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## Article

# Determinants of Digital Innovation in Micro and Small Industries

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**Abstract:** Micro and small industries (MSIs) must utilize digital technology if they hope to meet obstacles and endure in a market that is always evolving owing to technological advancements. This study aims to examine the capacity of business factors, marketing factors, constraint factors, credit factors, entrepreneur factors, and firm factors as determinants of digital innovation proxied by internet adoption and internet usage levels (for communication and information, for promotion, for buying and selling, and for fintech). This study uses a sample size of 90,295 MSIs and secondary data from the MSIs survey in 2019. As analytical tools, logit and ordinary least square (OLS) were employed. The findings demonstrate that business factors, marketing factors, constraint factors, credit factors, entrepreneur factors, and MSIs' firm factors are substantial and continuously affect digital innovation, and primarily its influence is as a motivator. These results will hopefully offer insights for the government as consideration regarding policies on how to encourage MSIs' digital innovation, and for MSIs themselves as references when they are about to make digital innovation decisions.

**Keywords:** digital innovation; business factors; internet adoption; internet usage levels; micro small industries



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## 1. Introduction

These days, digital innovations are developing quickly and taking over the commercial sector (Jahnmir and Cavadas 2018). For many businesses, countries, and regions globally, digital technologies are increasingly serving as a catalyst for economic growth (Brodny and Tutak 2022). Penetration of the Internet opens up a set of possibilities for digital innovation to improve the business process of micro and small businesses by enabling technology (Trinugroho et al. 2022). The Internet has changed many aspects of business, from how to access information and how to communicate to how to promote and sell (with the emergence of e-marketing and e-commerce) and how to do financial transactions (with the advent of fintech) (Trinugroho et al. 2022; Bai et al. 2021; Tambunan 2020). According to Tambunan (2020) and Andaregie and Astatkie (2022), all businesses, including micro and small enterprises (MSEs), need to adopt technology if they want to be able to face challenges and survive in an ever-changing business environment.

During and after COVID-19, micro, small, and medium enterprises (MSMEs) boosted the use of information and communication technology (ICT) in their business operations, since it was proven that using ICT could increase competitiveness and save cost (Kumar et al. 2022). Small businesses' digital innovations through ICT and digital technology adoption have a positive impact on presales activities, after-sales activities, marketing performance, market efficiency, and company competitiveness, especially in improving

the quality of human resources and organizational performance (Andaregie and Astatkie 2022; Kraft et al. 2022; Ejemeyovwi et al. 2019). Internet technology is a resource and a significant component of digital technology and ICT which has advanced rapidly to this point (Trinugroho et al. 2022; Falentina et al. 2021; Owusu-Agyei et al. 2020). Almost all of today's information, communication, and digital technologies require an internet connection.

ICT is an umbrella term for communication devices, mobile phones, network hardware, application devices such as video conferencing and distance learning, and satellite systems (Kumar et al. 2022). Digital technology is the use of internet-based tools and systems, such as text messaging, digital payments (mobile and web transfers), live sales, social media platforms, mobile technology, enterprise resource planning (ERP), data-driven manufacturing, and others (Bai et al. 2021; Kimuli et al. 2021). Digital technology and ICT assist MSMEs to improve innovation, worker productivity, and export performance (Ren et al. 2022; Gaglio et al. 2022; Falentina et al. 2021; Jean and Kim 2020), keeping businesses linked, ensuring business continuity, preserving sustainable production and consumption, and facilitating smart work environments (Bai et al. 2021). It also facilitates market expansion and customer management at the international level (Fraccastoro et al. 2021; Hossain et al. 2021), builds brand presence and trust globally easier, gets to a wider range of potential consumers and builds relationships with suppliers (Tiwary et al. 2021), and builds communication and consumer involvement easier to better maintain consumer loyalty (Zhang and Erturk 2022; Azemi et al. 2022; Lin 2021; Kapoor and Kapoor 2021).

According to Mathews et al. (2018), manufacturing is one of the industries under greater pressure to have a higher Internet adoption rate to enable digital innovation. MSIs are MSEs engaged in the manufacturing industry (Bahagia et al. 2022). In 2020, the number of MSIs in Indonesia who used the Internet for their business processes was still relatively low, only 16.39% (Bahagia et al. 2022). This figure increased quite high compared to 2019, which was 11.94% (Diliana et al. 2020). However, in 2019, the percentage of households using the Internet in Indonesia was 73.75% and increased to 78.18% in 2020 and 82.07% in 2021 (Sutarsih et al. 2022). Additionally, from an individual dimension, the proportion of Indonesia's population accessing the Internet in 2021 was 62.10%, an increase from 53.73% in 2020 and 47.69% in 2019 (Sutarsih et al. 2022). In 2020, the proportion of villages in Indonesia that receive cell phone Internet signals was 93.63%, and those that receive 4G/LTE type signals were 65.67% (Sutarsih et al. 2021).

The data above shows that MSI businesses are still reluctant to use the Internet to support their digital innovation and business activities. It is undeniable that to be able to successfully utilize internet-based ICT and digital technology requires the readiness of resources, including knowledge, understanding, abilities, skills, management, and costs (Kraft et al. 2022; Kapoor and Kapoor 2021; Mathews et al. 2018; Rahayu and Day 2015). MSE businesses are generally characterized by being of poor structure and informal, adopting the bottom-up method, having low managerial competence, and being hampered by limited operational costs, access to technology and equipment, and professional staff (Zhang and Erturk 2022; Bai et al. 2021).

Based on the description above, there are various benefits that MSIs may obtain through digital innovation, but Indonesian MSIs remain reluctant to do so, thus it is necessary to understand what variables might influence MSI digital innovation. To answer that, this study aims to determine what factors encourage or hinder MSIs to do digital innovation to increase their business activity performance. Further, our study explores the effect of variables such as business factors, marketing factors, constraint factors, credit factors, entrepreneur factors, and firm factors.

Following Forman and van Zeebroeck (2019), in this research, digital innovation is proxied by internet adoption. Another justification for this proxy is that the Internet is one of the extremely generative digital technologies (Hukal and Henfridsson 2017). By enabling interaction with its components, the Internet's design and architecture lead to

digital innovation (the creation of novel applications and features way beyond the initial intent) (Hukal and Henfridsson 2017).

Understanding the factors of technology adoption can help predict adoption patterns and improve knowledge on how to persuade MSEs to adopt useful technology (Andaregie and Astatkie 2022). The results of this study can be used by the government as one of the considerations in determining policies regarding the adoption of internet-based technology by MSIs. MSI entrepreneurs can also use the findings of this study as a consideration when making judgments about their digital innovation.

There have been quite a few previous studies examining a similar theme, namely, the determinants of Internet, ICT, and digital technology adoption by MSEs, such as Kumar et al. (2022), Kimuli et al. (2021), Gigliarano et al. (2017), Hanafizadeh et al. (2012), Kannabiran and Dharmalingam (2012), Tan et al. (2010), Alam (2009), Simmons et al. (2007), and Del Aguila-Obra and Padilla-Meléndez (2006). Studies in Indonesia include Trinugroho et al. (2022), Tambunan (2020), and Rahayu and Day (2015). Trinugroho et al. (2022), who empirically tested the determinants of digital technology adoption by MSEs, showed that internet connectivity played an important role in increasing the opportunities for MSEs to adopt digital technology; both MSEs engaged in services and retail. Tambunan (2020) identifies that the use of the Internet by MSEs is influenced by the characteristics of MSEs (knowledge, understanding, mindset, and ability to innovate), environmental conditions (amount of economic activity and level of income per capita), business category, and the complexity of business processes. Rahayu and Day (2015) identified that perceived benefits, technical readiness, and business actor characteristics (innovation power, IT capabilities, and experience) are the variables encouraging Indonesian SMEs to adopt e-commerce. To the best of our knowledge, this research differs from previous studies because it uses MSIs as research objects and is detailed based on Internet utilization level.

The grouping of internet usage in this study follows Panayiotou and Katimertzoglou (2015), who divides internet activity into four groups: the information-based activity group (email, business information search, and data exchange with partners), the website feature activity group (promotion, communication, and after-sales service), the commercial transaction activity group (e-procurement and e-sales), and the noncommercial transaction activity group (e-banking or fintech and public sector transactions). This study arranges the activity or utilization groups in stages based on the order in which they appear and the order of complexity. Initially, internet usage was limited to information search and data exchange. As technology develops, progressively, the Internet can be used for advertising and marketing, then for internet-based commercial transactions, and finally for secure financial transactions. Of course, the procedures and components of these activities will become more complicated as the level increases.

## 2. Literature Review and Methods

### 2.1. Literature Review

According to the Resource Base Views (RBV) paradigm, MSEs' digitalization might be a resource to survive and be more sustainable (Bai et al. 2021). The RBV theory states that every company can or already has resources and capabilities within their organization that can be developed and utilized as specific capabilities for the operation of functional activities and/or create competitive advantage (Bai et al. 2021; Mathews et al. 2018). According to this theory, an organization decides to adopt certain resources based on consideration of the benefits and risks that will be obtained (Mathews et al. 2018).

The technology acceptance model (TAM) theory, which is the dominant model for investigating the factors that influence user acceptance of technology, also states that perceived usefulness is the most significant variable affecting the acceptance of new technology (Lo Presti et al. 2022; Marangunić and Granić 2015). Related to perceived usefulness, as one of the TAM constructs (Davis 1989), this study examines constraint factors and marketing factors as determinants of digital innovation. Digital innovation is considered a relatively easy and cheap strategy, such as digital innovation in the form of collecting and sharing

information online and e-marketing through instant messaging or social media (Lo Presti et al. 2022; Corral de Zubielqui and Jones 2022; Riquelme 2002). It might be used to increase marketing performance and to deal with business constraints such as resource constraints, competition constraints, marketing constraints, and others (Jean and Kim 2020; Kumar et al. 2022). The perceived usefulness and effectiveness of mobile instant messaging apps as a marketing tool or commercial channel are very often linked to a profile of young, small, and medium-sized enterprises operating in a B2C context (Lo Presti et al. 2022).

Internet adoption, with all its promised benefits, still requires resources (cost, knowledge, operating skills, and so on), which for some businesses may not be easy to satisfy, and the risks are thought not worth the benefits obtained. Therefore, this study will examine the influence of the following factors on internet adoption decisions by MSIs: business factors (partnerships, associations, and certificates), marketing factors (areas of purchasing raw materials, sales areas, and type of marketing: business to business/B2B or business to customer/B2C), constraint factors (resource constraints, capital constraints, marketing constraints, and competition constraints), credit factors (nonbank credit ownership, bank credit ownership, and bank credit constraints), entrepreneur factors (education and age), and firm factors (business size based on the number of workers, business age, ownership of business entities, and profits).

#### 2.1.1. Business Factors

Having business networks, such as by joining business associations and having business partners, can encourage digital innovation because it will support and accelerate the transfer of knowledge between participants about the existence and advantages of new technologies and raise the demands on businesses to adopt them. Cooperation with different organizations increases the possibilities for these companies to access necessary innovative resources, and this is true for the implementation of digital technologies that are not yet widely used (Brodny and Tutak 2022). Boschma and Weltevreten (2008) stated that companies require knowledge from outside, and business networks with strong mutual relations built on mutual respect and trust will promote information sharing. According to Costa et al. (2017), the purpose of companies joining certain business associations is the desire to exchange ideas and knowledge to obtain solutions to current and future problems, for company expansion and development, to obtain new business models, and to evaluate the company's new needs. The main advantages that SMEs gain from joining business alliances are increased awareness of industry problems and improved problem-solving skills (Battisti and Perry 2015).

On the other hand, strong business partnerships can minimize technology adoption and innovation (Mathews et al. 2018). MSIs may believe that they do not require digital innovation (i.e., e-marketing and e-selling) since for marketing and selling products they already have partners who take care of it or buy all of their products. For Japanese companies, business partnerships are considered more reliable, with lower levels of uncertainty and a mechanism for avoiding high risks (Mathews et al. 2018).

Companies that hold product or business process quality management certificates (such as ISO) must adhere to each of the quality management system standards that have been established. To make it easier to adopt, implement, control, and coordinate certain quality standards, companies usually use internet-based digital systems, such as ERP (enterprise resource planning) applications (Tarantilis et al. 2008).

#### 2.1.2. Marketing Factors

B2C marketers are believed to be more motivated in internet adoption than B2B marketers. This is because B2C marketing prioritizes the discipline of mass communication, while B2B marketing prioritizes the discipline of building business relationships (Morten Bach Jensen 2006). The Internet supports many services for a broad range of mass communications, including e-marketing and e-commerce. MSIs with a wider purchasing and marketing area may be more motivated to adopt the Internet because it will make

it easier for them to communicate, coordinate, and engage more closely with suppliers and customers. The effective integration of online and offline channels has predominantly become a priority for B2C companies than B2B because they have used social media and digital marketing channels to exploit business opportunities and have seen the benefits, while B2B enterprises continue to lag behind in their incorporation (Kolbe et al. 2021). The Internet enables MSMEs to utilize digital technology and ICT to maintain organizational connectivity (Bai et al. 2021), facilitate global customer management (Fraccastoro et al. 2021), establish connections with suppliers (Tiwary et al. 2021), and make it simpler to foster communication and consumer interaction (Azemi et al. 2022).

### 2.1.3. Constraint and Credit Factors

When a business has problems, it will try to overcome them by implementing strategies that are deemed relevant. Digital innovation can be a solution for facing various challenges. Implementation of e-marketing and e-commerce can overcome marketing constraints. In cases of capital constraints, internet adoption tactics can occasionally be a more cost-effective solution than other strategies (Corral de Zubielqui and Jones 2022; Kumar et al. 2022; Fraccastoro et al. 2021). And in case of resource constraints, the Internet makes it easier to find more extensive and complete information, including everything about the resources needed (Forman and van Zeebroeck 2019). MSIs with high turnover and financial risk are more likely to utilize the Internet in their commercial operations than MSIs with low turnover and financial risk (Tambunan 2020). Andaregie and Astatkie (2022) explain that sources of capital, access to credits, no capital constraints, and environmental conditions, such as high competition (Trinugroho et al. 2022; Mathews et al. 2018), can encourage businesses to adopt new internet-based technologies. Limited resources and capital can be a barrier to digital transformation by MSIs (Bai et al. 2021).

### 2.1.4. Entrepreneur Factors

MSIs are not interested in using the Internet, perhaps because of a lack of awareness and knowledge about the advantages of ICT or digital technology for their business and how to manage it and the lack of entrepreneurs' innovativeness (Tambunan 2020; Kimuli et al. 2021). This lack of understanding, knowledge, and innovativeness can be caused by age and entrepreneur education factors. Trinugroho et al. (2022) and Andaregie and Astatkie (2022) show that younger and more educated entrepreneur is more likely to use technology for business.

### 2.1.5. Firm Factors

According to Tambunan (2020), the intensity of internet usage by MSEs is positively related to the level of per capita income. Of course, the amount of income per capita is affected by the company's success (profit), from which residents draw income. Young business age and high income can increase the chances of MSEs adopting new technology (Trinugroho et al. 2022; Tambunan 2020). Firm size is one of the key factors influencing information technology (IT) adoption (Kannabiran and Dharmalingam 2012). The size of the company, among other things, describes the availability of resources to invest and the complexity of the information in its organizational structure (Gigliarano et al. 2017). The bigger the company, the greater the resources and complexity. Therefore, the opportunity to adopt the Internet is also getting bigger. Generally, the higher the level of legal entity or legality of a business, the larger the business. Companies with the form of business entity PT (limited company), which in this study occupy the highest level, are certainly much larger than companies that are unincorporated or individual businesses.

## 2.2. Methods

### 2.2.1. Data Sources and Variables

This investigation employs secondary and cross-sectional data. This data is the result of an MSIs survey conducted in 2020 by the Indonesian Central Bureau of Statistics and

represents MSIs conditions in 2019. The number of samples in this study was 90,295 MSIs that covered 23 categories of business fields and represents all regions of Indonesia. The 23 categories of business fields are (1) food industry; (2) beverage industry; (3) tobacco processing industry; (4) textile industry; (5) apparel industry; (6) leather industry, leather goods, and footwear; (7) wood industry, wood and cork goods (excluding furniture), and woven goods made of rattan, bamboo, and other similar materials; (8) paper and paper products industry; (9) printing and reproduction industry for recording media; (10) chemical industry and chemical goods; (11) pharmaceutical industry, chemical medicinal products, and traditional medicines; (12) rubber industry, rubber, and plastic goods; (13) nonmetal mineral goods industry; (14) base metal industry; (15) non-machine metal goods industry and its equipment; (16) computer industry, electronic goods, and optics; (17) electrical equipment industry; (18) machinery and equipment industry excluding others; (19) motor vehicle, trailer, and semitrailer industry; (20) other transportation equipment industry; (21) furniture industry; (22) other processing industries; and (23) repair and installation service industry for machinery and equipment. To see whether different industries have different behaviors in internet adoption and to make the comparison simpler, we divide the 23 categories into three main groups: the food and beverage and tobacco industries, fashion-related industries (textiles, apparel, leather accessories, and footwear), and other industries (including the wood industry and all categories not included in the previous two groups). This grouping is based on the proximity of the category types, and the food industry, wood industry, and clothing industry are the three categories that have the largest share in micro and small industries in 2019 (Diliana et al. 2020).

The dependent variable of this study is digital innovation, which is proxied by internet adoption and internet usage levels by MSIs. Digital innovation is defined as a product, process, or business model that is thought to be novel, necessitates major adopters' adjustments, and is embodied in or made possible by digital technology (Ramdani et al. 2022). Internet adoption by MSIs refers to the behavior of MSIs using the internet in their business operations for digitalization, such as searching for information online, communicating via internet-based platforms, e-marketing, e-commerce, and fintech (Cueto et al. 2022). The internet adoption variable is a dummy variable that has a value of 1 if MSI adopts the internet and a value of 0 otherwise. Internet usage level is the level of internet usage ranging from merely collecting and sharing information to fintech (Panayiotou and Katimertzoglou 2015). The internet usage level variable is a categorical variable that has a value from 0 to 4, and the description of each value can be seen in Table 1.

**Table 1.** Variable description.

Variables	Description
Dependent variable: Digital innovation	
Internet adoption	Dummy variable, value 1 if adopt the internet, 0 otherwise
Internet usage level	Category variable, has a value of 1 if used only for information and communication, 2 if any usage for promotion but not for buying/selling and fintech, 3 if any usage for buying/selling but not for fintech, and 4 if any usage for fintech, 0 do not use the internet
Independent variables: business factors	
Partnership	Dummy variable 1 if has a business partner, 0 otherwise
Association	Dummy variable 1 if a member of an association, 0 otherwise
Certificate	Dummy variable 1 if it has a product/production process certificate, 0 otherwise
Independent variables: marketing factors	
Supply territory	Categorical variable, worth 1 if it is only within the district, 2 if it comes outside the district in one province, 3 if it comes outside the province in one country, and 4 if it comes to other countries
Marketing area	Categorical variable, has a value of 1 if it is only in the district, 2 if it comes outside the district in one province, 3 if it comes outside the province in one country, and 4 if it comes to other countries

Table 1. Cont.

Variables	Description
B2C Independent variable: constraint factor	Dummy variable 1 if at least 20% of products are sold to end users or customers (households or individuals), 0 otherwise
Resource constraints	Dummy variable 1 if it has resource constraints (raw materials, fuel oil/energy, labor, infrastructure and others), 0 otherwise
Marketing constraints	Dummy variable 1 if it has a marketing constraint (small markets; a lack of market information and knowledge; poor of marketing and customer care skills; and so on), 0 otherwise
Competition constraints	Dummy variable 1 if it has competition constraints (competition from imported products and other businesses that produce the same or substitute products), 0 otherwise
Capital constraints Independent variable: credit factor	Dummy variable 1 if it has capital/liquidity constraints, 0 otherwise
Non-bank credits	The percentage value of capital comes from non-bank credits
Bank credits	The percentage value of capital comes from bank credits
Bank credit constraints	Dummy variable 1 if it has bank credit problems (don't know the procedure, interest rates are too high, don't have collateral, applications are rejected, and so on), 0 otherwise
Independent variables: entrepreneur factors	
Age	Age of business owner/person in charge
Last education level	Category variable, value 1 did not finish elementary school, 2 Elementary School and equivalent, 3 Junior High School and equivalent, 4 Senior High School and equivalent, 5 Vocational High School, 6 Diploma I/II/III, 7 Diploma IV/Bachelor, 8 Masters and doctoral degrees
Independent variable: firm factors	
Size	Total workers
Age	Business age since establishment
Business entity	Categorical variables, worth 7 PT, 6 CV, 5 Firms, 4 cooperatives, 3 foundations, 2 special permits from agencies, 1 unincorporated/individual
Profit	Natural logarithm (ln) of the company's profit for a year

In this study, there are 19 independent variables that are divided into 6-factor categories: business factors (3 variables: partnerships, associations, and certificates), marketing factors (3 variables: areas of purchasing raw materials, sales areas, and B2C), constraint factors (4 variables: resource constraints, capital constraints, marketing constraints, and competition constraints), credit factors (3 variables: non-bank credit, bank credit, and bank credit constraints), entrepreneur factors (2 variables: age and last education level), and firm factors (4 variables: size, age, business entity, and profits). Descriptions and measurements of each independent variable are listed in Table 1.

Related to business factors, what is meant by a partnership is mutually beneficial business cooperation between MSI businesses and larger businesses or organizations accompanied by coaching and development so that they need, benefit from, and strengthen each other (Diliana et al. 2020). The B2C variable in the marketing factor indicates whether or not MSI engages in B2C marketing, be it as a B2C marketer only or also as a B2B marketer. The B2C variable is a dummy variable with a value of 1 if at least 20% of products are sold to end users or customers (households or individuals) and a value of 0 otherwise. The data we utilize provides evidence that MSI actors that truly intend to make end users their marketing target (B2C) sell at least 20% of the product to end users or customers (households or individuals), which forms the basis for our assessment of the value of 20%. Those who have less than 20% are those who do not intend to make the end user their marketing target (focus only on B2B business types), and if there are end users who become buyers, they are usually neighbors, family, or friends.

Regarding business constraint factors, the concept of business constraints in the MSI's survey refers to factors or circumstances that limit, hinder, or prevent efforts to achieve a business goal (Diliana et al. 2020). Business constraint factors contain four variables:



resource constraints, marketing constraints, competition constraints, and capital constraints. All of them are dummy variables that have a value of 1 if they have the constraint in question and a value of 0 if they do not. Resource constraints can take the form of difficulties in obtaining raw materials, fuel difficulties, limited infrastructure, limited human resources, and so on (Diliana et al. 2020). The marketing constraints for SMEs include small markets or a lack of a formed market; a lack of market information and knowledge; poor marketing, customer care, and strategic skills; and so on (Mashenene and Rumanyika 2014; Ongori and Migiro 2010). Meanwhile, competition constraints include high competition from other businesses that produce the same or substitute products and competition from imported products (Mashenene and Rumanyika 2014).

### 2.2.2. Data Analyzed

To examine the role of each independent variable in Table 1 as a determinant of internet adoption and as a factor influencing the level of internet usage, this study uses a logit model (for the dependent variable in the form of a dummy variable) that is formulated in Model 1 and ordinary least square (OLS) model (for the dependent variables in the form of level of use) that is formulated in Model 2 as an analytical tool. The model was validated using the robustness technique to get more valuable results. The following is the estimation model:

$$\ln\left(\frac{\text{prob}_{\text{InternetAdoption}_i}}{1-\text{prob}_{\text{InternetAdoption}_i}}\right) = \beta_0 + \beta_1\text{Partnership}_i + \beta_2\text{Association}_i + \beta_3\text{Certificate}_i + \beta_4\text{Supply territory}_i + \beta_5\text{Marketing area}_i + \beta_6\text{B2C}_i + \beta_7\text{ResourceC}_i + \beta_8\text{MarketingC}_i + \beta_9\text{CompetitionC}_i + \beta_{10}\text{CapitalC}_i + \beta_{11}\text{NonBankC}_i + \beta_{12}\text{BankC}_i + \beta_{13}\text{BankCreditC}_i + \beta_{14}\text{Age}_i + \beta_{15}\text{Education}_i + \beta_{16}\text{Size}_i + \beta_{17}\text{FirmAge}_i + \beta_{18}\text{BusinessEntity}_i + \beta_{19}\text{Profit}_i + \varepsilon_i \quad (1)$$

$$\text{UsageLevel}_i = \beta_0 + \beta_1\text{Partnership}_i + \beta_2\text{Association}_i + \beta_3\text{Certificate}_i + \beta_4\text{Supply territory}_i + \beta_5\text{Marketing area}_i + \beta_6\text{B2C}_i + \beta_7\text{ResourceC}_i + \beta_8\text{MarketingC}_i + \beta_9\text{CompetitionC}_i + \beta_{10}\text{CapitalC}_i + \beta_{11}\text{NonBankC}_i + \beta_{12}\text{BankC}_i + \beta_{13}\text{BankCreditC}_i + \beta_{14}\text{Age}_i + \beta_{15}\text{Education}_i + \beta_{16}\text{Size}_i + \beta_{17}\text{FirmAge}_i + \beta_{18}\text{BusinessEntity}_i + \beta_{19}\text{Profit}_i + \varepsilon_i \quad (2)$$

## 3. Results

### 3.1. Descriptive Analysis

This study used descriptive analysis to provide an explanation to ease the interpretation of further analysis results.

Table 2 demonstrates that the proportion of the MSIs that adopt the Internet is 15.21% and most users are up to the level of buying and selling (commercial transactions), that is 7730 MSIs. Only 57 MSIs use the Internet up to the level of fintech. The apparel business field category has the highest percentage of internet usage, which is 19.59%, but the other two are not far behind, as they still have a percentage of more than 10%.

Table 3 presents that the means value of the partnership is 0.08, which means that about 8% of MSIs have a partnership with other organizations. In the same way, it is obtained that 2.4% of MSIs join business associations. Mostly, MSIs supply and marketing areas are within the district; it concluded from the means value that close to 1 (1.237 and 1.308). Concerning the constraint factor, less than 30% of MSIs faced business constraints, i.e., marketing constraints mean value is 0.294 (29.4%). The credit components have a wide distribution because the standard deviations (i.e., 16.462 for bank credits) are significantly greater than the means values (i.e., 4.104 for bank credits). On average, the entrepreneur's age in MSIs is 46 years (means value 46.482), and their last education is equivalent to junior high school (means value 2.940). Mostly, MSIs' business entity is unincorporated or individual (means value 1.086), and about 5.6% already have product or production process certificates.

**Table 2.** Descriptive statistics of dependent variables and business field categories.

Variable	Category	Frequency	%
Internet adoption	0	76,560	84.79
	1	13,735	15.21
Internet usage level	0	76,560	84.79
	1	2784	3.08
	2	3164	3.50
	3	7730	8.56
	4	57	0.06
Business field	Food etc.	27,806	30.79
	Use Internet	3034	10.91
	Do not use	24,772	89.08
	Clothing etc.	20,194	22.36
	Use Internet	3957	19.59
	Do not use	16,237	80.41
	Other	42,295	46.84
	Use Internet	6744	15.95
	Do not use	35,551	84.05

**Table 3.** Descriptive statistics of all variables.

Variables	Obs.	Means	Std. Dev.	Min.	Max.
Digital innovation					
Internet adoption	90,295	0.152	0.359	0	1
Internet usage level	90,295	0.360	0.906	0	4
Business factors					
Partnership	90,295	0.080	0.271	0	1
Association	90,295	0.024	0.153	0	1
Certificate	90,295	0.056	0.229	0	1
Marketing factors					
Supply territory	90,295	1.237	0.533	1	4
Marketing area	90,295	1.308	0.594	1	4
B2C	90,295	0.632	0.482	0	1
Constraint factor					
Resource constraints	90,295	0.272	0.445	0	1
Marketing constraints	90,295	0.294	0.455	0	1
Competition constraints	90,295	0.240	0.427	0	1
Capital constraints	90,295	0.281	0.450	0	1
Credit factor					
Non-bank credits	90,295	3.065	14.261	0	100
Bank credits	90,295	4.104	16.462	0	100
Bank credit constraints	90,295	0.183	0.387	0	1
Entrepreneur factors					
Age	90,295	46.482	11.363	14	99
Last education level	90,295	2.940	1.471	1	8
Firm factors					
Size (number of workers)	90,295	2.241	2044	1	19
Age	90,295	13.362	11.684	0	119
Business entity	90,295	1.086	0.504	1	7
ln profit	90,295	16.704	1.498	−18.633	26.098

### 3.2. Determinant Test Results

Using a sample size of 90,295 MSIs, this study examines the determinants of digital innovation proxied by internet adoption and the level of internet usage by complexity. Table 4 displays the empirical findings of the logit model for internet adoption as the dependent variable (model 1) and the OLS model for internet usage level as the dependent variable (model 2). Table 4 also shows the tobit model (model 3) for internet usage level

as the dependent variable. The tobit model is used to determine whether the effects of the independent variables are still consistent with the OLS results when the zero value of internet usage level (not using the Internet) is censored but still considered in the testing process.

**Table 4.** Determinant of digital innovation.

Dependent Var.	Model 1 (Logit)			Model 2 (OLS)		Model 3 (Tobit)	
	Internet Adoption			Usage Level		Usage Level	
Independent Var.	Coef.	Std. Dev	Odds R.	Coef.	Std. Dev	Coef.	Std. Dev
Business factors							
Partnership	0.64 *	0.034	1.896	0.22 *	0.013	1.02 *	0.054
Association	0.63 *	0.056	1.873	0.25 *	0.024	1.00 *	0.087
Certificate	0.22 *	0.040	1.241	0.10 *	0.015	0.38 *	0.065
Marketing Factors							
Supply territory	0.33 *	0.018	1.392	0.13 *	0.007	0.54 *	0.029
Marketing Ar.	0.48 *	0.017	1.616	0.18 *	0.007	0.81 *	0.027
B2C	0.49 *	0.025	1.638	0.11 *	0.006	0.82 *	0.040
Constraint Factors							
Resource	0.03	0.024	1.029	0.03 *	0.007	0.07 ***	0.040
Marketing	0.15 *	0.023	1.159	0.06 *	0.006	0.32 *	0.038
Competition	0.24 *	0.024	1.272	0.06 *	0.007	0.41 *	0.039
Capital	0.04 ***	0.024	1.046	0.02 **	0.006	0.09 **	0.040
Credit Factors							
Non-Bank	−0.003 *	0.001	0.997	−0.001 *	0.0002	−0.005 *	0.001
Bank	0.004 *	0.0005	1.004	0.002 *	0.0002	0.008 *	0.001
Bank credit con.	0.16 *	0.027	1.177	0.03 *	0.008	−0.27 *	0.045
Entrepreneur factors							
Age	−0.03 *	0.001	0.971	−0.005 *	0.0003	−0.048 *	0.002
Education	0.38 *	0.007	1.460	0.11 *	0.002	0.64 *	0.011
Firm factors							
Size	0.04 *	0.005	1.042	0.02 *	0.002	0.07 *	0.009
Age	−0.02 *	0.001	0.985	−0.002 *	0.000	−0.025 **	0.002
Business entity	0.07 *	0.018	1.075	0.04 *	0.008	0.04 ***	0.024
Profit	0.26 *	0.009	1.297	0.04 *	0.002	0.44 *	0.019
_cons	−7.82 *	0.157	0.0004	−1.063*	0.036	−13.38 *	0.305
ModelFit test		0.000		0.000		0.000	
Coef. model		0.197		0.153		0.1198	
Total obs.		90,295		90,295		90,295	

Notes: \*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.1$ . The model fit test is the value of Prob (Wald Chi2) for the logistic model, Prob(F-stat) for the OLS model and Prob(LR chi2) for the tobit model. Coef. Models are Pseudo R2 values for logistic and tobit models and Adj R-squared for OLS models.

Model 1 shows that almost all of the independent variables tested are found to significantly influence internet adoption. Almost all variables in business factors, marketing factors, constraint factors, credit factors, entrepreneur factors, and firm factors improve MSIs' likelihood to use the Internet, except for resource constraint, nonbank credits, entrepreneur age, and firm age. The resource constraints variable, members of the constraint factor group, was found to be insignificant in influencing internet adoption by MSIs. The nonbank credits, entrepreneur age, and firm age variables were found to significantly reduce the likelihood of MSIs' Internet adoption. The older the entrepreneur and firm, the less likely they are to adopt the Internet. At a 1% significant level ( $* p < 0.01$ ), the odds of older entrepreneurs embracing the Internet are 0.971 (Odd R. value) times the chances of younger entrepreneurs. The empirical regression equations for the first suggested model (model 1) are as follows:

$$\ln \left( \frac{prob_{InternetAdoption_i}}{1-prob_{InternetAdoption_i}} \right) = -7.82 + 0.64 Partnership_i + 0.63 Association_i + 0.22 Certificate_i + 0.33 Supply\ territory_i + 0.48 Marketing\ area_i + 0.49 B2C_i + 0.15 MarketingC_i + 0.24 CompetitionC_i + 0.04 CapitalC_i - 0.003 NonBankC_i + 0.004 BankC_i + 0.16 BankCreditC_i - 0.03 Age_i + 0.38 Education_i + 0.04 Size_i - 0.02 FirmAge_i + 0.07 BusinessEntity_i + 0.26 Profit_i + \epsilon_i$$

Model 2 and model 3 examine the determinants of the level of internet usage complexity. In model 2, the outcomes demonstrate that all factors strongly influence the level of internet usage. The results in model 3 are consistent with model 2, except for the bank credit constraint variable. In model 2, bank credit constraint is shown to promote (coef. is positive) an increase in the internet usage complexity, while in model 3 it is shown to deter (coef. is negative) an escalation in the internet usage complexity. Regarding the business factors, MSIs who have partnerships and/or join associations are more likely to use the Internet with higher complexity. The broader MSIs’ buying and selling area, the more likely their internet usage is to be more complex, as well as when the MSIs’ primary business model is B2C (business to consumer). The test results also suggest that constraint factors, credit factors, entrepreneur factors, and firm factors tend to drive an increase in the level of internet usage, except for the indicators of nonbank credit, the age of the entrepreneur, and the age of the firm. These three factors greatly reduced internet usage complexity. The empirical regression equations for the second suggested model (model 2) are as follows:

$$UsageLevel_i = -1.063 + 0.22 Partnership_i + 0.25 Association_i + 0.10 Certificate_i + 0.13 Supply\ territory_i + 0.18 Marketing\ area_i + 0.11 B2C_i + 0.03 ResourceC_i + 0.06 MarketingC_i + 0.06 CompetitionC_i + 0.02 CapitalC_i - 0.001 NonBankC_i + 0.002 BankC_i + 0.03 BankCreditC_i - 0.005 Age_i + 0.11 Education_i + 0.02 Size_i - 0.002 FirmAge_i + 0.04 BusinessEntity_i + 0.04 Profit_i + \epsilon_i \tag{3}$$

For more in-depth analysis, this study also looks at whether different industries behave differently in the adoption of the Internet, and the results are shown in Table 5. The samples were divided into three business field categories—the food and related industries, the clothing and allied industries, and wood industry and others—since the food industry, wood industry, and clothing industry are the three categories that make up the highest share in our samples. Consistent with the overall sample, our results show that the determinant of internet adoption for the three business field categories is not much different. Different results are only shown on the variables of capital constraints, business entity, and resource constraints. At this level of testing, the results show that capital constraints insignificantly (coef. value, not marked with an asterisk) affect internet adoption in all categories. In the food and clothing industry category, the higher the level of business entity, the lower the chance of adopting the Internet, but at a much lower significance level (10% or \*\*\*  $p < 0.1$ ) compared to the overall samples test. Whereas in the wood and other industry groups, MSIs with resource constraints are less likely (coef. is negative) to adopt the Internet.

**Table 5.** Determinant of digital innovation by business field group.

Dependent Var.:		Internet								
Business Field:		Food etc.			Clothing etc.			Wood etc.		
Independent Var.	Coef.	Std. dv.	Odds	Coef.	Std. dv.	Odds	Coef.	Std. dv.	Odds	
Business factors										
Partnership	0.67 *	0.069	1.957	0.35 *	0.064	1.425	0.80 *	0.050	2.222	
Association	0.53 *	0.102	1.700	0.97 *	0.126	2.644	0.67 *	0.080	1.958	
Certificate	0.46 *	0.062	1.592	0.17 ***	0.088	1.180	0.23 *	0.067	1.260	

Table 5. Cont.

Dependent Var.:		Internet							
Business Field:		Food etc.			Clothing etc.			Wood etc.	
Independent Var.	Coef.	Std. dv.	Odds	Coef.	Std. dv.	Odds	Coef.	Std. dv.	Odds
Marketing Factors									
Supply territory	0.16 *	0.045	1.168	0.18 *	0.033	1.195	0.42*	0.025	1.529
Marketing area	0.71 *	0.042	2.035	0.34 *	0.032	1.409	0.44 *	0.024	1.548
B2C	0.51 *	0.051	1.663	0.73 *	0.050	2.074	0.38 *	0.036	1.458
Constraint Factors									
Resource	0.21 *	0.048	1.237	0.23 *	0.050	1.254	−0.14 *	0.035	0.866
Marketing	0.23 *	0.046	1.255	0.21 *	0.046	1.230	0.09 *	0.033	1.094
Competition	0.09 ***	0.048	1.098	0.23 *	0.046	1.258	0.32 *	0.034	1.380
Capital	0.08	0.050	1.086	−0.02	0.046	0.984	0.01	0.035	1.014
Credit Factors									
Non-Bank	−0.005 *	0.002	0.995	0.001	0.001	1.001	−0.004 *	0.001	0.996
Bank	0.002 **	0.001	1.002	0.01 *	0.001	1.008	0.004 *	0.001	1.004
Bank constraints.	0.06	0.056	1.065	0.21 *	0.051	1.228	0.18 *	0.039	1.192
Entrepreneur Factors									
Age	−0.03 *	0.002	0.973	−0.02 *	0.002	0.975	−0.03 *	0.002	0.971
Education	0.33 *	0.013	1.395	0.35 *	0.015	1.419	0.41 *	0.010	1.503
Firm factors									
Size	0.03 *	0.010	1.030	0.06 *	0.011	1.065	0.04 *	0.008	1.037
Age	−0.02 *	0.003	0.976	−0.02 *	0.003	0.979	−0.01 *	0.002	0.986
Business entity	−0.10 ***	0.052	0.905	−0.10 ***	0.054	0.904	0.11 *	0.022	1.119
Profit	0.17 *	0.018	1.189	0.38 *	0.020	1.464	0.26 *	0.015	1.302
_cons	−6.322 *	0.298	0.002	−9.28 *	0.321	0.0001	−8.02 *	0.247	0.0003
Prob(Wald Chi2)		0.000			0.000			0.000	
Pseudo R2		0.1504			0.1920			0.2299	
Total Obs.		27,806			20,194			42,295	

Notes: \*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.1$ .

#### 4. Discussion

The findings of this study demonstrate that business, marketing, constraint, credit, entrepreneur, and firm factors digital innovation in MSIs. The variables that tend to encourage internet adoption and increase internet usage complexity are having business partners, being members of associations, having wider supply and marketing areas, having higher proportions of B2C marketing types, having business constraints (resources, marketing, competition, and capital), higher percentages of credit capital from banks, having bank credit constraints, higher entrepreneur education, larger workforce, higher level of business entity, higher profit, and having product or production process certificates. Variables that are likely to limit internet adoption and minimize the complexity of its use are the older age of entrepreneurs and firms, and a higher share of nonbank credit capital.

The results of this study support several previous studies. [Boschma and Weltevreden \(2008\)](#) also empirically demonstrate that being a member of a trade association improves the likelihood of retail traders using the Internet for their information strategy. Interorganizational relations such as communication, collaboration (partnership), and information sharing have been shown to influence the decision of Malaysian SMEs to adopt e-business in their supply chain ([Chong et al. 2009](#)). [Trinugroho et al. \(2022\)](#) and [Kannabiran and Dharmalingam \(2012\)](#) demonstrate that MSMEs facing competitive challenges have better opportunities to implement digital and advanced information technology. Younger ages, both in terms of companies and entrepreneurs, higher revenue, and higher education can increase the opportunities for MSEs to adopt the Internet and digital technology ([Trinugroho et al. 2022](#); [Alam 2009](#)). Businesses with a small scale of operation that are typically not legal entities or individuals and have few employees are less likely to adopt advanced IT

(Kannabiran and Dharmalingam 2012). Gigliarano et al. (2017) proved that the number of workers and the scope of the marketing area are positively related to the opportunities for micro businesses to adopt the Internet. Generally, B2C companies produce digital strategies faster than B2B companies (López-López and Giusti 2020). B2C companies without a clear digital strategy continue to use social media significantly, while B2B companies postpone using social media until they develop a clear digital strategy (López-López and Giusti 2020). SMEs encountering marketing issues like lower consumer demand during COVID-19 can clarify consumer needs and boost sales by implementing technology, such as social media and e-commerce (Kumar and Ayedee 2021). The Internet's low investment costs and ease of use can reduce credit constraints such as information asymmetry and trigger various applications that support credit availability (Owusu-Agyei et al. 2020).

However, a number of earlier studies have refuted the findings of this study. Mathews et al. (2018) stated that business partnerships will minimize technology adoption. Trinugroho et al. (2022) demonstrate empirically that MSEs that receive assistance from the government in the form of government-subsidized bank credits typically do not employ digital technology. Meanwhile, the results of this study indicate that the higher the percentage of capital from bank credits, whether they contain subsidies from the government or not, the higher the chances for MSEs to adopt the Internet. Kannabiran and Dharmalingam (2012) established that the lack of financial capability (capital limitations) has a negative impact on the adoption of advanced IT among SMEs. However, on the other hand, many internet-based technologies, such as e-marketing tools, are free and can be utilized by SMEs with financial limitations and marketing constraints (Lin 2021). E-marketing tactics with social media are thought to be more effective and efficient, partly because they are less expensive to deploy (Corral de Zubielqui and Jones 2022; Lin 2021).

This research's results contribute to enriching and supporting the body of knowledge on digital innovation, particularly in terms of research scope that focuses on MSIs, internet adoption, and internet usage activities. It also confirms the RBV paradigm that MSEs' digitalization might be a resource to survive and be sustainable (Bai et al. 2021) and the TAM theory that perceived usefulness is the most significant variable affecting the acceptance of new technology (Lo Presti et al. 2022; Marangunić and Granić 2015). MSIs with business and bank credit constraints, wider supply and marketing areas, and higher proportions of B2C marketing types tend to utilize the Internet and increase its complexity more than MSIs that do not have those criteria. SMEs encountering marketing issues, competitive challenges, and credit constraints have better opportunities to implement digital and advanced information technology to reduce credit constraints, trigger various applications that support credit availability, and boost sales (Trinugroho et al. 2022; Kumar and Ayedee 2021; Owusu-Agyei et al. 2020; Kannabiran and Dharmalingam 2012). Digital innovations have a positive impact on presales activities, after-sales activities, marketing performance, market efficiency, and company competitiveness (Andaregie and Astatkie 2022; Kraft et al. 2022).

The results suggest that to encourage MSIs' digital innovation, the government should support and facilitate MSI's partnerships with other institutions and membership in business associations. It also suggests that easing bank credit and increasing MSI entrepreneurs' knowledge and comprehension of digital technology can encourage MSIs to increase their digital innovation. According to the Indonesian Central Bureau of Statistics data, organizations that collaborate with Indonesian MSIs include private businesses, local governments, government-owned firms, banks, and foundations (Diliana et al. 2020). In terms of proportion, the largest partnerships are with private companies at 36.25%. Collaborations with the government are only about 5.56%, partnerships with government-owned businesses are 3.23%, and ties with banks are 2.49% (Diliana et al. 2020). Alliances and partnerships provide access to complementary knowledge and abilities, both in technical and marketing fields, and appear to be one of the most important success elements of innovation processes (Chiaromonte 2006). Partnerships with organizations willing to fund firms and support start-ups should be encouraged to promote innovation (Fombang and Adjasi 2018).

## 5. Conclusions and Recommendations

This study aims to determine the ability of the components of business factors, marketing factors, constraint factors, credit factors, entrepreneur factors, and MSIs' firm factors as determinants of digital innovation proxied by internet adoption and improvement of internet usage complexity. The results suggest that these factors are significant and consistently affect digital innovation, and mostly its influence is as an encouragement.

The findings of this study contribute to enriching and supporting the body of knowledge on digital innovation, particularly in terms of research scope that focuses on MSIs, internet adoption, internet usage activities, and various business field categories, which are quite different from earlier studies. This study also supports RBV and TAM paradigms about digital innovations. This research can be used by the government for consideration regarding policies on how to encourage digital innovation by MSIs, such as whether the government should enhance MSIs' partnerships and association membership, increase ease of access to bank loans, and expand the availability of internet-based technology training. Specifically, MSIs can also use this research as a reference when they are about to make decisions about internet adoption or digital innovation, such as whether utilizing internet-based technology can be a solution to business constraints they faced.

The current study offers insights into the determinants of digital innovation by MSIs and employs a sufficiently large sample from all regions of Indonesia, it has its own limitations. This study solely looks at the factors that influence digital innovation and does not look at the impact of digital innovation itself. Future studies might look into the influence of digital innovation on business performance. Furthermore, the current study investigated the predictor of digital innovation in micro and small-scale industries. Therefore, it is interesting to explore digital innovation in medium- to large-scale industries. Previous studies have the importance of human capital (Latifah et al. 2022), business strategies (Farida and Setiawan 2022), and female leadership (Latifah et al. 2021), therefore, it is suggested future studies consider the importance of human capital, business strategy, and female leadership.

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