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Article

# Unraveling the empirical impact on MSMEs: Socio-economic characteristics, nudging application, and e-commerce adoption

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**Abstract:** This study examined socio-economic factors affecting Micro, Small, and Medium Enterprises (MSME) e-commerce adoption, focusing on gender, income, and education. Using the 2022 National Socio-Economic Survey (Susenas) data, a logistic regression model was employed to analyze key determinants of e-commerce utilization. Additionally, an online survey of 550 MSMEs across 29 provinces was conducted to assess the impact of digitalization on business performance. In comparison, an offline study of 42 MSMEs with low digital adoption provided insights into the barriers hindering digital transformation. A natural experiment was conducted to evaluate the effectiveness of behavioral interventions in promoting the adoption of e-payments and e-commerce. The main contribution of this study lies in integrating large-scale national survey data with experimental approaches to provide a deeper understanding of digital adoption among MSMEs. Unlike previous studies focusing solely on socio-economic determinants, this research incorporated a digital nudging experiment to examine how targeted incentives influenced e-commerce participation. The findings revealed that digital transformation significantly enhanced MSME performance, particularly in turnover, product volume, customer base, and worker productivity. Socio-economic factors such as gender, household head status, and social media access significantly influenced digital adoption decisions. Behavioral nudging proved effective in increasing MSME participation in e-commerce. Although this study was limited to Susenas 2022 data and survey responses, it bridges a critical research gap by linking socio-economic factors with behavioral interventions in MSME digitalization. The findings offer key insights for policymakers in formulating evidence-based strategies to drive MSME digital transformation and e-commerce growth in Indonesia.

**Keywords:** e-commerce; MSMEs; logistic regression; nudge theory

## 1. Introduction

Indonesia's digital economy is one of the largest among Southeast Asian countries, contributing approximately 40 percent of Southeast Asia's digital economy value. This highlights Indonesia's position as a major player in the region's digital economy. According to a study conducted by Google, Temasek, and Bain & Company (2022), the value of Indonesia's digital economy in 2022 reached US$ 77 billion, marking a 22 percent increase from US$ 63 billion in 2021. This value is projected to continue growing, potentially reaching US$ 130 billion by 2025 and US$ 220–360 billion by 2030. As seen in **Figure 1**, e-commerce is the largest sector within Indonesia's digital economy, contributing US$ 59 billion in 2022. This data

emphasizes the tremendous potential of the e-commerce sector in Indonesia's digital economy.

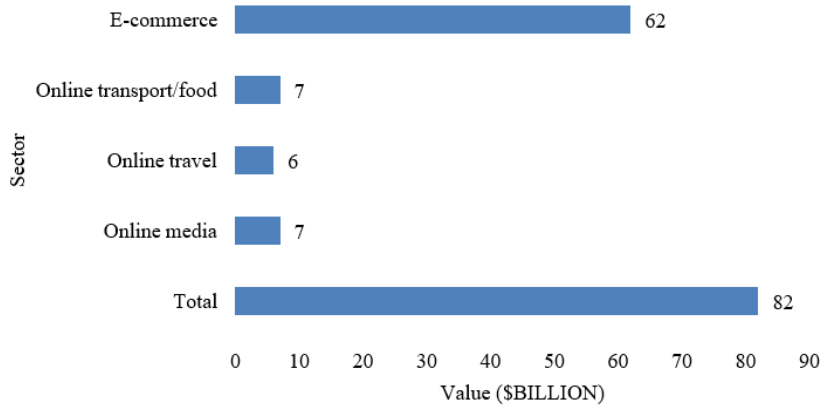


**Figure 1.** Indonesia's digital economy value by business sector in 2022.
Source: Google, Temasek, and Bain & Company 2023 (Processed).

Despite this potential, many Micro, Small, and Medium Enterprises (MSMEs) in Indonesia face challenges in fully adopting digital platforms. Digital transformation, particularly for MSMEs, has become increasingly significant in the era of globalization and digitalization (Ardhito et al., 2021; Bouwman et al., 2019). MSMEs play a crucial role in the economic structure, especially in creating jobs and being the main driver of economic activity in remote areas, contributing substantially to economic growth. During the Covid-19 pandemic, MSMEs have proven themselves as resilient pillars of the national economy. The crisis triggered the accelerated adoption of digital technology to fulfill consumption needs, production processes, and investment transactions. The utilization of digital platforms has the potential to empower MSMEs more effectively by increasing their capacity in terms of productivity and innovation. Moreover, the use of digital platforms also facilitates the expansion of MSMEs' access to various sectors, including marketplaces, industries, and financial institutions. Thus, engaging MSMEs in the digital ecosystem is expected to strengthen their competitiveness, positively impact economic growth, and ensure economic sustainability amid the current global dynamics.

Digitalization in business operations has great potential to support micro, small, and medium-sized enterprises (MSMEs) in various aspects, such as strategic planning, administration, production and logistics, marketing, promotion, and communication (Bianchini and Kwon, 2021). This is expected to positively impact product innovation, increased production efficiency, and marketing strategies, as discussed by Estensoro et al. (2022), and Radicic and Petkovic (2023). The development of MSME transformation and digitalization can be seen as the implementation of a roadmap that includes four essential stages. These stages include production and institutionalization, expanding market share, increasing productivity, increasing added value, and downstreaming of strategic industries and food. By following this roadmap, it is expected that MSMEs can elevate the quality of their business to be more productive, innovative, and adaptive to change, positively contributing to the overall business ecosystem. Several studies have highlighted the positive impact of digitalization on

improving productivity, operational efficiency, product innovation, and promotion and marketing strategies, both on a national and regional scale (Estensoro et al., 2022; Radicic and Petkovic, 2023; Saleem et al., 2020). However, research related to the transformation and digitalization of MSMEs in Indonesia is still limited, where the scope is in the form of district-level case studies or specific sectors only (Indriastuti and Kartika, 2022; Rahayu and Day, 2017; Raharja et al., 2019).

Digital transformation roadmaps, such as the SDT-SMEs Roadmap, provide structured approaches for MSMEs to enhance operational efficiency by evaluating digital maturity and aligning with strategic objectives (Pinto et al., 2024). The adoption of digital technologies also helps MSMEs overcome internal inefficiencies, thereby stabilizing their competitive advantage (Acerbi et al., 2023). Furthermore, digitalization fosters product innovation and adaptability by enabling MSMEs to better understand and respond to market needs through strategic management and modern technology (Sulistiyawan et al., 2024). Entrepreneurial orientation and knowledge management are crucial in leveraging digital tools effectively, leading to improved performance and innovation (Aliyah and Wahyuni, 2024). In terms of marketing, digital platforms allow MSMEs to adopt a customer-centric approach, which is vital for sustaining economic activity and competitiveness (Denmamode and Panchoo, 2024). Additionally, e-commerce adoption is a key strategy for expanding market reach and enhancing customer engagement, particularly in the food and beverage industry (Aliyah and Wahyuni, 2024). While digitalization offers numerous benefits, MSMEs often face challenges such as limited resources and a lack of confidence in adopting new technologies. Addressing these challenges requires a comprehensive understanding of digital tools and strategic planning to ensure successful digital transformation (Denmamode and Panchoo, 2024). By overcoming these barriers, MSMEs can significantly enhance their contribution to the national and regional economies

MSMEs are crucial to Indonesia's economic growth, accounting for 99% of all business units. They contribute approximately 60.5% to the Gross Domestic Product (GDP), absorbing around 96.9% of total employment nationwide (Ministry of Cooperatives and SMEs, 2022). Most MSMEs in Indonesia still face various constraints in improving their products' productivity and added value. These constraints involve a lack of market access, skills and knowledge about technology, limited access to capital, and not yet optimal MSME digitalization processes in supporting downstream industries and strategic food in Indonesia. Through the Ministry of Cooperatives and SMEs, the government set a target to encourage the digitization of 30 million MSMEs by 2024. However, the MSME digitization mission still faces several obstacles, including (1) the uneven level of technological literacy and understanding of business digitization among MSME players and (2) the hesitation and fear of MSME players to try various digital platforms.

The transformation and digitalization of MSMEs involve digitalization measures on the supply chain (input), marketing (e-commerce), and payment (e-payment). For example, a study by Kilay et al. (2022) shows the positive impact of e-payment and e-commerce services on the supply chain performance of MSMEs in Indonesia. Research by Costa et al. (2022) in Brazil proved that the level of digitalization correlates with the innovation and business income of MSMEs. Gaglio et al. (2022)

found that digital communication technologies, such as social media and mobile phones, support innovation and increased labor in MSMEs. Furthermore, MSME linkages with large industries also contribute to MSME development. Research conducted by Francisco and Canare (2018) shows that these engagements provide knowledge transfer, market access, and a positive influence on the bargaining power of strong industries.

The primary research question of this study is: What socio-economic factors most significantly influence the decision of MSMEs to adopt e-commerce in Indonesia? This study aims to identify the key determinants of e-commerce utilization among MSMEs, focusing on variables such as gender, position in the household, marital status, age, education, main activity, internet access, mobile phone usage, social media access, and income level. This research extends previous studies, such as those by Beckers et al. (2018) and Lubis (2018), by using a logistic regression model to estimate the likelihood of MSMEs adopting e-commerce platforms. Logistic regression is widely used to analyze decision-making processes where the dependent variable is binary, such as in the case of e-commerce adoption by MSMEs (Weisburd et al., 2022).

Furthermore, this study uses primary data from online surveys and nudge theory experiments to assess the impact of digital transformation on MSME performance. These methods aim to encourage the voluntary adoption of digital platforms across various business aspects. This combination of primary and secondary data provides a comprehensive view of the socio-economic factors influencing e-commerce adoption and the broader impact of digital transformation on MSMEs in Indonesia.

By examining these issues, this research aims to contribute to the extant literature on digitalization and e-commerce adoption, particularly in the context of MSMEs, and offers insights for policymakers and industry players to enhance e-commerce penetration in Indonesia.

## 2. Literature review

Digital transformation refers to the utilization of digital technologies for changes to business models, operational processes, and customer interactions, with the aim of creating new added value (World Bank, 2019). The integration of digital technologies into economic, social, and political spheres aims to enhance quality of life and productivity by leveraging advancements such as artificial intelligence, blockchain, and the Internet of Things (IoT). These technologies play a crucial role in addressing global challenges, boosting economic efficiency, and fostering social progress. Digital transformation enhances economic productivity by improving enterprise innovation and reducing information asymmetry (Dong, 2024), while the adoption of technologies like 5G, AI, and data analytics drives entrepreneurship and labor market expansion (Zaichenko, 2023). In the social domain, digitalization strengthens societal interactions, raises living standards, and creates new job opportunities (Khaustova, 2023). Moreover, in Europe, digital technology adoption has reshaped social structures, improved connectivity, and promoted economic growth, as reflected in indices measuring digital and social progress (Cetulean et al., 2024). On a global scale, digital technologies contribute to solving critical issues such as climate change by optimizing resource use and energy efficiency (Krupa et al., 2024). However, challenges such as

cybersecurity risks, digital inequality, and potential unemployment require strategic policy responses, regulatory frameworks, and international collaboration to ensure an inclusive and secure digital transformation (Khaustova, 2023).

Deloitte Indonesia (2020) defines digital transformation as the strategic adoption of digital technologies to create added value for customers, streamline business processes, and enhance overall organizational performance. This transformation is a multi-stage process that includes digitization, digitalization, and full-scale transformation, driving fundamental changes in enterprise strategies, organizational structures, information technology, supply chains, and marketing. To remain competitive in an increasingly digital and globalized market, companies must develop and leverage key technological assets such as IT infrastructure, Big Data, AI, IoT, and cloud solutions. Digital transformation not only fosters innovation and strengthens customer engagement but also plays a critical role in addressing challenges posed by global digital platforms and rising digital inequality (Oliinyk, 2024).

Micro, Small, and Medium Enterprises (MSMEs) in Indonesia are defined by specific characteristics related to assets, turnover, employee numbers, and capital, according to the Ministry of Cooperatives and Small and Medium Enterprises (2019). Based on Government Regulation No. 7 of 2021, MSMEs are categorized by business capital and annual sales. Micro businesses have a maximum capital of IDR 1 billion or a turnover of up to IDR 2 billion per year. Small businesses range from IDR 1 billion to IDR 5 billion in capital or a turnover between IDR 2 billion and IDR 15 billion per year, while medium businesses have a capital of IDR 5 billion to a maximum of IDR 10 billion, with a turnover ranging from IDR 15 billion to IDR 50 billion per year.

MSMEs play a crucial role in economic growth and sustainable development, as highlighted by Alam and Adeyinka (2021), who note that MSMEs contribute significantly to the production sector, manufacturing support, income generation, and job creation. Zutshi et al. (2021) emphasize that MSMEs can act as economic pillars during crises, helping to drive post-crisis recovery. In Indonesia, MSMEs contribute 60.5% to the nation's GDP and employ about 96.9% of the national workforce (Coordinating Ministry for Economic Affairs, 2022). The development and resilience of MSMEs are influenced by both internal factors (such as employee, firm, and managerial performance) and external factors (including government involvement, stakeholder engagement, and consumer preferences). Makanyeza et al. (2022) add that government support, institutional policies, and collaboration play a key role in fostering MSME innovation and growth, with technological adaptation and digitalization being critical for enhancing marketing, advertising, communication, and payment systems.

E-commerce, which encompasses electronic transactions between companies and stakeholders, including financial transactions and information exchange, is a key element of the digital economy (Chaffey, 2009). With the use of Internet technology, e-commerce spans a broad spectrum of business activities (Schneider, 2015). It is classified into five categories: business-to-consumer (B2C), business-to-business (B2B), consumer-to-consumer (C2C), consumer-to-business (C2B), and business-to-government (B2G). E-commerce has successfully shortened the gap between companies and customers by leveraging technology to better meet customer needs

(Igwe et al., 2014). Implementing e-commerce offers strategic benefits and increases profitability, as demonstrated by rising sales volumes (Gilaninia et al., 2011).

Emerging research highlights that e-commerce adoption is also influenced by digital consumer behavior. Studies employing sentiment analysis indicate that customer reviews and perceptions significantly affect purchase decisions in online marketplaces (Ma et al., 2024). Advanced deep learning models, such as BERT-LSTNet-Softmax, have demonstrated superior accuracy in analyzing consumer sentiment, suggesting that businesses leveraging sentiment analysis can optimize their marketing strategies and improve sales performance.

Additionally, the use of predictive analytics in e-commerce has gained traction. Research shows that deep learning-based sales forecasting models, such as CNN, Bi-LSTM, and FCNN, outperform traditional statistical methods in predicting e-commerce sales trends (Li et al., 2024). These models integrate structured, image-based, and historical sales data to provide better decision-making insights, which is particularly relevant for MSMEs seeking to optimize inventory management and pricing strategies.

The digitalization of MSMEs is becoming increasingly important, with the Agency for the Assessment and Application of Technology (BPPT) (2020) stating that digitalization affects various aspects of daily life. To accelerate digital transformation in Indonesia, mastering Industry 4.0 technologies like the Internet of Things, artificial intelligence, big data, and cloud computing is crucial. Digital transformation involves significant changes in how organizations operate, influenced by these digital technologies (Kane et al., 2015). Marketplaces and digital platforms have facilitated MSME digitalization, especially in the payment and marketing sectors. For payments, MSMEs can utilize technologies like QRIS, a digital payment system introduced by Bank Indonesia to empower MSMEs, which by November 2021 had integrated 12 million merchants (Bank Indonesia, 2022). Ease of use, perceived benefits, and income expectations drive the adoption of QRIS among MSMEs (Kusumaningtyas, 2023; Sholihah, 2023). Beyond payments, MSMEs have also embraced e-commerce and online marketing to reach broader markets, increase productivity, and enhance value-added processes, which in turn support downstream industries and improve supply chain performance through greater efficiency and competitiveness.

Despite these advancements, MSMEs still face challenges in digital adoption. Studies have shown that businesses struggle with personalized digital marketing, as conventional advertising methods do not effectively engage customers. Recent research on deep learning-based recommendation systems highlights that AI-driven product recommendations, such as those generated using DeepFM and NeuMF models, can significantly increase user engagement and conversion rates (Qian and Wang, 2024). This suggests that integrating personalized recommendation systems into MSME digital platforms could address barriers to consumer engagement and competitiveness in online marketplaces.

Although research on the factors influencing individuals' decisions to shop or use services online has been widely conducted, there is significant variation in the findings from different studies in Indonesia. Some studies highlight differences in demographic factors such as gender, age, and education level, which influence online shopping behavior. For example, Hasyyati (2017) found that women with lower education levels

were more likely to shop online, while Ariansyah et al. (2021) found that younger men with higher education were more likely to use e-commerce. Additionally, research conducted across different regions of Indonesia reveals varying findings, suggesting that social, cultural, economic, and geographical factors may influence consumer behavior differently in each area (Lubis, 2018; Yusmita et al., 2017).

Existing research tends to focus on specific regions or populations and does not comprehensively consider the complexity of the interactions between these broader factors. For instance, Hasyyati (2017) and Ariansyah et al. (2021) both identified demographic and socio-economic factors as significant determinants of online shopping behavior, but their findings differ. Similarly, Yusmita et al. (2017) and Lubis (2018) demonstrated that consumer behavior can vary significantly depending on regional contexts, highlighting differences in the factors influencing shopping decisions in areas like Aceh and Medan. The key research gap here is the need for more comprehensive and cross-regional studies to understand how these factors operate across Indonesia as a whole.

Moreover, most existing studies have been limited to demographic and socio-economic aspects without exploring other important factors, such as digital skills, access to technology, and the influence of exposure to harmful content, which may hinder e-commerce adoption. Exposure to harmful content can impede the digitalization process and the adoption of technology by consumers (Ariansyah et al., 2021). Thus, a more holistic and integrated research approach is needed to explain how various factors, both demographic and technological, influence the development of e-commerce and the digitalization of MSMEs across Indonesia.

## 3. Method, data, and analysis

In this study, the data used are both secondary and primary. The secondary data were obtained from the 2022 National Socio-Economic Survey (Susenas) by the Central Statistics Agency (BPS), specifically related to the MSME sector and digitization. The Susenas dataset represents the entire population of Indonesia, ensuring comprehensive national coverage. These secondary data were primarily used to estimate the logistic regression model for analyzing the factors influencing MSMEs in utilizing e-commerce, with an explanation of the variables presented in **Table 1**.

**Table 1.** Variables in logistic regression.

| Variables | Scale | Category (Description) |
|---|---|---|
| jk (Gender) | Dummy | 1 = Female; 0 = Male |
| HOH (Head of Household) | Dummy | 1 = Head of Household; 0 = Other |
| couple | Dummy | 1 = Wife/husband; 0 = Other |
| not_married | Dummy | 1 = Unmarried; 0 = Divorced/other |
| mating | Dummy | 1 = Married; 0 = Other |
| less19 | Dummy | 1 = Age < 19 years old; 0 = Other |
| u19_24 | Dummy | 1 = Age 19–24 years; 0 = Other |
| u25_30 | Dummy | 1 = Age 25–30 years; 0 = Other |
| u31_36 | Dummy | 1 = Age 31–36 years; 0 = Other |

**Table 1.** (*Continued*).

| Variables | Scale | Category (Description) |
|---|---|---|
| u37_42 | Dummy | 1 = Age 37–42 years; 0 = Other |
| u43_48 | Dummy | 1 = Age 43–48 years; 0 = Other |
| U49_54 | Dummy | 1 = Age 49–54 years; 0 = Other |
| ES | Dummy | 1 = Elementary school graduate; 0 = Other |
| JHS | Dummy | 1 = Junior high school graduate; 0 = Other |
| SHS | Dummy | 1 = High school graduate; 0 = Other |
| diploma | Dummy | 1 = College Graduate; 0 = Other |
| work | Dummy | 1 = Employed; 0 = Other |
| school | Dummy | 1 = School; 0 = Other |
| manage_hh | Dummy | 1 = Taking care of the neighborhood; 0 = Other |
| KK (Small Family) | Dummy | 1 = Small family (≤ 4); 0 = Large family (> 4) |
| HP | Dummy | 1 = HP/Mobile Phone; 0 = PC/Laptop |
| social_media | Dummy | 1 = Access Social Media; 0 = No |
| residence | Dummy | 1 = Urban; 0 = Rural |
| income | Dummy | 1 = Above average; 0 = Below average |
| work*gender | Dummy | 1 = People who work and female; 0 = Other |
| work*u25_30 | Dummy | 1 = People who work and aged 25-30 years; 0 = Other |
| work*31_36 | Dummy | 1 = People who work and aged 31-36 years; 0 = Others |
| work*43_48 | Dummy | 1 = People who work and aged 43-48 years; 0 = Other |
| work*diploma | Dummy | 1 = People who work and diplomas; 0 = Other |
| work*social_media | Dummy | 1 = People who work and use social media; 0 = Other |
| work*residence | Dummy | 1 = People who work and live in urban areas; 0 = Other |
| work*income | Dummy | 1 = People who work and earn above average income; 0 = Other |
| work*e_buy | Dummy | 1 = People who work and buy goods/services in e-commerce; 0 = Other |

Source: BPS.

Additionally, primary data were collected through an online survey of 550 MSME respondents from 29 provinces in Indonesia (ensuring national representation of the MSME sector across different regions) to examine the effect of digital transformation on improving MSME performance. An offline survey was also conducted on 42 MSME respondents with relatively low levels of digital technology, particularly those who have not utilized e-payment or e-commerce, to better understand MSME behavior and motivate them to voluntarily adopt digitalization in various business aspects to enhance their performance. The classification of enterprises used in this study comprehensively covers the entire spectrum of MSMEs in Indonesia, ensuring an accurate representation of different business scales.

The methodology developed to analyze the determinants of MSME decisions in utilizing e-commerce is based on previous research. Factors such as gender, age, and education level have been shown to affect an individual's decision to access e-commerce services. For instance, men are generally more inclined to shop online, as they tend not to prioritize direct interactions between sellers and buyers, while women

may prefer direct bargaining (Rodgers and Harris, 2003). However, this trend differs in Indonesia, where more women are reported to use e-commerce (Hasyyati, 2017). Other factors, such as higher income, can also drive online shopping due to an increased awareness of time efficiency (Lubis, 2018; Punj, 2011). Additionally, younger individuals with higher education tend to find it easier to navigate the technological features offered in e-commerce platforms (Beckers et al., 2018; Haver, 2008). Furthermore, living in a city with reliable internet infrastructure or easy access to mobile devices is likely to increase e-commerce usage in that location (Abrar and Handoyo, 2020; Hasyyati, 2017).

In this study, a logistic regression model was employed to determine the factors and their interactions that influence the use of e-commerce from a socio-economic perspective. The response variable in this model is the decision of MSMEs to use e-commerce. The logistic regression model used is presented as follows:

$$\begin{aligned} ln\left(\frac{p_i}{1-p_i}\right) = {} & \beta_0 + \beta_1 D_{gender} + \beta_2 D_{HOH} + \beta_3 D_{couple} + \beta_4 D_{not_{married}} + \beta_5 D_{mating} + \beta_6 D_{less19} + \beta_7 D_{u19_{24}} \\ & + \beta_8 D_{u25_{30}} + \beta_9 D_{u31_{36}} + \beta_{10} D_{u37_{42}} + \beta_{11} D_{u43_{48}} + \beta_{12} D_{u49_{54}} + \beta_{13} D_{ES} + \beta_{14} D_{JHS} + \beta_{15} D_{SHS} \\ & + \beta_{16} D_{Diploma} + \beta_{17} D_{work} + \beta_{18} D_{school} + \beta_{19} D_{manage_{hh}} + \beta_{20} D_{KK} + \beta_{21} D_{HP} \\ & + \beta_{22} D_{social_{media}} + \beta_{23} D_{residence} + \beta_{24} D_{income} + \mu \end{aligned} \quad (1)$$

where the variables represent various socio-economic factors such as gender, education, income, and access to digital infrastructure.

For the offline survey, a natural experiment was conducted by applying the Nudge Theory with Choice Architecture. This approach involved providing MSMEs with a concise video that illustrated the transformation and digitalization of MSMEs across various business aspects, including payment systems and e-commerce. The application of Nudge Theory aimed to motivate MSMEs to voluntarily adopt digital technologies in their business operations, ultimately improving their productivity and adding value. Experimental data were collected to measure the changes in the use of digital technologies by MSMEs before and after the implementation of the Nudge Theory.

## 4. Result and discussion

### 4.1. Determinants of MSMEs using e-commerce

To analyze the determinants of MSME decisions and the community's utilization of e-commerce, a contingency table or cross-tabulation can be used, using Susenas data in 2022. The determinants that will be tested include gender, age, education, income, position as head of household, marital status, family size, cellphone use, social media access, residential location, and income level.

**Table 2** shows that the number of respondents who sell goods/services online is 23,828 MSMEs or 2.27% of Susenas respondents. Among these, 14,056 (58.99%) also purchase goods/services online, either for their own needs or as intermediate materials for their products. The number of respondents who purchased goods/services online was 82,227, including MSMEs, or 7.84% of Susenas respondents.

These findings align with prior research on consumer behavior in e-commerce, where purchasing and selling behavior is strongly interconnected (Ma et al., 2024).

Studies on sentiment analysis in e-commerce have demonstrated that consumers who engage in online shopping tend to leave reviews, influencing purchasing decisions and fostering e-commerce adoption. MSMEs that actively sell online are more likely to purchase online due to supply chain efficiency and accessibility advantages.

From **Table 2**, it is clear that there is a strong relationship between online selling and online buying behavior, as shown by the Khi-square test statistics with a very small *p*-value or chance of error (0). MSMEs that sell online tend to also buy their goods/services online for their needs (58.99%). Meanwhile, respondents who do not sell online tend to buy their goods/services not online for their needs (93.35%).

**Table 2.** Number of respondents involved in purchasing and selling goods/services online.

| **Selling Online? (e_sell)** | **Buying Online? (e_buy)** | | **Total** |
|---|---|---|---|
| | **Yes (1)** | **No (0)** | |
| Yes (1) | 14,056<br>(58.99%)<br>(17.09%) | 9772<br>(41.01%)<br>(1.01%) | 23,828<br>(100%)<br>(2.27%) |
| No (0) | 68,171<br>(6.65%)<br>(82.91%) | 956,576<br>(93.35)<br>(98.99) | 1,024,747<br>(100%)<br>(97.73%) |
| Total | 82,227<br>(7.84%)<br>(100%) | 966,348<br>(92.16)<br>(100%) | 1,048,575<br>(100%)<br>(100%) |

Pearson chi2 (1): 880000 Pr: 0.000.
Notes: Figures in parentheses represent percentages: the first row within each cell indicates row percentages, while the second row represents column percentages.
Source: Susenas (2022).

The factors that influence respondents to sell goods/services online (e_sell) can be seen from the results of the alleged "best" logistic regression model (from several alternative models tried) presented in **Table 3**. The results of this study can provide implications or recommendations on how to increase online sales of MSME goods/services so that their productivity increases. The table shows that women have a higher chance of selling goods/services online, 1.09 times compared to men, and the people who are heads of households also have a higher chance by a factor of 1.13 times to do selling online compared to those who are not heads of households. Women usually take the burden of unpaid domestic work and care for families (Miranti et al., 2022). This encourages women to start doing business while taking care domestic work. Women in Indonesia are highly related to informal sector, even during pandemic, the high adoption on digital technology gives alternative work options, as they can work and manage their businesses from home while taking care of their families (Miranti et al., 2022; Sulistyaningrum et al., 2022). Moreover, in Indonesia, the head of household is the family member that highly related to e-commerce (Hasyyati, 2017). Head of the households are usually the owner of the business (MSMEs); thus, they will hold the responsibility as the decision maker in doing online business.

**Table 3.** Estimation results of logistic regression model of factors affecting respondents who sell goods/services online (e_sell = 1).

| Y1 (e_sell) | Coefficient | Odds Ratio | $P>z$ | [95% Conf. Interval] | |
|---|---|---|---|---|---|
| gender | 0.087407 | 1.09134 | 0.139 | 0.971878 | 1.225487 |
| HOH | 0.128633 | 1.137273 | 0.001 | 1.056181 | 1.224591 |
| not_married | −0.29619 | 0.743643 | 0.000 | 0.690491 | 0.800886 |
| less19 | −0.89036 | 0.410506 | 0.000 | 0.36142 | 0.466259 |
| u25_30 | 0.455783 | 1.577407 | 0.000 | 1.394282 | 1.784584 |
| u31_36 | 0.411773 | 1.509491 | 0.000 | 1.323638 | 1.721439 |
| u37_42 | 0.255993 | 1.291744 | 0.000 | 1.201532 | 1.388728 |
| u43_48 | 0.301254 | 1.351553 | 0.001 | 1.137849 | 1.605393 |
| ES | 0.01591 | 1.016037 | 0.614 | 0.955173 | 1.08078 |
| JHS | 0.016327 | 1.016461 | 0.629 | 0.951242 | 1.086152 |
| SHS | −0.0203 | 0.979908 | 0.525 | 0.920528 | 1.043119 |
| diploma | 0.004413 | 1.004423 | 0.963 | 0.832327 | 1.212102 |
| KK | −0.01036 | 0.989697 | 0.658 | 0.945322 | 1.036155 |
| HP | 2.835872 | 17.04526 | 0.000 | 14.03938 | 20.69473 |
| social_media | 0.229111 | 1.257481 | 0.000 | 1.12292 | 1.408166 |
| residence | 0.363229 | 1.437965 | 0.000 | 1.311271 | 1.576899 |
| income | −0.05424 | 0.947203 | 0.003 | 0.914296 | 0.981295 |
| e_buy | 2.248096 | 9.469687 | 0.000 | 8.625409 | 10.39661 |
| work*gender | −0.05669 | 0.944885 | 0.391 | 0.829976 | 1.075704 |
| work*u25_30 | −0.26505 | 0.76717 | 0.000 | 0.665739 | 0.884054 |
| work*u31_36 | −0.16796 | 0.845385 | 0.024 | 0.730958 | 0.977724 |
| work*u43_48 | −0.07505 | 0.927697 | 0.430 | 0.770084 | 1.117569 |
| work*diploma | −0.03581 | 0.96482 | 0.746 | 0.777038 | 1.197983 |
| work*social_media | −0.17928 | 0.83587 | 0.007 | 0.733892 | 0.952018 |
| work*residence | 0.065825 | 1.06804 | 0.234 | 0.958235 | 1.190427 |
| work*income | 0.065041 | 1.067203 | 0.000 | 1.054932 | 1.079617 |
| work*e_buy | −0.11322 | 0.892951 | 0.041 | 0.801205 | 0.995202 |
| cons | −6.79227 | 0.001122 | 0.000 | 0.000649 | 0.001942 |

Logistic regression Number of obs = 340,032
Wald chi2(27) = 17,463.19
Prob > chi2 = 0.0000
Log pseudolikelihood = −31,009.269 Pseudo R2 = 0.2716
Source: Researcher analysis based on Susenas 2022 data.

Moreover, the probability of selling online for respondents who are not married is smaller or 0.74 times compared to respondents who are married. According to Kredivo (2022) and Yogatama (2023), most e-commerce users are married with no children. As for those who buy from e-commerce, they will have a higher probability as well to sell products through e-commerce. This is confirmed as well by the result in **Table 3**, that the behavioral factor of buying goods/services online significantly increases the chance to sell the products through online as well by 9.46 times. Another factor affecting respondents to sell goods/services in online market is age. The

opportunity to sell goods/services online for respondents aged 25–36 years is the greatest, followed by respondents aged 43–48 years, 37–42 years, and less than 19 years. E-commerce penetration is usually highly related to people in productive age, particularly the younger one (Ariansyah et al., 2021).

The education factor in 2022 does not have a significant effect, for respondents with a Diploma (1.00 times), SHS (0.97 times), JHS (1.02 times), ES (1.02 times) compared to respondents who have not graduated from elementary school or other. Meanwhile, in the research of Juanda et al. (2023) using Susenas data in 2021 found that the higher the respondent's education, the higher the opportunity to sell their goods/services online.

**Table 4.** Cross tabulation between education level and selling online 2021 and 2022.

| **Education** | **Selling Online (e_sell)-2022** | | **Total** |
|---|---|---|---|
| | **Yes (1)** | **No (0)** | |
| Elementary | 14,508 | 627,483 | 641,991 |
| | (2.26%) | (97.74%) | (100%) |
| Middle | 4835 | 206,869 | 211,704 |
| | (2.28%) | (97.72%) | (100%) |
| High | 1694 | 73,541 | 75,235 |
| | (2.25%) | (97.75%) | (100%) |
| Total | 21,037 | 907,893 | 928,930 |
| | (2.26%) | (97.74%) | (100%) |
| Pearson chi2(2) = 0.4773 Pr = 0.788 | | | |
| **Education** | **Selling Online (e_sell)-2021** | | **Total** |
| | **Yes (1)** | **No (0)** | |
| Elementary | 7534 | 677,533 | 685,067 |
| | (1.10%) | (98.90%) | (100%) |
| Middle | 12,375 | 272,297 | 284,672 |
| | (4.35%) | (95.65%) | (100%) |
| High | 8495 | 111,605 | 120,100 |
| | (7.07%) | (92.93%) | (100%) |
| Total | 28,404 | 1,061,435 | 1,089,839 |
| | (2.61%) | (97.39%) | (100%) |
| Pearson chi2(2) = 19.000 Pr = 0.000 | | | |

Source: Researcher analysis based on Susenas 2022 data.

This is proven by the data structure in Susenas (2021, 2022) that in 2022, the higher education of the respondents, the proportion of respondents who sell online does not change significantly. This data is shown in **Table 4**, which gives a hint that digital adoption, particularly in accessing e-commerce, in 2022, could be done by people with various education levels. Unlike in the previous year, in Susenas 2021 when people are still adapting due to pandemic covid-19, the urge to access e-commerce had been done mostly by people with higher education. Not only that, the family size also have insignificant impact on influencing people selling products in

the online market. The opportunity to sell goods/services online for small family respondents (maximum 4 household members) is almost the same or 0.99 times compared to large families (more than 4 household members). Whereas in the research of Juanda et al. (2023) using Susenas data in 2021, the effect of family size is significant, namely the opportunity to sell goods/services online for small family respondents is 1.16 times compared to those with large families. In 2021 there was an urgent need for MSMEs to expand their business through online market to recover from pandemic siutation. With smaller family members, it might provide smaller number of workers to the businees, thus, expanding the market sales through online channel was the alterntive. However, in 2022, the urgency to sell products online is no more dependent on the family size. This could give a hint that along with the time, technology adaptation always grows.

In comparison with the results found by Juanda et al. (2023), the coefficient estimation results of the logistic regression model from the 2022 Susenas data show that the factors influencing MSMEs to sell goods/services online are not significantly different compared to the 2021 Susenas data. The difference in the significance of the effect is only in the education factor and the family size factor, which in the previous year's Susenas data (2021) had a significant effect.

Using cellphone significantly support the MSMEs to sell products online. The opportunity to sell goods/services online for respondents who use cell phones is 17.04 times higher compared to those who do not have cell phones. Nowadays, the cellphone used by e-commerce user is already connected to the internet which will ease them to access e-commerce anywhere and anytime. The social media also living in urban areas are giving higher chance to the respondents to sell their products online. The opportunity to sell goods/services online for respondents who have access to social media by 1.25 times higher compared to respondents who do not have access to social media. Social media itself can be used as marketing channels and helping the seller to communicate with customers (Maskuroh et al., 2022). Moreover, the opportunity to sell goods/services online for MSMEs residing in urban areas is 1.44 times higher than of those residing in rural areas. Urban areas indeed provide better infrastructure and internet connection than rural areas. This then supports the MSMEs from urban areas to access e-commerce more than the MSMEs from rural areas. In 2021, Kredivo (2022) found that the highest e-commerce transactions are from big cities in Java Island in Indonesia, such as Jakarta, Bogor, Bekasi, Bandung, and Tangerang. These big cities provide better internet penetration and digital infrastructure.

There are several characteristics of respondents, that affect the selling online behaviors, also depending on working status. For income level, the higher the respondent's income, the lower the chance of selling goods/services online. For respondents with above average income, the chance of selling goods/services online is smaller or 0.95 times than those with lower income. However, if those with above-average income work, the chances of selling goods/services online are higher or 1.06 times than if he does not. For female respondents, if she works, the chance of selling goods/services online is smaller or 0.94 times than if she does not work. For respondents aged 25–30 years, if he/she works, the chance of selling goods/services online is smaller or 0.77 times than if he/she does not work. For older respondents, aged 31–36 years, if he/she works, the chance of selling goods/services online is

smaller or 0.85 times than if he/she does not work. For respondents who have social media, if they work, the chance of selling goods/services online is smaller or 0.84 times than if they do not work. And, for respondents who buys goods/services via online, if he works, the chances of selling goods/services online are smaller or 0.89 times than if he does not work.

Demographic factors such as gender, household head status, age, and online buying behavior influence MSMEs opportunities to sell online, while technological support such as the use of mobile phones and access to social media also increases these opportunities. Additionally, digital adoption in 2022 has become more widespread, with education level and family size no longer significantly affecting the decision to sell online.

## 4.2. Digital transformation to improve MSME performance from online survey

The adoption of e-commerce by MSMEs, as discussed in previous section, is the first step in digital transformation. However, beyond simply entering the digital marketplace, it is essential to understand how digitalization, particularly through e-commerce and e-payment impacts their business performance.

**Table 5.** MSME performance before and after using e-commerce and e-payment.

| Performance Indicators | Mean Before (n) | Mean After (n) | Increase (*p*-value) |
|---|---|---|---|
| Turnover (Rp/month) | IDR 23,059,796 (491) | IDR 27,995,299 (491) | IDR 4,935,503 (0.000)* |
| Number of Products (Units/month) | 804.18 (492) | 1217.89 (492) | 413 (0.0006)* |
| Number of Customers (Person/month) | 222.28 (485) | 317.24 (485) | 94 (0.001)* |
| Unit/Operational Cost (Rp/month) | IDR 9,468,690 (475) | IDR 8,454,273 (475) | (-) IDR 1,014,416 (0.1684) |
| Total Labor (Person/month) | 5.41 (447) | 5.80 (447) | 0.39 (0.3843) |
| Turnover/Labor | IDR 7,046,144/Labor (453) | IDR 7,845,657/Labor (453) | IDR 799,513 (0.2620) |
| Number of Products/Labor | 318.6798 Units/Labor (452) | 449.257 Units/Labor (452) | 130.5772 (0.0411)* |

Notes: Numbers in parentheses are the number of respondents who answered the questions for each performance aspect, and the *p*-value of the *t*-test statistic in the last column.
Source: Online survey.

Digital transformation is the use of digital technology to create value for customers, accelerate business processes, and improve overall organizational performance. **Table 5** describes how the organization's performance changes in several performance indicators, before and after using digital technology such as using e-Payment and e-Commerce, and also its performance improvement. Based on the survey results, digital transformation has significantly improved several key performance indicators for MSMEs:

a) Monthly turnover increased by IDR 4,935,503 after adopting e-commerce dan e-payment,
b) The number of products sold increased by 413 units per month and the number of customers grew by 94 per month, both significantly,
c) Monthly operational costs decreased by IDR 1,014,416, although the reduction was not statistically significant,

d) The increase in workforce (0.39 per month or 4.7 per year) was not statistically significant
e) The increase in turnover per worker (IDR 799,513 per month) was also not statistically significant.
f) However, the increase in products per worker (130.58 units per month) was statistically significant, indicating improved production efficiency.

These findings suggest that digital transformation, especially via e-commerce, enables MSMEs to expand their market rearch and improve operational efficiency. However, the absence of significant gains in workforce size and turnover per worker indicates that MSME may not yet be fully leveraging digital adoption to achieve proportional business growth.

These findings are consistent with research on e-commerce performance, where digital transformation positively impacts turnover, product diversity, and customer reach (Li et al., 2024). Prior studies utilizing deep learning-based sales forecasting models have shown that businesses implementing data-driven decision-making in e-commerce achieve higher efficiency and sales performance. Predictive analytics in e-commerce can optimize inventory management, reduce operational costs, and enhance MSME competitiveness.

### 4.3. Analysis of the influence of MSME digitalization information with nudging from offline surveys

Based on the online survey, the most difficult challenges in developing digital businesses faced by MSMEs are all related to access to capital for digital investment and obtaining information/knowledge to develop and operate digital businesses. To sharpen this analysis, an offline survey was conducted with 42 MSME respondents consisting of 16 (38.1%) MSMEs from Bogor Regency, 12 (28.6%) from Bogor City, and 14 (33.3%) from Bekasi City, which were selected using a purposive sampling method, namely MSMEs with relatively low levels of digital technology.

In this offline survey, a natural experiment was conducted to apply Nudge Theory with Choice Architecture in the form of a visual design that contains an explanation of the transformation and digitalization of MSMEs in various aspects of their business, such as e-payment and e-commerce, and changes in their performance. The application of Nudge Theory is to motivate the behavior of MSMEs to take advantage of the digitalization of their business in various aspects so as to increase the productivity and added value of MSMEs.

**Table 6** describes that 90.48% of MSMEs in this offline survey have never utilized e-commerce, 7.14% rarely and 2.38% sometimes. After being given a brief explanation of MSME digitization (Nudging), overall 59.52% of MSMEs will try, and 38.1% will use e-commerce more often. From the Khi-squared test statistics, it reinforces the description in the table that the description of changes in e-commerce utilization after nudging is independent of the existing conditions of MSMEs before the experiment.

**Table 7** describes that 69% of MSMEs in this offline survey never utilize e-Payment, 22% rarely, 2% sometimes and 7% often. After being given a brief explanation of MSME digitalization (Nudging), overall 64.29% of MSMEs will use

e-Payment more often. This expected value is much greater than the percentage of MSMEs that are in the same condition before this experiment, which is only 35.71%. From the Khi-squared test statistics, it reinforces the description in the table that the description of changes in e-Payment utilization after this nudging does not depend on the existing conditions of MSMEs before the experiment.

**Table 8** describes that 52.38% of MSMEs in this offline survey were not very interested or not interested in digitizing their business, and only 47.62% of MSMEs were interested. After being given a brief explanation of MSME digitization (Nudging), overall 88.1% of MSMEs would be more interested in digitizing their business. This expected value is much greater than the percentage of MSMEs that were in the same condition before this experiment, which was only 11.9%. From the Khi-squared test statistics, it reinforces the description in the table that the description of changes in MSMEs will digitize their business after this nudging, regardless of the existing conditions of MSMEs before the experiment.

**Table 6.** Change in the number of MSMEs (%) utilizing e-commerce before and after the briefing on MSME digitalization.

| **E-Commerce utilization (before)** | **Utilization of e-Commerce (After Brief Explanation of MSME Digitalization)** | | | **Total (%)** |
|---|---|---|---|---|
| | **Won't Try** | **Will Try** | **More Often** | |
| Never | 1<br>(2.63)<br>(100.00) | 23<br>(60.53)<br>(92.00) | 14<br>(36.84)<br>(87.50) | 38<br>(100.00)<br>(90.48) |
| Rare | 0<br>(0.00)<br>(0.00) | 1<br>(33.33)<br>(4.00) | 2<br>(66.67)<br>(12.50) | 3<br>(100.00)<br>(7.14) |
| Sometimes | 0<br>(0.0)<br>(0.0) | 1<br>(100.00)<br>(4.00) | 0<br>(0.00)<br>(0.00) | 1<br>(100.00)<br>(2.38) |
| Total | 1<br>(2.38)<br>(100.00) | 25<br>(59.52)<br>(100.00) | 16<br>(38.10)<br>(100.00) | 42<br>(100.00)<br>(100.00) |

Pearson chi2 (4) = 1.7721 Pr = 0.778
Notes: Numbers in the first bracket are row %, numbers in the second bracket are column %.
Source: Offline Survey.

**Table 7.** Change in the number of MSMEs (%) utilizing e-payment before and after the briefing on MSME digitalization.

| **Utilization of e-Payment (Before)** | **Utilization of e-Payment (After Brief Explanation of MSME Digitalization)** | | **Total (%)** |
|---|---|---|---|
| | **Same** | **More Often** | |
| Never | 11<br>(37.93)<br>(73.33) | 18<br>(62.07)<br>(66.67) | 29<br>(100.00)<br>(69.05) |
| Rare | 3<br>(33.33)<br>(20.00) | 6<br>(66.67)<br>(22.22) | 9<br>(100.00)<br>(21.43) |
| Sometimes | 0<br>(0.00)<br>(0.00) | 1<br>(100.00)<br>(3.70) | 1<br>(100.00)<br>(2.38) |

**Table 7.** (*Continued*).

| Utilization of e-Payment (Before) | Utilization of e-Payment (After Brief Explanation of MSME Digitalization) | | Total (%) |
|---|---|---|---|
| | Same | More Often | |
| Often | 1<br>(33.33)<br>(6.67) | 2<br>(66.67)<br>(7.41) | 3<br>(100.00)<br>(7.14) |
| Total | 15<br>(35.71)<br>(100.00) | 27<br>(64.29)<br>(100.00) | 42<br>(100.00)<br>(100.00) |

Pearson chi2 (3) = 0.6473 Pr = 0.886
Notes: Numbers in the first bracket are row %, numbers in the second bracket are column %.
Source: Offline Survey.

**Table 8.** Change in the number of MSMEs (%) interested in digitizing their businesses before and after the brief explanation on MSME digitalization.

| Interest in Business Digitalization (Before) | Interest in Business Digitalization (After Brief Explanation of MSME Digitalization) | | Total (%) |
|---|---|---|---|
| | Same | More Interested | |
| Very Uninterested | 0<br>(0.00)<br>(0.00) | 5<br>(100.00)<br>(13.51) | 5<br>(100.00)<br>(11.90) |
| Not Interested | 4<br>(23.53)<br>(80.00) | 13<br>(76.47)<br>(35.14) | 17<br>(100.00)<br>(40.48) |
| Interested | 1<br>(5.00)<br>(20.00) | 19<br>(95.00)<br>(51.35) | 20<br>(100.00)<br>(47.62) |
| Very Interested | 0<br>(0.00)<br>(0.00) | 0<br>(0.00)<br>(0.00) | 0<br>(0.00)<br>(0.00) |
| Total | 5<br>(11.90)<br>(100.00) | 37<br>(88.10)<br>(100.00) | 42<br>(100.00)<br>(100.00) |

Pearson chi2 (2) = 3.7753 Pr = 0.151
Notes: Numbers in the first bracket are row %, numbers in the second bracket are column %.
Source: Offline survey.

**Table 9** describes that 80.95% of MSMEs in this offline survey are very unprepared or not ready to digitize their business, and only 19.05% of MSMEs are ready. After being given a brief explanation on MSME digitization (Nudging), overall 57.14% of MSMEs will be more ready to digitize their business. This expected value is relatively larger than the percentage of MSMEs that were in the same condition before this experiment, which was only 42.86%. From the Khi-squared test statistics, it reinforces the description in the table that the picture of changes in MSMEs will be more ready to digitize their businesses after this nudging, depending on the existing conditions of MSMEs before the experiment was carried out. From those that were previously not ready, it turns out that only 10% will be more ready to digitize their business. These findings are consistent with previous research on personalized recommendation systems in e-commerce, where AI-driven digital nudging has been shown to enhance user engagement and influence behavioral changes (Qian and Wang, 2024). Studies on deep learning-based recommendations models, indicate that tailored

product recommendations significantly improve customer interaction and conversion rates.

The key findings reveal that MSMEs face major challenges in digital business development, primarily due to limited capital for digital investment and insufficient knowledge about digital operations. An offline survey involving 42 MSMEs from Bogor Regency, Bogor City, and Bekasi City was conducted using purposive sampling to target those with lower levels of digital technology. In this survey, a natural experiment was implemented by applying Nudge Theory through a visual design that explained various aspects of digital transformation, such as e-commerce and e-payment. Before the intervention, 90.48% of MSMEs had never utilized e-commerce and 69% had never used e-payment.

However, after a brief explanation on digitalization, 59.52% of the respondents expressed a willingness to try e-commerce with 38.1% planning to use it more frequently while 64.29% intended to use e-payment more often. Additionally, the interest in digitalizing business operations rose significantly from 47.62% to 88.1%, and readiness for digital transformation increased from 19.05% to 57.14%, although only 10% of those initially unprepared became more ready.

**Table 9.** Change in number of MSMEs (%) ready to digitize before and after briefing on MSME digitalization.

| **Business Digitalization Readiness (Before)** | **Business Digitalization Readiness (After Brief Explanation of MSME Digitalization)** | | **Total (%)** |
|---|---|---|---|
| | **Same** | **More Prepared** | |
| Not Ready | 9<br>(90.00)<br>(50.00) | 1<br>(10.00)<br>(4.17) | 10<br>(100.00)<br>(23.81) |
| Less Ready | 9<br>(37.50)<br>(50.00) | 15<br>(62.50)<br>(62.50) | 24<br>(100.00)<br>(57.14) |
| Ready | 0<br>(0.00)<br>(0.00) | 8<br>(100.00)<br>(33.33) | 8<br>(100.00)<br>(19.05) |
| Very Ready | 0<br>(0.00)<br>(0.00) | 0<br>(0.00)<br>(0.00) | 0<br>(0.00)<br>(0.00) |
| Total | 18<br>(42.86)<br>(100.00) | 24<br>(57.14)<br>(100.00) | 42<br>(100.00)<br>(100.00) |

Pearson chi2 (2) = 15.3563 Pr = 0.000.
Notes: Numbers in the first bracket are row %, numbers in the second bracket are column.

## 5. Conclusion and suggestion

The number of respondents who sell goods/services online is 2.27% of Susenas 2022 respondents. Among these MSMEs, 58.99% also purchase goods/services online, either for their own needs or as intermediary materials for their products. Meanwhile, 7.84% of all respondents buy goods/services online, and 17.09% of online buyers are also online sellers.

There is a strong relationship between online selling and online buying behavior. MSMEs that sell online are more likely to buy their goods/services online (58.99%),

while those who do not sell online tend to buy their goods/services through offline channels (93.35%).

Several socio-economic factors significantly influence MSME engagement in online sales, including female gender, head of household status, married status, age (25–48 years), mobile phone usage, social media access, urban residence, moderate income, and online purchasing behavior. Additionally, the impact of age, diploma education, social media access, residential location, income, and online purchasing veries depending on employment status, indicating the interaction between work status and digital adoption.

This study focuses on examining the socio-economic factors influencing e-commerce adoption among MSMEs in Indonesia. While previous studies have largely focused on specific sectors or district-level case studies, this research provides a broader perspective by using national-scale data (Susenas, 2022) and integrating experimental methods such as nudging interventions**.** The study also explores the impact of digital transformation on MSME performance**,** particularly in turnover, productivity, and digital readiness**.**

To enhance MSME performance through increased online sales, several key aspects require attention. MSMEs led by men need targeted training and coaching, while household heads can play a strategic role in business development. Special support is essential for MSME owners under 25, over 48, and those with lower education through tailored digital training. Improving digital accessibility for MSMEs without mobile phones or social media is crucial. Rural MSMEs face market access challenges, requiring better policy support. Lastly, MSMEs with low incomes and no primary occupation need financial assistance to increase business capacity and sustainability. Those that have not yet engaged in online purchasing should be encouraged to expand their market reach through digital platforms.

Findings from the online survey confirm that digital transformation significantly enhances MSME performance, particularly in turnover and labor productivity. Meanwhile, the offline survey shows that digital literacy programs improve MSME interest and readlines to implement digitalization in various business aspects.

Strengthening collaboration between MSMEs, the private sector, and the government is crucial to support digital transformation and economic sustainability. Based on the experimental findings, MSMEs that have not yet undergone digitalization require assistance to transition into the digital economy, while those that have already adopted digital platforms must focus on maintaining product quality assurance. Ensuring trust through partnerships with larger companies is essential to enhance market credibility and long-term business sustainability.

Micro enterprises constitute the majority of small businesses in Indonesia. According to SIDT 2024, micro enterprises with annual sales of $\leq$ 2 billion IDR account for 13,357,332 business units (99.68%). Despite their dominance in terms of quantity, micro enterprises face significant challenges in digital adoption due to their informal nature and difficulties in achieving economies of scale.

Since most micro enterprises operate informally and struggle with access to capital, technology, and markets, collaboration among government agencies, financial institutions, and digital platforms is essential to facilitate their integration into the formal economy. Policies should focus on improving financial access, promoting

technology adoption, and providing capacity-building programs tailored to the needs of micro enterprises.

Ensuring the sustainability of digital transformation in micro enterprises is another critical area of study. This includes exploring collaboration models between micro enterprises and large industries, enhancing financial inclusion, and integrating environmentally sustainable business practices into digital strategies. Given that a significant portion of Indonesia micro enterprise sector remains informal, implementing sustainable and eco-friendly business models presents a major challenge. Further research is needed to examine how digitalization can support the transition toward more sustainable economic and environmental practices for micro enterprises.

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