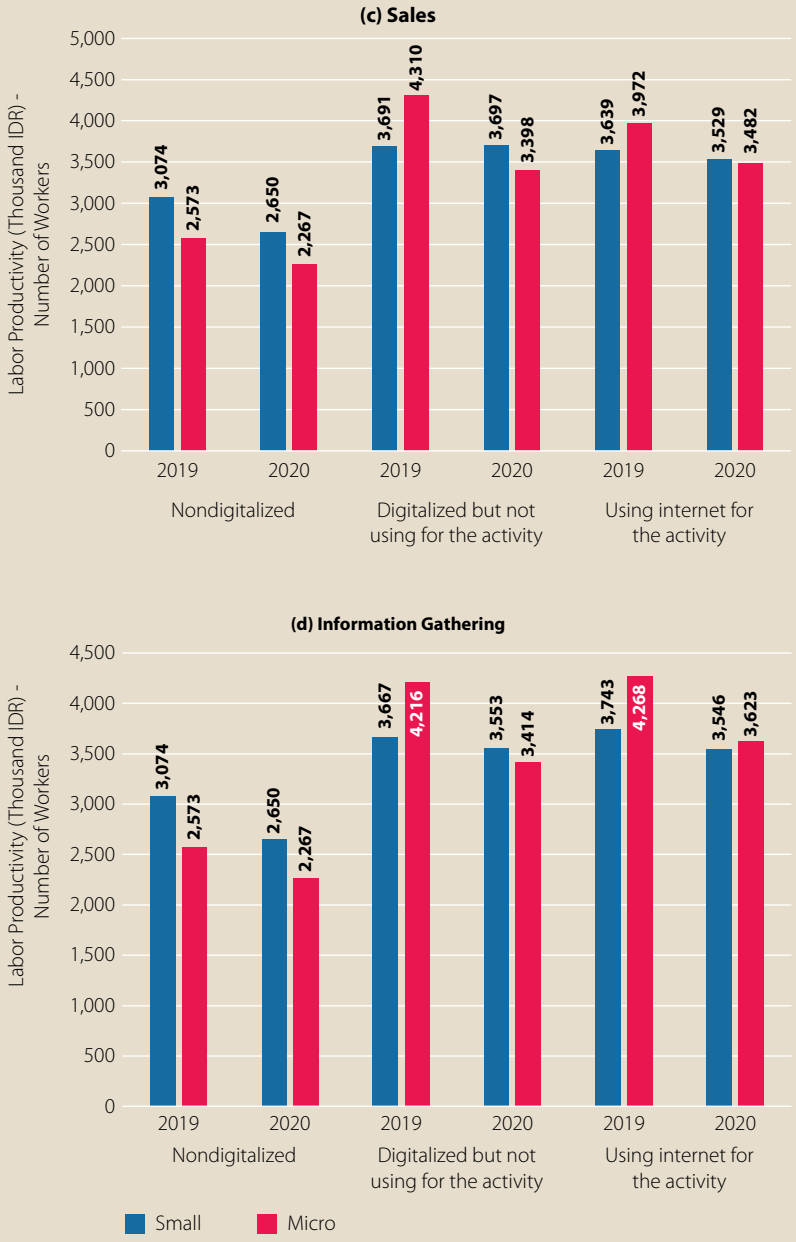


Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

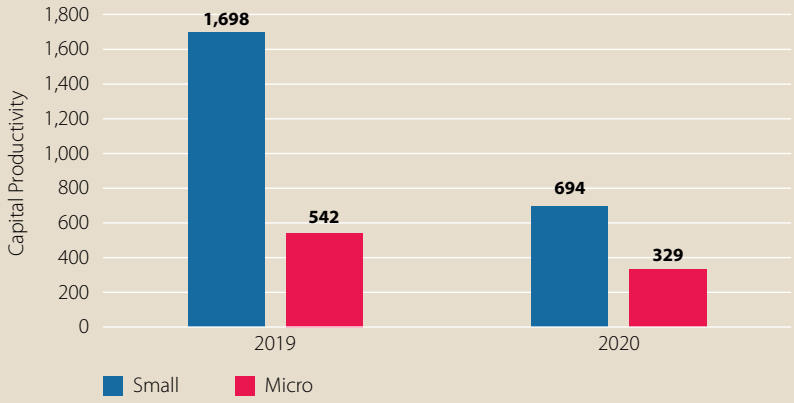
Capital Productivity and Digitalization

To gain a more comprehensive understanding of business productivity, we measured productivity not only through TFP and labor productivity but also by examining capital productivity. Complementing the insights gained from labor and TFP analyses, capital productivity provides insights into how effectively firms are utilizing their capital investments to generate output. While labor productivity focuses on the efficiency of human resources and TFP captures overall efficiency across all inputs, capital productivity specifically highlights the role of capital resources in driving output. This measure is particularly relevant for assessing whether enterprises are able to leverage their capital investments effectively.

Our findings show a decrease in capital productivity for both small and microenterprises from 2019 to 2020 (Figure 11). This decline suggests that these enterprises became marginally less efficient in utilizing their capital during the COVID-19 pandemic.

FIGURE 11

CAPITAL PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY SIZE, 2019 AND 2020.



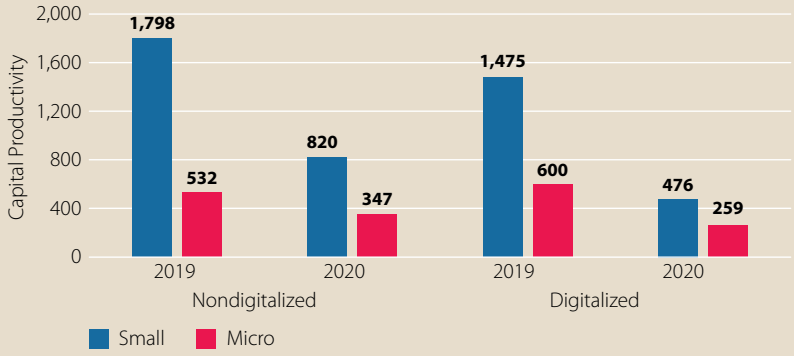
Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

Consistent with the findings for TFP and labor productivity, small enterprises demonstrated higher capital productivity than their micro counterparts (Figure 12). This suggests that the efficiency advantage often associated with larger operations scales. Digitalization appears to play a negative role in enhancing

capital productivity. Both small and microenterprises that adopted the internet in their business processes achieved slightly lower capital productivity compared to nondigitalized firms. As such, digital integration, even when limited, leads to the less efficient use of capital resources where less product is produced using the same amount of capital.

FIGURE 12

CAPITAL PRODUCTIVITY OF MANUFACTURING MSES BY SIZE AND DIGITAL ADOPTION, 2019 AND 2020.



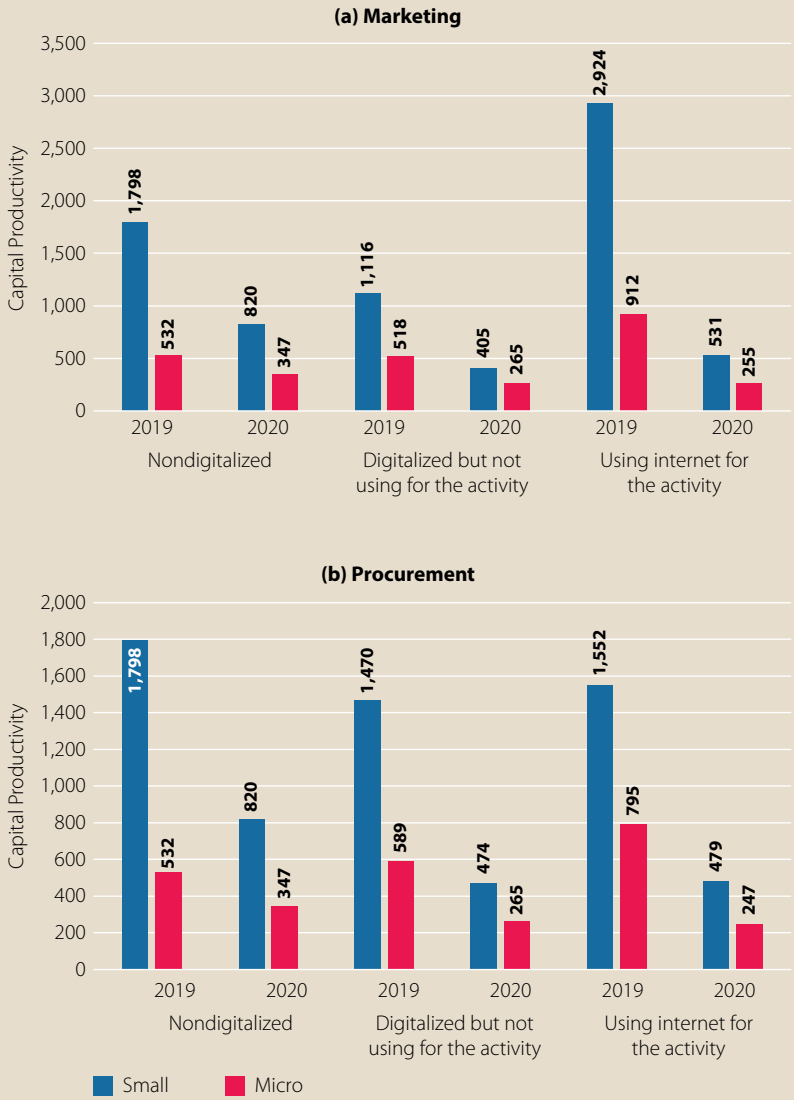
Source: Author's calculation based on Annual Micro and Small Industry Survey (VIMK).

Moving on to the analysis of digital adoption for the four types of activities, Figure 13a illustrates how small manufacturing enterprises that used the internet for marketing had higher capital productivity than those that did not use internet for the specific activity. The capital productivity of manufacturing MSEs that specifically used the internet for marketing was higher than that of nondigitalized firms in 2019, but this did not apply in 2020.

Manufacturing MSEs using the internet for procurement activities (Figure 13b) had higher capital productivity compared to digitalized manufacturing enterprises that did not use the internet for procurement in 2019, but in 2020, the difference was relatively modest. In both years, firms using internet for procurement had lower capital productivity than their nondigitalized counterparts. Meanwhile, capital productivity for manufacturing MSEs using the internet for sales activities and information gathering was generally lower than that of those that did not (Figure 13c and 13d).

FIGURE 13

CAPITAL PRODUCTIVITY OF MANUFACTURING MICRO AND SMALL ENTERPRISES BY DIGITAL ADOPTION FOR SPECIFIC ACTIVITIES, 2019 AND 2020.



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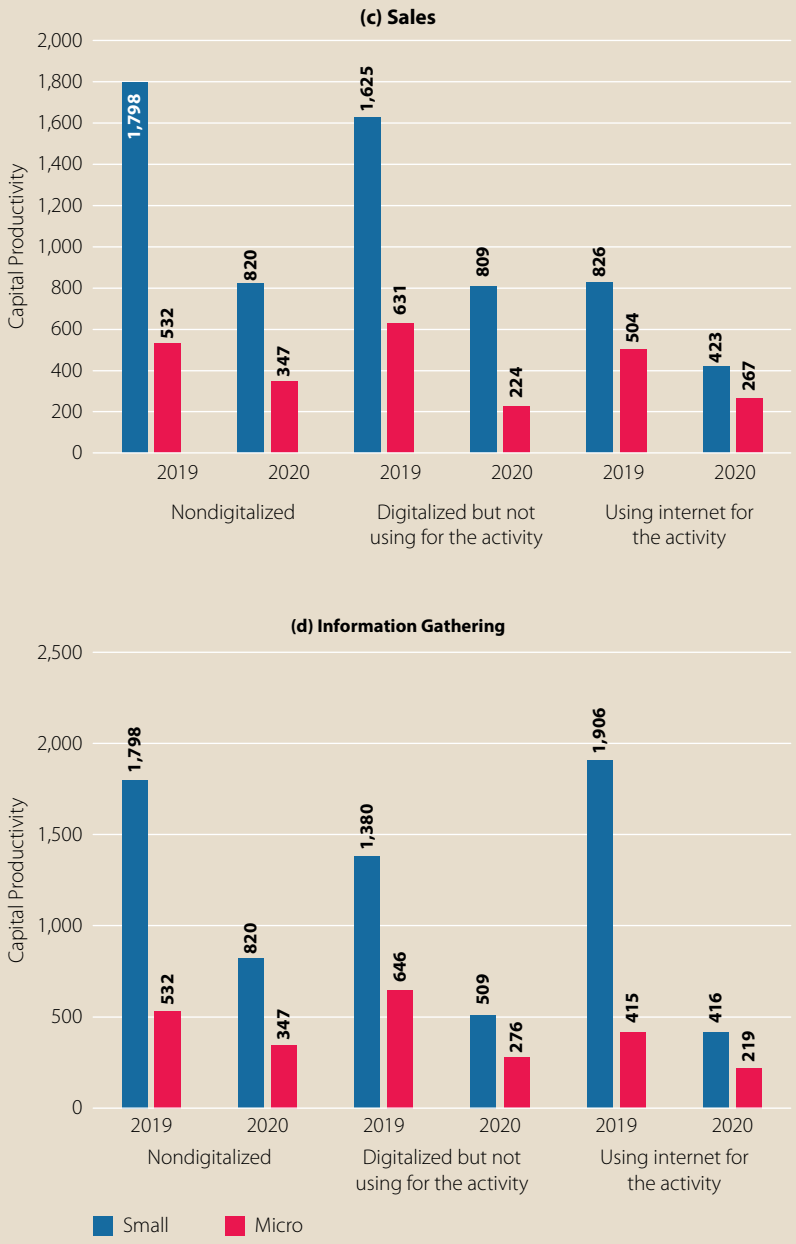


Source: Author's calculation based on the Annual Micro and Small Industry Survey (VIMK).

DIGITAL SKILLS IN MICRO AND SMALL INDUSTRIAL / MANUFACTURING ENTERPRISES

Definition and Criteria of Digital Skills

Productivity and digital transformation within firms are deeply intertwined with the competencies and digital skills of their workforce (Beitinger et al., 2020). Labor serves as one of the primary drivers of growth, reflecting how effectively the firm develops and manages its human capital. Following an analysis of productivity in manufacturing MSEs, this section will take a closer look at the labor context within these enterprises.

In an era of rapid technological advancement, digital competencies have become indispensable to achieving and sustaining productivity. According to the European Commission (2022), competence is defined as the demonstrated ability to apply knowledge, skills, and attitudes to produce tangible results. This definition highlights the integrated nature of several critical factors in labor productivity. Competence encompasses not only the technical expertise required for specific tasks but also the ability to navigate complex problems effectively. Skills represent the practical abilities needed to execute processes and apply knowledge in real-world scenarios. Such skills serve as the practical mechanisms that enable employees to translate their competencies into productive outcomes within the workplace.

Furthermore, knowledge encompasses the concepts, theories, facts, and foundational ideas that deepen understanding in a given field. Within the realm of digitalization, knowledge could range from understanding the functionality of common digital devices to grasping the broader implications of data management and cybersecurity. Together, these elements (competence, skills,

and knowledge) form the foundation for effective human capital management in manufacturing MSEs, driving both individual and organizational productivity in an increasingly digital landscape.

TABLE 2

DIGITAL SKILLS CLASSIFICATION USING INDONESIAN WORKFORCE SURVEY DATA.

Digital Skill Level	Identification		
Unskilled	Unemployed and not completing compulsory education up to senior high school	or	Not using internet in their job and not completing compulsory education up to senior high school
Basic	Have completed at minimum senior high school	or	Using digital devices and internet for work
Intermediate	Have completed higher education or vocational school with ICT-related major		
Advanced	Have completed higher education with ICT-related major	or	Work as professional technician

ICT, information and communication technology.
Source: Author, 2023.

Based on Table 2 above, we classify digital skills and competencies as follows:

- **Digitally unskilled:** A workforce with limited familiarity with or minimal exposure to digital technology, particularly in using basic digital tools. This can be identified when individuals do not incorporate the internet or digital resources into their work at all.

- **Basic digital competence:** The ability of a worker to perform simple tasks using basic digital technologies, such as using Microsoft Office for document processing or Google Chrome for browsing and email. This level of competence is typically seen in workers with educational attainment below or equivalent to vocational secondary graduates in fields not related to information and communication technology (ICT). These skills are not specialized for specific jobs but are essential for general workplace functions.

- **Intermediate digital competence:** The ability of a worker to use a variety of digital technologies relevant to their specific occupations.

This skill level is typically required in mid-level roles, where digital tools are integral to job functions. For example, journalists need to effectively use digital platforms to collect, search for, and analyze information as part of their daily work. This type of work is usually performed by vocational secondary level graduates or above.

- **Advanced digital competence:** A worker's ability to apply sophisticated analytical skills and theoretical knowledge, typically required in highly ICT-intensive occupations such as AI specialists. Workers with this level of competence often possess a level 4 diploma (an advanced qualification equivalent to the first year of a bachelor's degree) or university degree in ICT-related fields, demonstrating proficiency in more complex digital tasks and technologies critical to their roles.

Digital Potential and Skill Levels in Indonesia's Manufacturing Micro and Small Enterprises

Entrepreneurial Capacity

In Indonesia, manufacturing MSEs encompass businesses focused on the production or processing of goods on a small scale. These enterprises operate with limited capital, labor, and production capacity compared to larger firms, serving primarily localized markets. Based on the official classification system in Indonesia, the definition of a firm's size depends both on workforce size and annual revenue. Generally, manufacturing MSEs have fewer than 20 employees and generate annual revenue of less than IDR15 billion. Their production activities typically focus on types of goods such as food and beverages, textiles, furniture, and handicrafts, utilizing either home-based setups or small-scale factories.

To better understand employment conditions within this segment, this analysis will leverage data from Indonesia's National Labor Force Statistics Survey (SAKERNAS), conducted biannually in February and August by the Central Bureau of Statistics. This survey offers valuable insights into labor trends, workforce dynamics, and socioeconomic conditions within the sector.

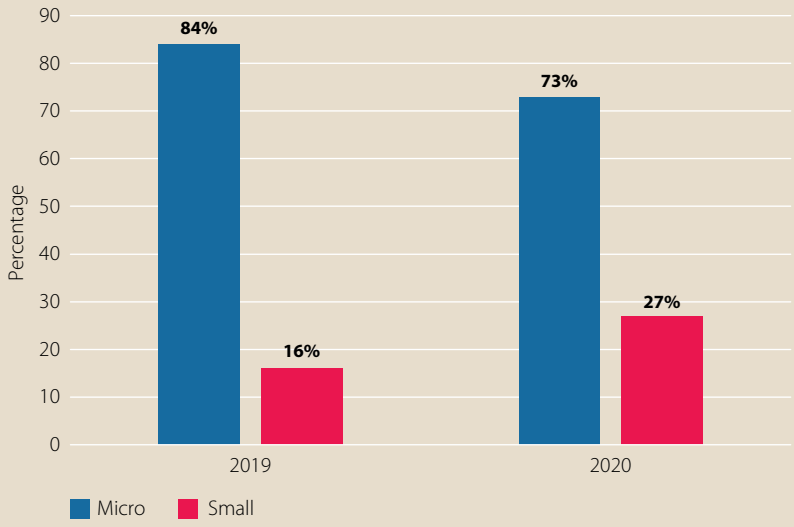
Having a nuanced understanding of MSEs requires distinguishing between entrepreneurs and their workers and understanding their distinct roles and contributions. Microenterprise entrepreneurs are typically self-employed individuals managing businesses with one to four employees. These

entrepreneurs often wear multiple hats, taking charge of everything from strategic decisions to daily operations. Their hands-on approach and personal financial investment characterize their businesses, making them central to the survival and growth of their enterprises (Lin et al., 2022).

On the other hand, small enterprises generally employ between five and 19 individuals, allowing for a more structured business environment. Entrepreneurs in this category may have greater capacity to delegate tasks, engage in strategic planning, and focus on scaling their operations compared to their microenterprise counterparts (Charles et al., 2015; Nichter & Goldmark, 2005). This distinction highlights the varying levels of complexity and organizational dynamics that entrepreneurs face, influenced by the size and scale of their operations.

FIGURE 14

PERCENTAGE OF MICRO AND SMALL ENTERPRISES.



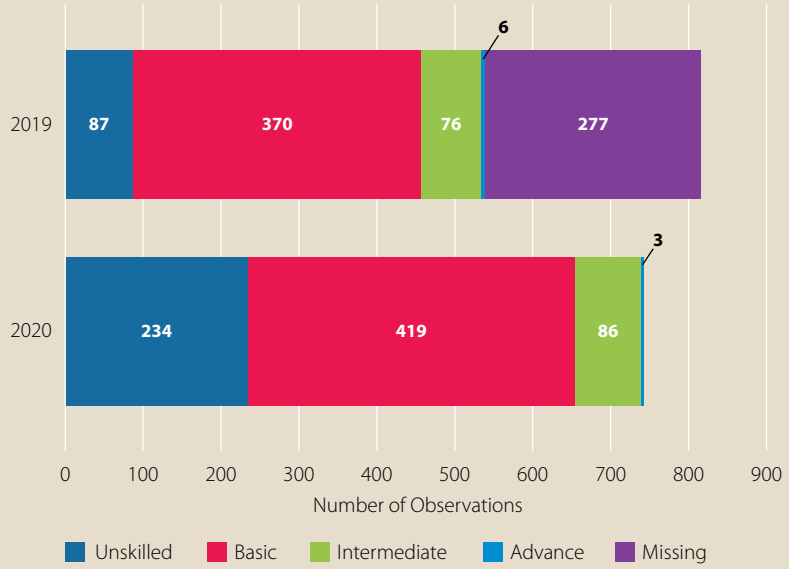
Source: Authors, 2024.

Figure 14 demonstrates that while the microenterprise sector continues to dominate the landscape of MSEs in Indonesia, there is a trend of businesses gradually transitioning from micro to small enterprises over time. This shift suggests potential growth opportunities within the sector. However, this growth

is a matter of not only leveraging revenue but also fostering other enabling factors such as entrepreneurial capacity. Therefore, we will consider the conditions of digital skills among manufacturing MSE entrepreneurs in Indonesia.

FIGURE 15

NUMBER OF DIGITAL COMPETENT WORKER FOR ENTREPRENEUR IN MICRO AND SMALL ENTERPRISE MANUFACTURING SECTOR IN THOUSANDS.



Source: Authors, 2024.

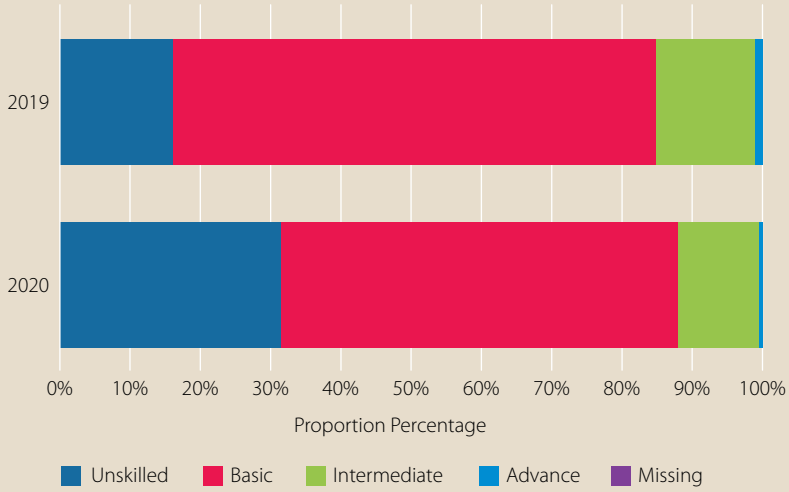
Regarding the digital skill level of entrepreneurs in manufacturing MSEs, most have basic competence (see Figure 15). These basic digital skills include everyday skills such as smartphone use, social media, and simple digital transactions, which enable them to engage with customers and suppliers online. These skills are beneficial for running a business with minimum requirements that doesn't need more advanced technology, such as data analysis and machinery.

It's important to note that in 2019, there was a segment of the workforce that reported "missing"; these individuals were unable to use any digital devices. However, the onset of COVID-19 forced a significant shift. As mobility

restrictions were implemented to curb the spread of the virus, many people found themselves needing to adapt rapidly to using digital tools to sustain their livelihoods. As a result, they were absorbed into the digitally unskilled group in 2020, giving the appearance of an increasing number of unskilled individuals (Figure 16). This trend is relevant for all contexts discussed in this section and beyond.

FIGURE 16

DIGITAL COMPETENCE OF MICRO AND SMALL ENTERPRISE ENTREPRENEURS IN THE MANUFACTURING SECTOR IN PERCENTAGES.



Source: Authors, 2024.

It's likely that the challenges that manufacturing MSEs face when lacking digital skills have an impact on their efficiency, scalability, and competitiveness (Anatan & Nur, 2023). Several studies indicate that limited digital skills among MSME entrepreneurs restrict their ability to automate processes and utilize digital platforms, preventing them from improving production efficiency, quality control, and market reach (Muafi et al., 2023; Fachrunnisa et al., 2020; Elia et al., 2020).

Without digital skills, many businesses continue to rely on manual, error-prone processes, limiting their ability to operate at a larger scale or with higher

efficiency. Additionally, inadequate digital competence also prevents manufacturing MSE entrepreneurs from taking advantage of online marketplaces or digital marketing, further narrowing their market reach and competitiveness. This digital gap makes it challenging for MSEs to compete with larger firms that have already adopted advanced technologies. More advanced skills, such as data analytics, inventory management software, and digital marketing, are necessary for optimizing production processes.

Muafi et al. (2023) highlight that barriers like insufficient digital culture, lack of training, and limited digital infrastructure are key factors preventing enterprises from advancing technologically. Efforts to improve digital skills among MSE entrepreneurs, such as government-led and private-sector corporate social responsibility training programs, have been actively advocated over the past five years. For example, Pertamina UMK Academy encourages MSE entrepreneurs to grow their businesses by giving training and mentoring sessions. The aim of equipping entrepreneurs with knowledge of digital tools specific to manufacturing (such as supply chain software, quality monitoring systems, and digital financial platforms) is to reduce operational inefficiencies, increase production speed, and expand their market presence.

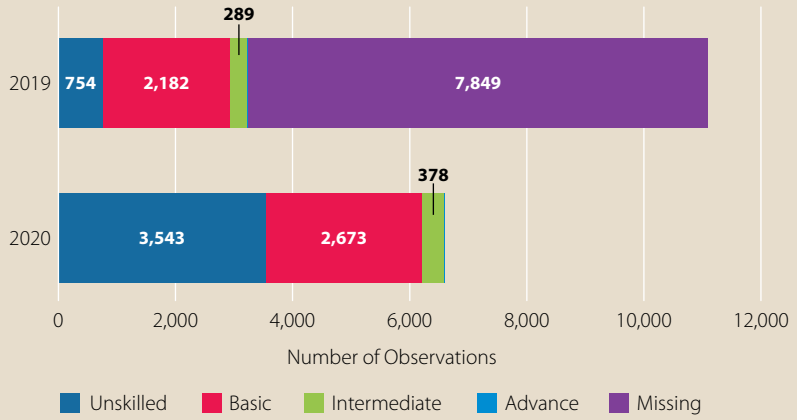
Employee Contribution

While the capabilities of entrepreneurs are crucial for the success of a business, the contribution of employees has its own part in driving business growth and profitability. However, it's important to recognize the distinct nature of employment within MSEs compared to larger enterprises. Workers in MSEs often operate in informal settings (Rothenberg et al., 2016), such as home-based production, street vending, or market stalls. This type of informal employment sets them apart from employees in medium and large enterprises, where formal contracts and structured work environments are more common.

The informality that characterizes the MSE sector in Indonesia often means minimal regulatory oversight and a lack of standardized protections. As a result, many small business workers operate without formal contracts, job security, or benefits, increasing their economic vulnerability. While the flexibility of informal work arrangements can be advantageous, allowing for easier entry into the labor market, it often comes at the cost of lower wages and fewer opportunities for skill development and career advancement (Benavides et al., 2022; OECD & ILO, 2019).

FIGURE 17

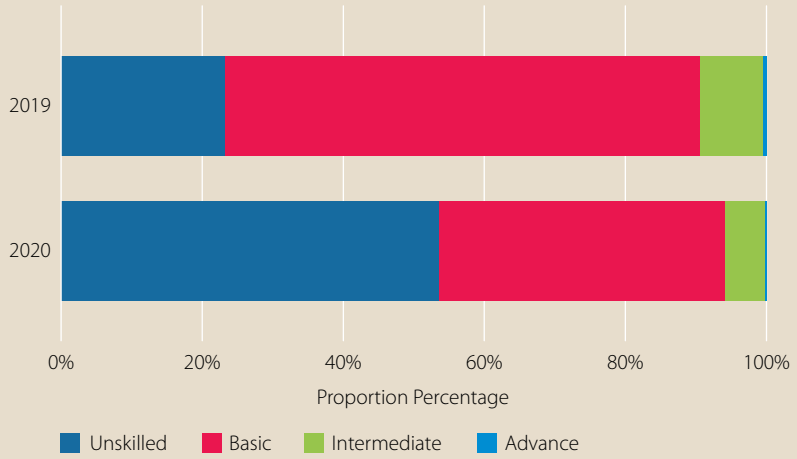
DIGITAL COMPETENCE OF EMPLOYEES OF MANUFACTURING MICRO AND SMALL ENTERPRISES IN THOUSANDS.



Source: Authors, 2024.

FIGURE 18

DIGITAL COMPETENCE OF EMPLOYEES OF MANUFACTURING MICRO AND SMALL ENTERPRISES IN PERCENTAGES.



Source: Authors, 2024.

A deeper exploration of digital skill levels in Indonesia's manufacturing sector (see Figure 17 and Figure 18) reveals that most employees in manufacturing MSEs possess limited or basic digital competence. Their skills are often restricted to the use of smartphones for simple tasks, such as communication via messaging apps, which may enhance connectivity but do little to directly impact or optimize production processes. Advanced digital skills, such as proficiency in inventory management software, computer-aided design, digital quality control systems, and data entry for production tracking, are largely absent among manufacturing MSE employees.

This lack of digital proficiency significantly hampers productivity in several ways (Beitinger et al., 2020). For one, the continued reliance on manual and analog processes leads to slower workflows, diminished precision, and increased error rates, all of which can be highly detrimental in a competitive manufacturing landscape (Leesakul et al., 2022). Employees who lack digital skills often struggle to adapt when new technologies are introduced, which can delay the full realization of digital investments aimed at enhancing efficiency. Moreover, the limited digital literacy within MSEs also constrains data-driven decision-making. Employees who are not proficient with digital tools may find it challenging to gather, interpret, or use production data effectively (Tawil et al., 2024).

Pandemic Push: How Forced Digital Adoption Transformed Productivity

The COVID-19 pandemic marked a significant turning point in various aspects of our lives, especially in how we approach work and daily routines. With strict restrictions on mobility and physical interaction, individuals and organizations had to quickly adapt to new ways of sustaining daily operations and securing employment. Even technologically advanced firms faced challenges in transitioning to a fully digitalized work environment (Faraj et al., 2021), but even so, digitalization has become a crucial element in modern business practices.

The accelerated shift toward digital learning and remote work during the pandemic had complex implications for organizational productivity. According to studies by Bloom et al. (2023) and Katz et al. (2020), many companies adopted digital tools at an unprecedented pace, which allowed them to adapt swiftly to remote work requirements. This rapid transformation, which might have taken years to implement under normal circumstances, was achieved in

just a few months due to the urgency of the situation. The adoption of digital platforms not only streamlined workflows but also improved data management and communication processes, enabling companies to maintain business continuity in a virtual setting (Katz et al., 2020; Pirosçă et al., 2021).

Digitalization has also demonstrated its advantages in enhancing customer engagement, optimizing communication, reducing operational costs, and fostering better relationships with business partners (Kala'lembang, 2021). However, not all firms experienced productivity gains. Many encountered significant challenges, such as inadequate digital infrastructure, varying levels of digital literacy among employees, and high initial adjustment costs (Faraj et al., 2021; Matli & Wamba, 2023).

Moreover, the sudden transition led to "digital fatigue": a state where employees became overwhelmed by the intensity of digitalized work, impacting their mental health and overall job performance (Marsh et al., 2022). This phenomenon highlighted the need for organizations to balance productivity with employee well-being, recognizing that long-term success requires attention to both performance outcomes and the mental health of the workforce.

BOX 2

BRIEF CONDITION OF THE MANUFACTURING SECTOR IN INDONESIA.

Alongside its contribution to the country's GDP, the manufacturing sector has opened up valuable opportunities for technological growth and innovation. From a broader look at the digital skill levels of employees in Indonesia's manufacturing sector, Figure 19 shows that the skills of the workers range from basic to intermediate. Large and multinational manufacturing firms, particularly in urban centers, tend to have a more digitally skilled workforce, as they often invest in upskilling and advanced digital training, including knowledge in data analytics, digital quality control, and automated systems. These firms generally have access to resources and infrastructure that enable employees to work with more sophisticated digital tools (Helper et al., 2021).

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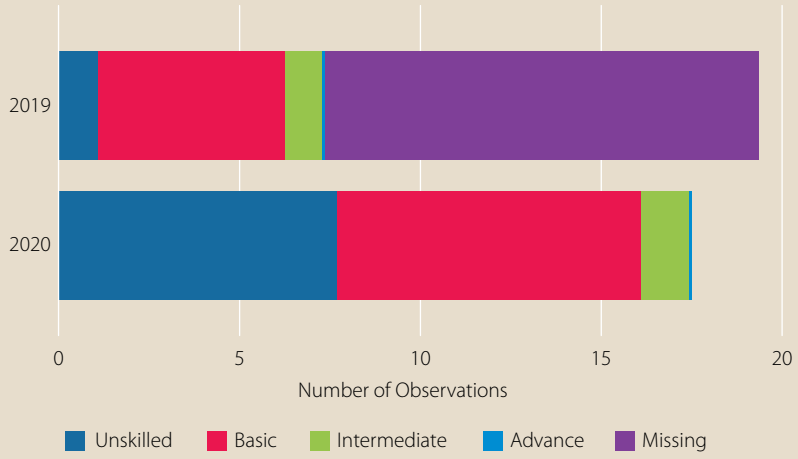
However, based on the previous discussion, employees in smaller manufacturing enterprises, especially those in rural areas, often have only basic digital skills. These skills are typically limited to operating simple digital devices, data entry, or using basic software for communication. Limited training budgets, a lack of digital infrastructure, and the prioritization of manual processes over automation in smaller firms contribute to this digital skill gap.

Efforts by the Indonesian government, such as digital literacy programs and technical training initiatives, aim to address these skill gaps, yet the rate of adoption and upskilling remains uneven. Bridging these digital skill disparities is crucial for Indonesia's manufacturing sector to remain competitive as higher digital competence in areas like IoT, robotics, and data-driven decision-making becomes increasingly essential for productivity and innovation.

FIGURE 19

DIGITAL COMPETENCE LEVELS OF ALL WORKERS IN THE MANUFACTURING SECTOR IN MILLIONS.



Source: Authors, 2024.

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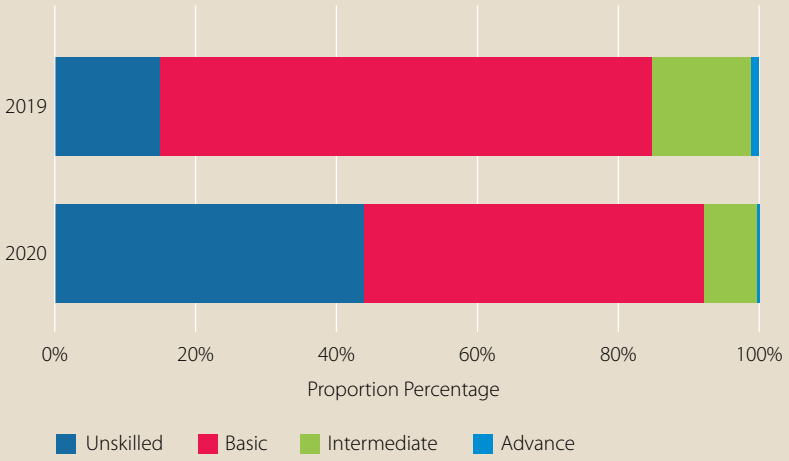
FIGURE 20

DIGITAL COMPETENCE LEVELS OF ALL WORKERS IN THE MANUFACTURING SECTOR IN PERCENTAGES.



Source: Authors, 2024.

OVERVIEW OF INDONESIAN WORKERS' DIGITAL SKILLS

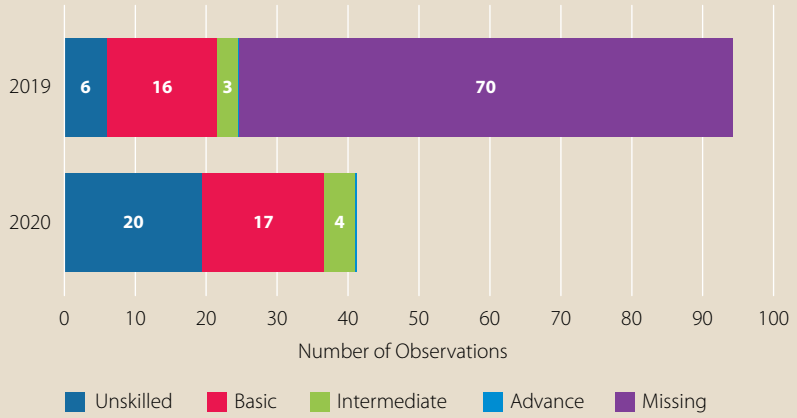
The majority of workers in both manufacturing MSEs and nonmanufacturing MSEs possess a basic level of digital competence. MSEs, which represent the vast majority of Indonesia's businesses, often rely on laborers and owners with limited formal education (Statistics Indonesia, 2020). Consequently, many workers in MSEs possess only basic digital skills, such as those required for using smartphones for communication or basic digital transactions. While these are beneficial, they are not sufficient for more complex digital operations.

The gap in digital skills among MSE workers stems from factors such as limited access to upskilling resources, restricted budgets for technology investments, and a lack of structured digital training programs tailored to small enterprises. While the Indonesian government and various nonprofit organizations have introduced digital literacy and basic training programs, the pace of upskilling in MSEs lags behind that of larger enterprises and urban areas, leaving MSEs less equipped to fully leverage digital technologies for productivity gains.

Digital skill levels among Indonesian workers vary significantly across sectors and regions. While the pandemic accelerated digital adoption, particularly in urban areas and among large firms, a substantial gap remains, especially between workers in urban and rural areas and in small and large enterprises. Many Indonesian workers possess only basic digital skills (e.g., being able to use smartphones and social media) while advanced skills in areas such as data analysis, digital marketing, and programming are limited. The number of digitally unskilled people in the general workforce decreased in 2020 compared to 2019 primarily due to a significant shift in the previously unaccounted for "missing" category.

FIGURE 21

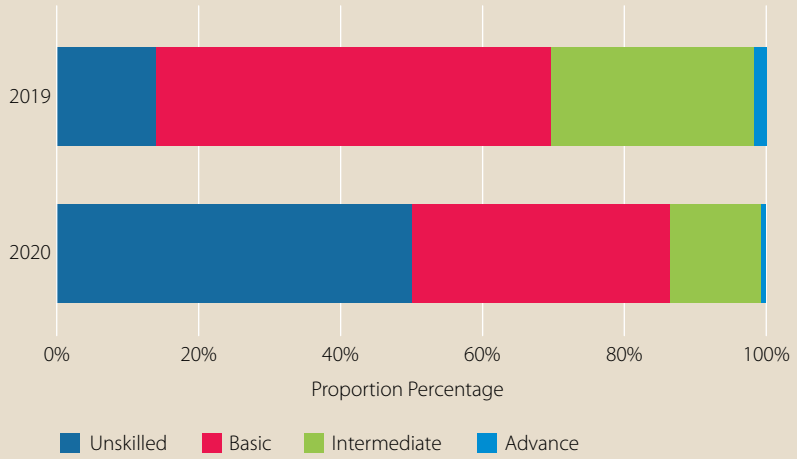
DIGITAL COMPETENCE LEVELS OF ALL WORKERS (INCLUDING ENTREPRENEURS) IN ALL MICRO AND SMALL ENTERPRISES IN MILLIONS.



Source: Authors, 2024.

FIGURE 22

DIGITAL COMPETENCE LEVELS OF ALL WORKERS (INCLUDING ENTREPRENEURS) IN ALL MICRO AND SMALL ENTERPRISES IN PERCENTAGES.



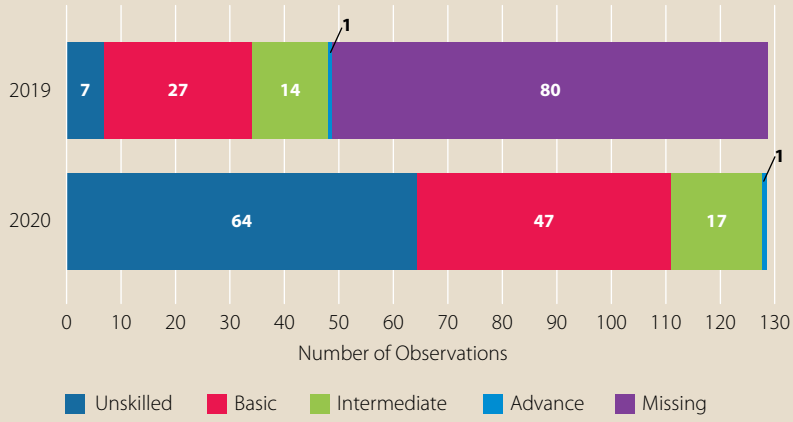
Source: Authors, 2024.

Government initiatives, such as the Digital Talent Scholarship program, aim to bridge the skill gap by offering training in higher-level digital skills. However, the digital divide persists due to factors like inconsistent internet access, limited funding for training, and varying levels of education and familiarity with technology. For Indonesia to fully capitalize on digital transformation, expanded access to digital upskilling programs and infrastructure improvements will be essential, particularly to support workers in traditionally underserved sectors and regions.

An increasing number of workers acquired at least basic digital skills in 2020, reflecting a growing recognition of the importance of digital literacy in the modern job market (see Figure 23). This positive trend has resulted in a decline in the number of digitally unskilled workers, indicating that initiatives aimed at enhancing digital competencies are beginning to take effect.

FIGURE 23

DIGITAL COMPETENCE LEVELS OF WORKERS IN THE ENTIRE WORKFORCE IN MILLIONS.

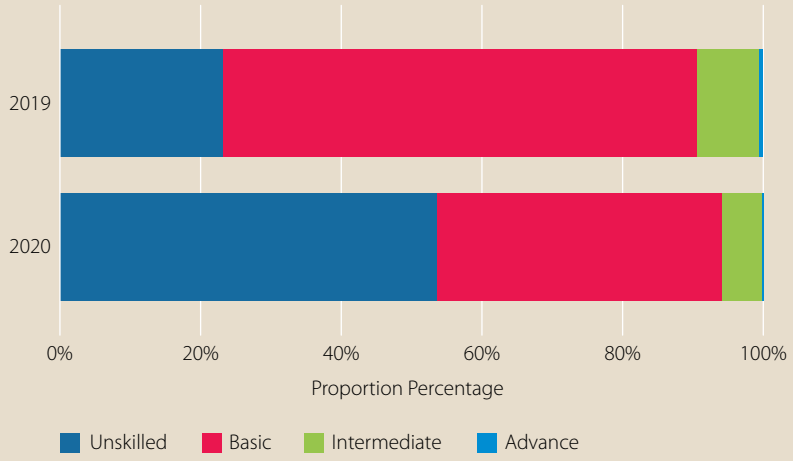


Source: Authors, 2024.

However, despite these advancements at the basic skill level, a significant gap remains in the development of intermediate and advanced digital competencies within Indonesia's workforce (see Figure 24). This skill gap is particularly pronounced in sectors experiencing rapid digital transformation, such as

FIGURE 24

DIGITAL COMPETENCE LEVELS OF WORKERS IN THE ENTIRE WORKFORCE IN PERCENTAGES.



Source: Authors, 2024.

e-commerce, IT services, and manufacturing. In these industries, the demand for advanced digital expertise, such as data analytics, programming, digital marketing strategies, and sophisticated technological troubleshooting, continues to grow. This discrepancy poses a challenge for businesses seeking to innovate and compete effectively in an increasingly digital economy.

CONCLUSION AND RECOMMENDATIONS

This study's findings emphasize crucial areas for increasing the efficiency of MSEs in manufacturing in Indonesia, particularly through digital adoption and skill development. While digitalization adoption in Indonesia's MSE manufacturing sector increased during the COVID-19 pandemic, significant challenges remain in terms of productivity and digital skills. Our research found that digitalization sometimes correlated with increases in TFP and labor productivity, but this was inconsistent. Digitalization especially drove increases in TFP in microenterprises, which are more flexible; however, small businesses experienced a sharper decline in productivity despite adopting digital technologies. Key factors influencing digital adoption include digital workforce competence level, with most workers remaining at the basic level. Many workers in MSEs have minimal educational backgrounds, which severely limits their digital skills and causes stagnation in the adoption and effective use of digital technologies.

Internet use is revealed to be a crucial driver of increased productivity, with the TFP of digitalized firms outperforming that of those with no digital integration. Similarly, capital productivity trends show modest improvements among digital adopters, indicating that digital tools help optimize resource use. Despite these advantages, the study underscores the persistent digital skill gap among MSE workers, where most employees and entrepreneurs exhibit only basic digital competencies. The forced digital adoption during the pandemic accelerated digital transformation but also exposed the uneven readiness across enterprises, with smaller firms struggling more. This situation was compounded by the broader challenge of low digital literacy within the labor force, as outlined in the analysis of the digital skill landscape of Indonesia's workforce.

The following are important interventions that would help to overcome the challenges and increase the productivity of manufacturing MSEs. Firstly, the

general level of education needs to be increased to at least nine years to provide a better foundation for digital literacy. A foundation of basic cognitive and technical skills acquired through general education will make workers easily adaptable to digital tools and processes. In addition to this, targeted digital training programs should be provided for those already meeting or exceeding this educational threshold, especially in the area of ICT, to further develop their competencies in practical applications related to digital marketing, supply chain management, and data analytics, which all directly benefit MSE operations. Productivity gains in the digital sector depend more on the integration of capital assets, such as advanced machinery and software, than on labor. This will necessitate improved access to digital infrastructure and technological tools, especially for resource-constrained MSEs, and the creation of government and private sector initiatives offering MSEs financial support, such as subsidies or grants, to invest in digital technologies. At the same time, fruitful partnerships with technology firms and educational institutions can help tailor training programs and digital ecosystems to support the particular needs of MSEs. By combining better education with targeted digital upskilling and increasing access to digital assets, these recommendations will bridge the digital divide and improve productivity, securing the long-term resilience of Indonesia's manufacturing MSEs in an increasingly digital economy.

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[1] The original title of the work uses the term "digit workers," which appears to be a typographical error. It is likely intended to refer to "digital workers" given the context of the article.

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