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From Crisis to Innovation: Bridging the Digital Divide for Micro and Small Enterprises in Yogyakarta during the COVID-19 Pandemic

Helen Dian Fridayani[1]*; Li-Chun Chiang[2]

[1,2]Department of Political Science, Faculty of Social Science, National Cheng Kung University
Tainan, Taiwan 70101
[1]Department of Government Studies, Faculty of Social and Political Science, Universitas Muhammadiyah Yogyakarta
Yogyakarta, Indonesia 55183
[1]helen.dian@umy.ac.id; [2]lcchiang@mail.ncku.edu.tw

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ABSTRACT

The research aimed to analyze the challenges faced by Micro and Small Enterprises (MSEs) in Yogyakarta, Indonesia, during the COVID-19 pandemic in adopting digital tools and platforms. The research explored the difficulties encountered by MSEs in Yogyakarta during the pandemic and their efforts to utilize digital solutions, employing a qualitative methodological approach and analyzing secondary data sources. Through in-depth interviews and Focus Group Discussions (FGDs) with 50 MSE owners and stakeholders, supplemented by document analysis of government policies, and existing studies, the research provided insights into the experiences, perceptions, and barriers to adopting digital innovations. Thematic coding of interview transcripts and data synthesis from secondary sources reveal recurring challenges such as financial constraints, limited Internet access, inadequate digital literacy, and insufficient technology infrastructure. Despite these obstacles, the research identifies a positive trend toward digitalization among MSEs, driven by the imperative to adapt to pandemic-induced disruptions and the growing recognition of the benefits of digital technologies. The analysis underscores the critical role of awareness-building, training, and infrastructure development in facilitating successful digital adoption. Additionally, the research highlights the necessity of government initiatives to support MSEs in overcoming the digital divide and emphasizes the importance of sector-specific strategies to address variations in digital adoption patterns. The research contributes to a nuanced understanding of digital adoption dynamics among MSEs in Yogyakarta. It suggests avenues for future research to explore the long-term impacts of digitalization on MSE sustainability and growth.

Keywords: digital transformation, local government, Micro and Small Enterprises (MSEs), digital economy

INTRODUCTION

The emergence of the COVID-19 pandemic roughly two years ago was widely recognized as having a profound impact on Micro and Small Enterprises (MSEs) worldwide, and Yogyakarta was no exception to this phenomenon (Anderson et al., 2020). While digital innovation has emerged as a critical tool for MSEs' survival and resilience in the face of the COVID-19 pandemic, several challenges hinder its effective implementation. The research focuses on MSEs facing a significant digital divide, which impedes their ability to embrace digital solutions fully. A major barrier is the limited digital infrastructure in certain areas, characterized by inadequate Internet access and connectivity. This limitation hinders their adoption and utilization of digital tools and platforms, ultimately hampering the effective integration of digital innovation into their operations (Sanggrama et al., 2020; Niode, 2009).

*Corresponding Author

Furthermore, a significant digital skills gap exists among MSE owners and employees (Muzdalifah et al., 2020). The absence of essential digital skills and literacy hampers their capacity to leverage these technologies effectively, hindering their ability to adapt and sustain their businesses during the crisis. Financial constraints are another significant challenge (Ma et al., 2024). Limited financial resources make it difficult for MSEs to invest in digital innovation, including acquiring hardware, software, and other necessary tools. This burden is particularly significant when businesses face reduced revenue and financial instability. Access to capital and support also poses challenges. Traditional financing channels may become more restrictive, and existing government support programs may not adequately address the specific needs of MSEs, hindering their ability to invest in digital solutions (Cueto et al., 2022; Rawat et al., 2022). Data in Figure 1 show the problem of why MSE has not fully adopted digital devices in Yogyakarta.

Figure 1 describes that a significant portion of businesses struggle to obtain financing and digital infrastructure. It can be due to a variety of factors, such as limited access to credit, high interest rates, or a lack of awareness about available digital tools and resources. Moreover, the lack of policy and business environment indicates that businesses feel unsupported by the government or there are regulations that make it difficult to operate. Inadequate infrastructure refers to a lack of essential physical resources, such as transportation networks or reliable power grids. The crisis further exacerbates the digital divide among MSEs (Singh et al., 2023). Those with limited resources and capabilities face greater challenges in adopting digital innovation. Factors such as geographic location, socio-economic status, and access to education and training contribute to this divide, impeding their ability to leverage digital tools effectively. MSEs that are heavily reliant on footfall or local customers encounter significant challenges during the crisis. Hence, shifting to digital platforms and e-commerce can provide new market opportunities (Valdez-Palazuelos et al., 2023). However, MSEs may struggle to reach a wider customer base due to limited online visibility and marketing capabilities, hindering their market access during the crisis.

Finally, trust and security concerns discourage MSEs from embracing digital innovation (Sachdev & Singh, 2023). Customers may have concerns regarding the trustworthiness and security of digital platforms and transactions, including data breaches, cybersecurity threats, or scams. These concerns can lead to hesitation in adopting digital solutions, potentially resulting in financial losses or reputational damage (Pinto & Antonio, 2023).

The Diffusion of Innovation theory, developed by Kwon et al. (2021), provides a valuable framework for understanding the adoption of digital innovations by local governments and their subsequent impact on MSEs in Yogyakarta, Indonesia. The theory is a conceptual framework that aims to elucidate how new ideas, products, or technologies spread and are adopted within a population or social system over time (Wang et al., 2024). This theory provides insights into the process by which innovations are communicated through various channels and eventually accepted or rejected by members of society. The theory posits that the adoption of innovation typically follows a bell-shaped curve, known as the diffusion curve, which categorizes individuals into different adopter categories based on their readiness to embrace the innovation (Yang & Lee, 2019). These adopter categories include Innovators, Early Adopters, Early

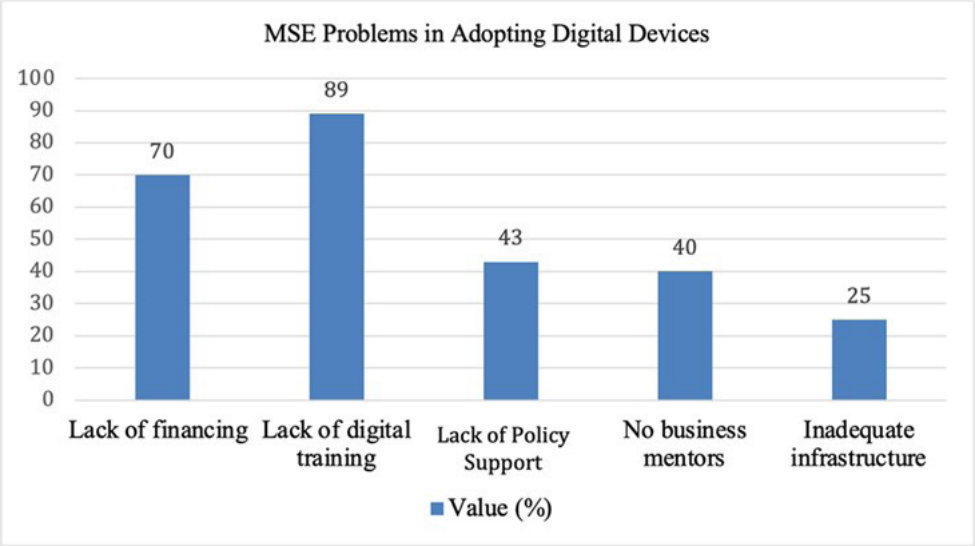

Figure 1 Problems of Micro and Small Enterprises (MSEs) in Adopting Digital Devices in Yogyakarta

Source: Processed by Authors

Majority, Late Majority, and Laggards provided in Figure 2.

Figure 2 shows that individuals tend to align with one of five overarching attitudes in the spectrum of technology adoption, a concept extensively articulated by Moore in his influential 1991 publication, "*Crossing the Chasm*" (Jaini et al., 2023). The first group, known as innovators or "techies", is driven by a passion for constructing novel solutions. Possessing deep technical expertise, they relish the process of experimentation inherent in bringing new products to fruition, feeling equipped to troubleshoot and refine them. Early Adopters, often termed "visionaries", are motivated to embrace technology by the potential social capital it affords or the resolution of personal challenges (Peñarroya-Farell & Miralles, 2022; Utama et al., 2022). While they may find technical glitches bothersome, their enthusiasm remains undiminished as they actively seek solutions and provide feedback to refine the product based on their forward-thinking vision. The early majority also referred to as "pragmatists," adopt technology when they perceive it as offering a tangible advantage to their workflow. However, they have little tolerance for errors or breakdowns, prioritizing immediate functionality over speculative future benefits (Abeywardana et al., 2023; Carvalho & Coêlho, 2023; Cera & Abbas, 2023).

The late majority, known as "conservatives", cautiously embraces technology only when its adoption becomes unavoidable (Ahmad et al., 2023). They prefer to rely on proven solutions endorsed by trusted acquaintances, accepting a minor delay in adopting new technologies to avoid potential technical complications they lack the expertise or motivation to address. Conservatives often perceive themselves as guardians of established practices, preferring new technologies to undergo rigorous testing before integrating into their workflow. Their role is pivotal in refining technology, stimulating demand for simplified and cost-effective iterations of existing products.

Finally, laggards or "skeptics" steadfastly resist adopting technology regardless of its ubiquity or utility. At the same time, this classification may carry negative connotations, exemplified by groups like the Amish, who eschew modern technology. They contribute valuably to society by preserving traditional skills and fostering debates on the ethical implications of technological advancement (Ahmad et al., 2023; Carvalho & Coêlho, 2023; Miniesy et al., 2021; Shahadat et al., 2023).

Numerous researchers have explored the factors influencing the diffusion of innovations. One of the central concepts is the idea of adopter categories, which classify individuals based on their readiness to adopt new innovations. Innovators, early adopters, early majority, late majority, and laggards represent distinct groups with varying propensities to adopt innovations. Researchers have investigated the characteristics and behaviors of each adopter category to understand their role in the diffusion process (Al Zoubi et al., 2023). Moreover, previous researchers have examined the influence of external factors,

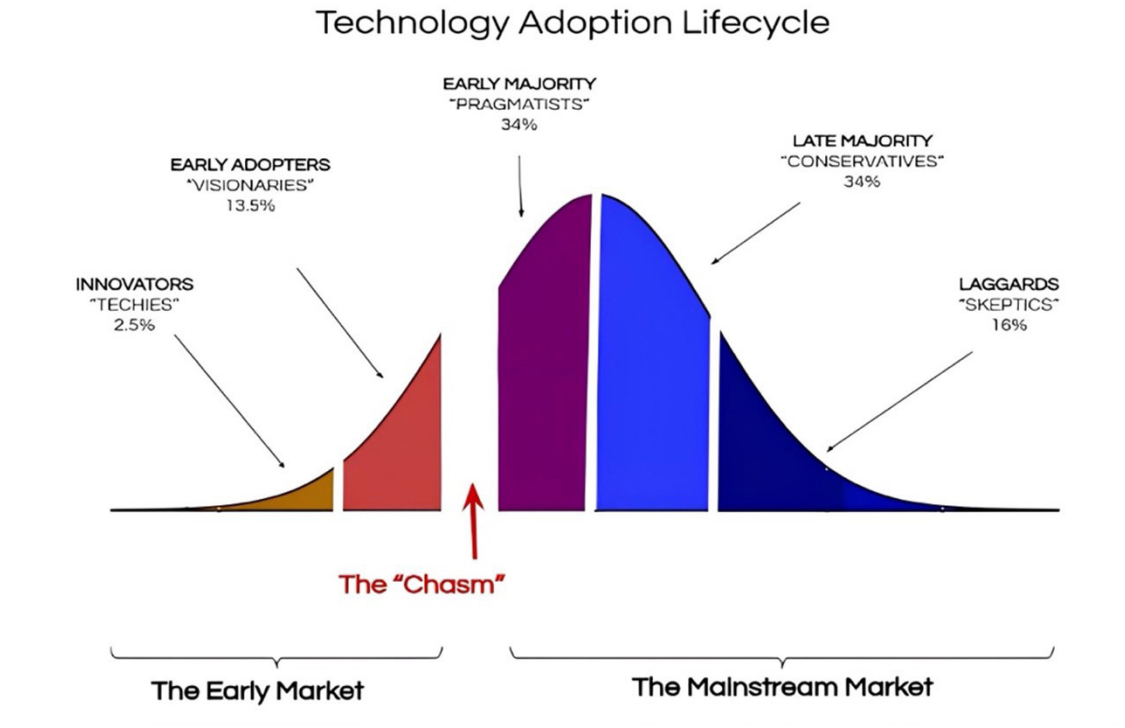

Figure 2 Technology Adoption Lifecycle

Source: Kwon et al. (2021)

such as communication channels, social networks, and organizational structures, on the diffusion of innovations. The role of opinion leaders, interpersonal networks, and mass media in disseminating information and shaping attitudes toward innovations has been a focus of empirical research (Schmidt & Rätzer, 2021). Additionally, previous studies have explored how organizational factors, such as leadership support, organizational culture, and resource availability, impact the adoption and implementation of innovations within organizations.

Furthermore, research on the Diffusion of Innovation theory has extended to the digital realm, particularly concerning the adoption and usage of digital technologies. Previous studies have investigated factors influencing the adoption of technologies such as smartphones, social media platforms, and e-commerce applications (Frogeri et al., 2019; Schmidt & Rätzer, 2021). The rapid evolution of digital technologies has prompted scholars to explore how factors such as perceived usefulness, ease of use, and compatibility influence individuals' decisions to adopt and use these innovations. The Diffusion of Innovation theory continues to be a valuable framework for understanding the adoption and spread of innovations across diverse contexts. This theory offers insights that can inform strategies for promoting the adoption and implementation of innovations in various domains by elucidating the factors shaping the diffusion process. However, scholars continue to refine and expand upon the theory to account for emerging trends and complexities in contemporary society.

Technological determinism is a simplifying theory positing that the progress of a society is primarily dictated by its technological advancements, influencing both its social dynamics and cultural evolution (Marsan et al., 2012). Though the term is commonly attributed to American sociologist, Thorstein Veblen, its foundations are notably discussed by Karl Marx, who underscores the pivotal role of production technology in shaping human relationships and organizational frameworks. Marx has contended that the technological and economic infrastructure of a society serves as the fundamental groundwork upon which social and cultural developments unfold. While not an absolute adherent to determinism, Marx's contributions significantly bolster the theory's prominence and widespread acceptance (Morgan, 2019). The theory aims to elucidate how advancements in technology, spanning various domains such as mass communication and media, act as the primary catalysts for societal transformation (Wulandari et al., 2020). Notably, the rapid technological progress witnessed during the 19th century has facilitated the inevitability of globalization, with innovation and development emerging as pivotal drivers of social, economic, cultural, and political change. Technological determinism posits that technology assumes a central role in shaping human behavior and societal functioning, transcending its conventional role as merely a tool for survival (Kneller, 2013).

In this context, the era characterized by unprecedented scientific advancements also emerges as a period of profound cultural and social upheaval. As technology evolves and becomes entrenched in societal structures (Penttinen & Tuunainen, 2010; Quetti et al., 2012), it exerts a significant influence over user behavior, potentially diminishing individual agency. Daniel Chandler's "inevitability thesis" further underscores this notion, positing that once technology is introduced into a particular environment, its proliferation and evolution become virtually certain. According to this perspective, advancements in technology shape various aspects of society, including cultural norms, economic structures, and individual behaviors (Wulandari et al., 2020). In the context of MSEs, technological determinism suggests that access to digital technologies can have transformative effects on business operations and market dynamics (Noel et al., 2019).

For MSEs, adopting digital tools and platforms can lead to significant improvements in productivity, efficiency, and competitiveness. By leveraging digital technologies such as e-commerce platforms, cloud computing, and digital marketing tools, MSEs can streamline processes, reduce costs, and reach a wider audience. This increased efficiency and market reach can translate into tangible benefits for MSEs, such as increased sales, improved customer satisfaction, and expanded business opportunities (Futri et al., 2023). Hence, embracing digital technologies can help MSEs to overcome traditional barriers to entry and access to markets. In many cases, MSEs face limitations in terms of physical infrastructure, financial resources, and market reach. However, digital technologies can help bridge these gaps by providing MSEs access to global markets, enabling them to compete on a level playing field with larger enterprises. Additionally, digital platforms can facilitate networking and collaboration among MSEs, allowing them to share resources, knowledge, and best practices (Utama et al., 2022).

Figure 3 shows that technological determinism unfolds through the introduction and evolution of technology, often resulting in the erosion of existing knowledge (Borowski et al., 2020). For instance, advancements in the agricultural sector have gradually diminished traditional farming techniques. Similarly, the invention of firearms has revolutionized conflict resolution by altering the dynamics of combat, favoring simplicity over skill in settling disputes. Subsequently, the emergence of nuclear weapons has shifted the landscape of warfare, with nations possessing the largest nuclear arsenals gaining dominance. Each technological breakthrough ushers in a new societal paradigm, as seen with the rise of industrialism following the discovery of the steam engine and the advent of the digital age propelled by computer innovation (Ho, 2022). Consequently, humanity becomes increasingly subservient to technology, necessitating adaptation to avoid obsolescence.

The concept of 'autonomous technological

determinism' posits that humans relinquish control over technology, allowing it to shape the course of the future. However, some contend that humans retain agency in the creation and utilization of technology (Martin et al., 2016). The decision to engage with technology rests squarely with individuals, highlighting the human-controlled aspect of technological adoption and usage. Technological determinism embodies reductionism, seeking to simplify complex phenomena by attributing societal changes to technological influences (Geels, 2022). This approach contrasts with holism, which emphasizes interconnectedness and the notion that the whole exceeds the sum of its parts. Determinists view humans as homo faber, both crafting and utilizing tools (Ihde & Malafouris, 2019). Benjamin Franklin's assertion "man is a tool-using animal" encapsulates this perspective, underscoring humanity's intrinsic relationship with technology (Byrne, 2018).

While existing literature highlights the critical role of digital innovation in fostering the resilience and survival of MSEs during the pandemic, significant gaps remain in understanding the specific barriers and enabling factors for MSEs in developing regions like Yogyakarta. The novelty of the research lies in its focus on the interplay between local digital infrastructure, digital literacy, and government interventions in addressing the unique challenges faced by MSEs during crises. Unlike previous studies that largely explore macro-level trends, the research provides granular insights into the micro-level dynamics shaping the digital transformation of MSEs in a provincial context.

One of the primary research gaps addressed is the limited exploration of how systemic factors such as inadequate digital infrastructure, financial constraints, and trust issues collectively hinder the effective adoption of digital tools by MSEs. Existing studies often treat these factors in isolation, thereby missing the compounded effects they impose on small enterprises (Sanggrama et al., 2020; Niode, 2009). Moreover, there is insufficient empirical evidence on the effectiveness of local government initiatives aimed at bridging these gaps, particularly in Yogyakarta, where socio-economic and geographic diversity creates unique challenges.

The research aims to investigate the effectiveness of digital tools and platforms implemented by local governments in Yogyakarta to support MSEs during the COVID-19 crisis. It examine show these initiatives address the challenges mentioned, specifically focusing on improving service delivery, reducing bureaucratic hurdles, and fostering a supportive environment for these businesses. The research aims to contribute to understanding the specific needs of MSEs in Yogyakarta by identifying these challenges and analyzing existing strategies. It allow for the development of tailored solutions that bridge the digital divide, enabling them to leverage digital innovation and navigate the current crisis towards sustainable growth and competitiveness.

METHODS

The research applies a qualitative research design aligned with international reporting standards, such as the Consolidated Criteria for Reporting Qualitative Research (COREQ) and Standards for Reporting Qualitative Research (SRQR). The research aims to explore the challenges faced by MSEs in Yogyakarta during the COVID-19 pandemic and their use of digital solutions. The methodological framework incorporates primary qualitative data collection and secondary data analysis to provide a comprehensive understanding of the research questions. The qualitative component involves in-depth interviews and Focus Group Discussions (FGDs) with MSE owners and relevant stakeholders. These activities aim to gain insights into their experiences, perceptions, and barriers to adopting digital innovation. Additionally, document analysis of government policies, reports, and existing studies are conducted to supplement the qualitative findings and provide a comprehensive understanding of the broader

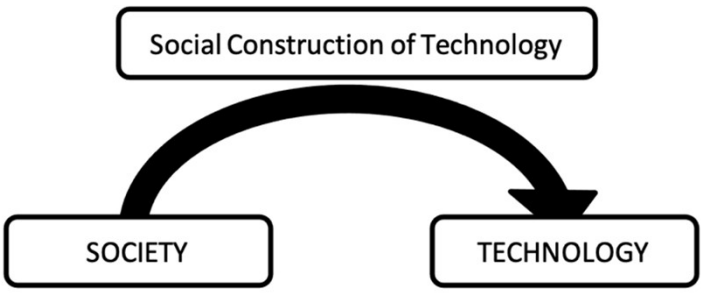

Figure 3 The Influence of Technology on Society and Vice Versa

Source: Mohandas et al. (2020)

context. Figure 4 illustrates the research methodology for conducting this study.

In-depth interviews and FGDs are conducted with a purposive sample of 50 MSE owners with the detailed micro-enterprises across various sectors in Yogyakarta, focusing on their business activities and contributions to the local economy. Participants (P1–P50) are selected from five municipalities: Yogyakarta, Sleman, Bantul, Kulon Progo, and Gunung Kidul, ensuring representation from different industries, including creative industries (e.g., Jaya Pigura, Besek Craft, Mulfa Ecoprint), culinary (e.g., Thoyonk Noodle, Aneka Cemilan Yusum), wholesale and retail trade (e.g., Mask Wholesale Jogja), fashion (e.g., Pondok Rajut Jogja, Batik Sleman), agriculture (e.g., Telur Murah Jogja, Azolla Bantul), processing industry (e.g., Pupuk Organik Tegal Makmur), and printing industry (e.g., Siap Cetak in Gunungkidul).

Using a qualitative approach, data was collected through semi-structured interviews with business owners, field visits, and document reviews to analyze business operations, growth strategies, and digital adaptation, providing a comprehensive understanding of how these enterprises contribute to local economic development. government officials, industry experts, and representatives from relevant organizations (Merriam, 2009). Semi-structured interview guides are utilized to explore participants' perspectives on the challenges faced by MSEs in adopting digital solutions, their experiences with existing support programs, and their suggestions for improvement. The interviews and discussions are audio-recorded with participants' consent and transcribed verbatim for analysis. Moreover, a comprehensive review of secondary data sources is conducted to supplement the qualitative findings and provide contextual information. Secondary data sources include government reports, academic literature, industry publications, and statistical data related to MSEs, digital adoption, and economic trends (Condon et al., 2024) in Yogyakarta. Data synthesis and thematic analysis will be employed to identify key themes, patterns, and trends relevant to the research objectives.

The qualitative data analysis involves thematic coding of interview transcripts and FGDs to identify recurring themes, patterns, and divergent perspectives. Themes are organized into categories and sub-categories to facilitate data interpretation and synthesis (Ugwu & Eze, 2023). Triangulation of qualitative findings with secondary data sources is performed to validate the findings and provide a comprehensive understanding of the research questions. Furthermore, ethical considerations are adhered to throughout the research process, including obtaining informed consent from participants, ensuring confidentiality and anonymity, and maintaining integrity in data collection, analysis, and reporting. The research is conducted in accordance with ethical guidelines and protocols established by the research institution and relevant regulatory bodies.

Moreover, the methodological framework follows a systematic approach, beginning with the recruitment of participants through purposive sampling to ensure a diverse representation of perspectives relevant to the study. Data collection involves conducting in-depth interviews and FGDs using semi-structured guides to explore participants' experiences and perceptions. This is complemented by collecting and analyzing secondary data, including government reports, academic literature, and industry publications, to provide contextual insights. Thematic analysis is then applied to identify recurring patterns and themes, with findings validated through triangulation between primary and secondary data sources to ensure robustness and reliability.

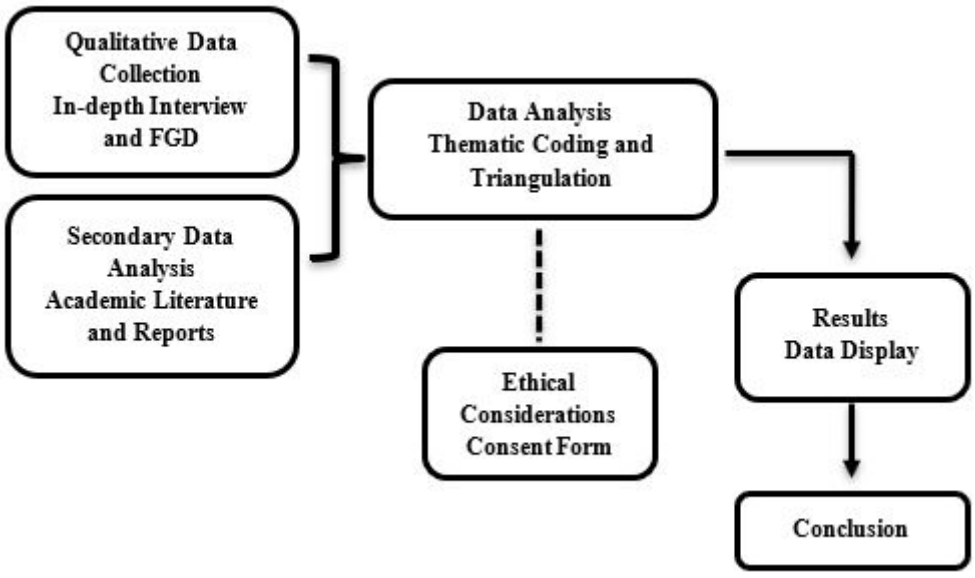

Figure 4 Research Framework

Source: Authors

RESULTS AND DISCUSSION

The first section is about the challenges MSEs face and the type of digital adoption in Yogyakarta before and during the COVID-19 in 2020. The research "From Crisis to Innovation" delves into the transformative potential of crisis for MSEs, particularly in the context of Yogyakarta, Indonesia. With a focus on understanding the impact of crises, such as the recent pandemic, on businesses, the research aims to explore how these challenges can serve as catalysts for MSEs to embrace new approaches and technologies. One key aspect of this exploration involves addressing the "digital divide," the gap between those with access to technology and those without (Bello et al., 2024; Dela Cruz et al., 2023; Rafiani et al., 2024). By navigating this digital gap, MSEs can harness digital tools to enhance their resilience and competitiveness. Through a Diffusion of Innovation Theory, the research analyzes the adoption of digital technologies among MSEs in Yogyakarta, identifying factors that facilitate or hinder this process. This geographic specificity allows for a nuanced understanding of the challenges and opportunities unique to MSEs in this region, shedding light on strategies for fostering innovation and growth amidst adversity. Table 1 shows the challenges faced by MSEs in Yogyakarta before and during the COVID-19 in 2020.

Figure 5 delineates the primary impediments encountered by individuals in accessing online resources, presenting them as distinct segments. The largest segment, comprising 31% of the chart, is denoted as 'financial constraints,' indicating that this factor represents the predominant challenge in accessing online resources. Additionally, the chart identifies three other significant barriers: difficulty accessing online resources (15%), lack of digital literacy skills (28%), and inadequate access to technology (26%). This breakdown underscores the multifaceted nature of the obstacles faced by users in accessing online resources, with financial constraints emerging as the most prominent concern. However, it is imperative to acknowledge the presence of other contributing factors, such as technological limitations and digital literacy deficits (Agustina et al., 2023). This nuanced understanding is crucial for devising comprehensive strategies to enhance access to online resources for diverse user populations.

The significant progress of MSEs in Yogyakarta during and after the COVID-19 pandemic is evident as they are compelled to adopt digital technologies. This transition reflects a fundamental shift in business operations, where the reliance on digital tools becomes essential for survival and growth (Saldarriaga Salazar et al., 2023). Despite initial challenges, such as limited resources and unfamiliarity with digital platforms, MSEs have demonstrated resilience and adaptability in embracing this change (Hassen et al., 2021). Through adopting digital technologies, MSEs have enhanced their ability to reach customers, streamline processes, and remain competitive in a rapidly evolving business landscape (Chanchaichujit et al., 2024). In 2021, MSEs in Yogyakarta began showing notable progress in adopting digital technologies, driven by the need to adapt to the challenges posed by the pandemic. Recognizing the importance of digitalization for business continuity, many MSEs have started investing in online platforms, e-commerce solutions, and digital marketing strategies (Simonova & Yuan, 2022).

This trend continued into 2022 and 2023, with MSEs increasingly integrating digital tools into their operations. From 2021 to 2023, steady growth was witnessed in digital adoption among MSEs, facilitated by government initiatives, support programs, and growing availability of affordable digital solutions. By 2023, MSEs in Yogyakarta made significant strides in leveraging digital technologies to enhance their competitiveness and resilience. With access to online marketplaces, digital payment systems, and social media platforms, MSEs expanded their reach and

Table 1 The Challenges Faced by Micro and Small Enterprises (MSEs) in Yogyakarta Before and During the COVID-19 in 2020

Challenges	Explanation
Difficulty accessing online resources	Limited Internet connectivity makes it hard to access market information, e-commerce platforms, and online training.
Lack of digital literacy skills	Even with Internet access, MSEs may struggle to navigate online platforms effectively to find resources for business growth.
Inadequate access to technology	Lack of computers, smartphones, or tablets limits the ability to sell online, communicate with customers, and manage businesses effectively.
Financial constraints	The cost of Internet access and devices can be a major barrier, especially for rural MSEs or those facing financial difficulties.

Source: Authors

diversified their customer base (Marzi et al., 2023). Despite the challenges posed by the pandemic, MSEs in Yogyakarta embraced digitalization as a means to navigate uncertainties and seize new opportunities. From 2021 to 2023, it marked a transformative period for MSEs, catalyzing innovation and growth in the digital landscape. This shift towards digitalization has not only enabled MSEs to survive the challenges of the pandemic but has also positioned them for long-term success in the digital economy. By harnessing the power of digital technologies, MSEs in Yogyakarta have demonstrated resilience, adaptability, and willingness to embrace change. As MSEs continue to embrace digitalization, they are likely to encounter new opportunities and challenges in the evolving digital landscape. However, by staying agile and responsive to changing market dynamics, MSEs can position themselves for sustainable growth and success in the years to come.

Table 2 shows that the digital landscape offers a wealth of resources for MSEs to flourish, but many struggle to bridge the gap. Limited Internet connectivity in some regions acts as a roadblock, restricting access to valuable market data, e-commerce platforms teeming with potential customers, and online training programs that can propel their businesses forward. Even with an Internet connection, a lack of digital literacy skills can leave MSEs feeling lost in the vast ocean of online information, hindering their ability to find the resources most relevant to their specific needs. Furthermore, the absence of essential tools like computers, smartphones, or tablets creates a significant disadvantage. Without these devices, MSEs are unable to participate in online sales, effectively communicate with customers, or manage their business operations efficiently. Finally, the financial burden of obtaining Internet access and the necessary technology can be heavy, especially for MSEs located in rural areas

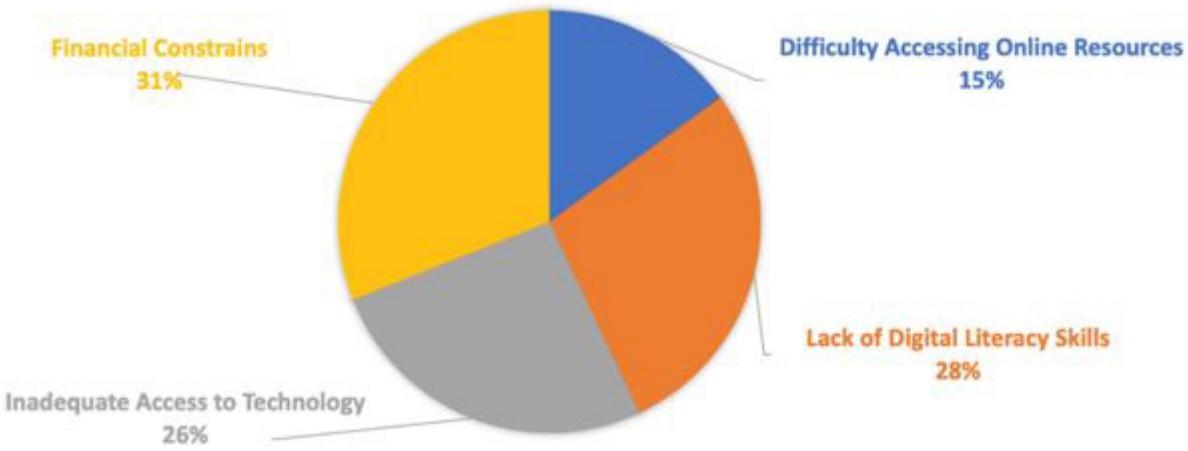

Figure 5 The Percentage Among the Difficulties Faced by Micro and Small Enterprises (MSEs)

Source: Authors

Table 2 Types of Digital Adoption by Micro and Small Enterprises (MSEs) in Yogyakarta

Digital Technology	Benefits for MSEs
Social media marketing (Facebook, Instagram, WhatsApp, and TikTok)	a. Showcase products and services with high-quality photos and videos. b. Connecting directly with customers through messaging features. c. Running targeted advertisements to reach a wider audience. d. Building brand awareness and customer loyalty.
E-commerce platforms (Gojek, Tokopedia, Shopee)	a. Selling products directly to customers across Indonesia and even internationally. b. Offering convenient purchase options and delivery services. c. Accessing a wider customer base compared to traditional brick-and-mortar stores.
Mobile payments (GoPay, Shopee Pay, OVO)	a. Providing customers with cashless and convenient payment methods. b. Simplifying financial transactions and record-keeping.

Source: Focus Group Discussions (FGDs) with MSEs in Yogyakarta.

or those already facing financial difficulties. These combined challenges act as a powerful barrier, preventing MSEs from fully unlocking the immense growth potential that the online world offers.

The second section is about the Diffusion of Innovation theory. The theory, developed by Rogers (2003), categorizes individuals or organizations based on their willingness to adopt new ideas or technologies. This theory can be very relevant to understanding how MSEs adopt new practices and technologies.

Table 3 shows that the digital landscape offers a rich tapestry of opportunities for MSEs to flourish, but navigating this new world can be a journey with varying pacesetters. Leading the charge are the tech-savvy innovators, readily adopting new online tools and platforms. They experiment with online marketing, explore e-commerce avenues, and actively seek out training resources. However, the majority of MSEs reside within the early and late majority categories. These businesses are more cautious, requiring clear demonstrations of value and successful examples before taking the plunge. Positive reviews, case studies, and a well-defined cost advantage compared to traditional methods can be persuasive factors for them. Laggards, on the other hand, present the most significant challenge (Moore et al., 2014). Often resource-constrained or deeply rooted in tradition, they exhibit strong resistance to change. These businesses may require targeted interventions and support to overcome their hesitation and bridge the digital divide. Understanding these distinct adopter categories is crucial for crafting effective strategies to promote digital adoption among MSEs. The researchers can empower a wider range of MSEs to embrace the online world and unlock their full potential for growth by addressing the specific needs and challenges of each group.

In the context of the Diffusion of Innovation theory, several key concepts play a vital role in understanding the process by which new innovations or technologies are adopted and integrated into society. One such concept is awareness building, which involves efforts to increase knowledge and understanding about innovation among potential adopters. Another critical aspect is adoption rates, which represent the proportion of individuals or organizations that have adopted the innovation within a given (Currie et al., 2021). Additionally, training and support are essential components that provide assistance and guidance to facilitate the adoption and implementation of the innovation. Lastly, technological infrastructure forms the backbone of the diffusion process, encompassing the necessary physical and organizational components to support the innovation's adoption and utilization. Together, these concepts contribute to understanding how innovations spread within a social system and influence the rate and extent of adoption.

Awareness-building initiatives are essential for introducing innovations to potential adopters and creating interest and understanding about their benefits and applications (Wang, Li, et al., 2024). These initiatives may include marketing campaigns, educational programs, or informational materials designed to inform and educate target audiences

Table 3 Adopter Categories and Characteristics in Micro and Small Enterprises (MSEs) Using Diffusion of Innovation Theory

Adopter Category	Characteristics	Adopting in MSEs
Innovators	○ First to adopt new ideas ○ Tech-savvy or high-risk tolerance ○ May adapt existing solutions	○ Experiment with new marketing tools
Early Adopters	○ Be open to new ideas but cautious ○ Opinion leaders influencing others ○ Pilot new technologies/practices	○ Implement new technologies after initial success ○ Provide positive reviews for others
Early Majority	○ The largest group, adopt after proven success ○ Pragmatic, prioritize solutions with benefits ○ Wait for positive reviews/case studies	○ Adopt after a clear value proposition or cost advantage
Late Majority	○ Skeptical of change, adopt after mainstream adoption ○ Resource-constrained or risk-averse ○ Hesitant to switch from traditional methods	○ Adopt due to regulations or competitive pressure
Laggards	○ Resist change entirely, last to adopt ○ Limited resources or a strong focus on tradition ○ May be forced to adopt due to external factors	○ Not adopt at all ○ Need significant support to overcome resistance

Source: In-Depth Interviews

about the innovation and its potential impact (Zhang, 2021). By increasing awareness and knowledge, organizations can stimulate interest and generate demand for innovation, laying the groundwork for adoption and diffusion (Mishra et al., 2024).

Adoption rates serve as a key metric for assessing the diffusion and acceptance of innovations within a population (Hossain, 2015). These rates represent the percentage of individuals or organizations that have adopted the innovation within a specific period, providing insights into the rate and extent of adoption. Adoption rates can vary depending on factors such as the perceived benefits of the innovation, its compatibility with existing practices, and the presence of facilitating conditions (Mobarak et al., 2024). Monitoring adoption rates over time allows researchers and practitioners to track the progress of diffusion efforts and identify factors that may influence adoption behavior (Tran, 2016).

Effective training and support are critical components of successful innovation adoption and implementation (Bui et al., 2019). Training programs provide individuals or organizations with the knowledge and skills needed to understand and use innovation effectively, while support services offer ongoing assistance and guidance throughout the adoption process (García-Peñalvo & Seoane-Pardo, 2015). By equipping adopters with the necessary training and support, organizations can reduce barriers to adoption, address challenges, and promote the successful integration of the innovation into existing practices and workflows (Chatterjee et al., 2021).

Technological infrastructure forms the foundation for the adoption and utilization of innovations, providing the physical and organizational components necessary to support their implementation (Wang, Li, et al., 2024). This infrastructure may include hardware, software, networking systems, data storage facilities, and communication networks (Yoo et al., 2012). A robust technological infrastructure is essential for enabling the widespread diffusion and utilization of innovations, as it provides the necessary foundation for their integration into existing systems and processes (Chen et al., 2023). Organizations must invest in developing and maintaining appropriate technological infrastructure to support innovation adoption and ensure long-term success (Kumar et al., 2024).

Based on Figure 6, awareness building in the phase incurs 12% of the total project cost, indicating a significant budget allocation towards raising awareness about the project and its objectives. Activities within this phase may encompass public relations campaigns, stakeholder engagement workshops, and the development of educational materials. These efforts are essential for informing stakeholders about the project's significance and garnering support for its implementation.

Moreover, according to the chart, the cost associated with adoption rates amounts to 15% of the total project budget. This allocation underscores the importance of encouraging individuals to embrace the new technological infrastructure. Efforts in this phase may involve implementing user training programs, creating user guides, and offering incentives to incentivize early adoption. By investing in adoption initiatives, project organizers aim to maximize the utilization and benefits of the new technology.

Data indicate 28% of the total project cost for training and support activities. This substantial allocation emphasizes the project's commitment to ensuring users possess the requisite skills and ongoing assistance to utilize the new technological infrastructure effectively. Training workshops, online tutorials, and the establishment of a help desk are among the measures intended to empower users and facilitate seamless integration of the technology into their workflows.

Figure 6 Influencing Factors in the Digital Adoption Through Diffusion of Innovation Theory

Source: Coding by NVivo 12 Plus

The costliest phase, accounting for 45% of the total project budget, is technological infrastructure. This allocation underscores the significant investment required to procure essential hardware, software, and potentially construct physical infrastructure necessary for the project's success. Allocating resources to this phase ensures the project has a robust foundation, enabling the seamless operation and sustainability of the new technological infrastructure.

In the analysis provided, Figure 7 shows an alternative categorization system proposed for understanding technology adoption patterns, distinct from the traditional Diffusion of Innovation theory. The categories outlined include innovators, early adopters, early majority, late majority, and laggards. Although these categories align conceptually with the Diffusion of Innovation model, the percentages associated with each group do not precisely mirror the traditional distribution outlined in the theory. The following is an elucidation of these categories and their potential application to technology adoption. Innovators (10%) represent the pioneering individuals or entities who are among the first to adopt new ideas and technologies. These early adopters are characterized by their inherent propensity for risk-taking and their inclination toward experimentation (Lin, 2014). Often comprising tech-savvy entrepreneurs or enthusiasts, innovators are driven by the potential rewards associated with being at the forefront of technological advancements. Within academic discourse, innovators may be studied to understand the factors influencing their decision-making processes and their role in catalyzing technological innovation within industries and societies.

Early adopters (5%) constitute a segment of the population that exhibits openness to novel ideas and technologies, albeit with a more cautious approach compared to innovators. Early adopters are influential figures within their respective communities or industries, often serving as opinion leaders who shape perceptions and attitudes toward emerging technologies. Their endorsement of innovations can significantly impact their adoption trajectory, as they lend credibility and legitimacy to the technologies they embrace. In academic analysis, early adopters may be examined to discern the criteria they use to evaluate and adopt new technologies, as well as their role in diffusing innovations to broader audiences.

The early majority (22%) represents the largest segment of adopters within the proposed framework. This group tends to adopt new ideas or technologies following the establishment of a demonstrably successful track record. Early majority adopters exhibit a pragmatic approach, preferring to observe the outcomes and benefits experienced by early adopters before committing to adoption themselves. Understanding the motivations and decision-making processes of the early majority is of academic interest, as their adoption behavior often determines the widespread acceptance and diffusion of innovations within society.

The late majority (38%) comprises individuals or entities who are more skeptical of change and tend to adopt new ideas only once they have become mainstream or widely accepted. Late majority adopters exhibit a degree of reluctance towards innovation, preferring the familiarity and stability of existing practices until external pressures necessitate

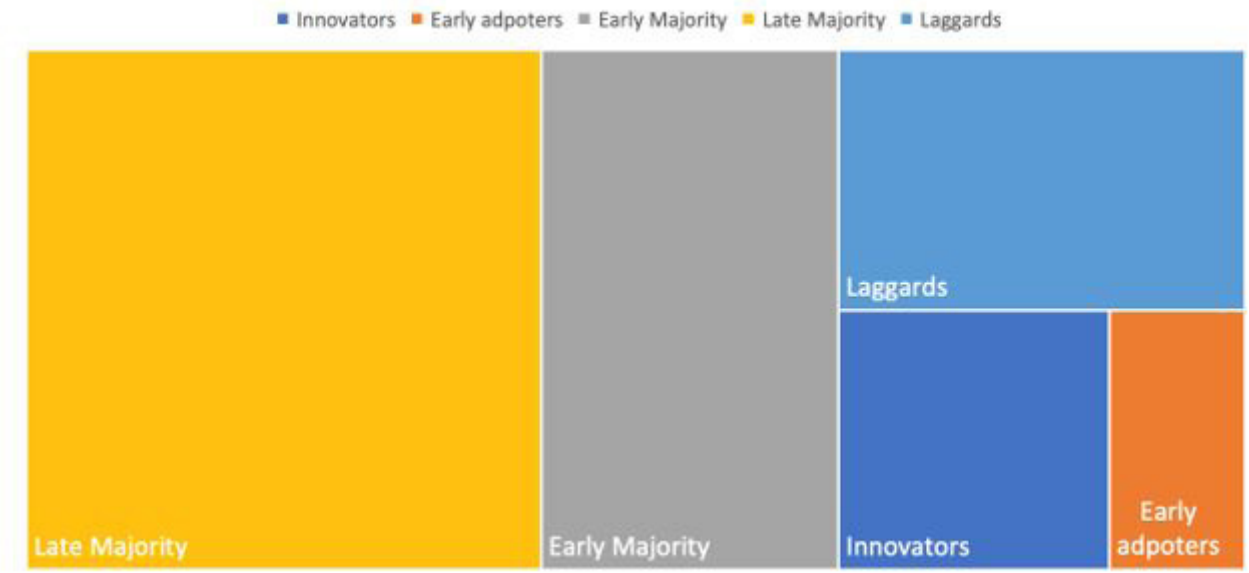

Figure 7 Level of Innovation in Micro and Small Enterprises (MSEs) based on Diffusion of Innovation Theory

Source: Coding by NVivo 12 Plus.

adaptation. Within academic discourse, studying the late majority offers insights into the barriers and challenges associated with technology adoption, as well as strategies for overcoming resistance to change within conservative segments of society.

Laggards (15%) represent the final segment of adopters, characterized by their resistance to change and propensity to adhere rigidly to traditional practices. Laggards are often hesitant or unwilling to embrace innovations, preferring to maintain the status quo even in the face of societal or technological advancements. Academic analysis of laggards may focus on understanding the underlying factors contributing to their resistance to change, as well as strategies for promoting adoption and addressing barriers to innovation within this population segment (Hatta et al., 2015).

The research effectively delineates the challenges encountered by MSEs in embracing digital technologies (Costello & Moreton, 2009; Yung & Chan, 2001). This identification of barriers provides a foundation for understanding the complexities involved in digital adoption and underscores the importance of addressing these challenges to facilitate successful implementation (Asrani & Kar, 2022). Moreover, the project reveals a positive trajectory of digitalization among MSEs in Yogyakarta, both during and after the pandemic. This observation suggests resilience and adaptability within the MSEs as businesses navigate the evolving digital landscape to maintain competitiveness and relevance in the market (Peansupap & Walker, 2005). The application of the Diffusion of Innovation theory offers a robust framework for comprehending the process of technology adoption among MSEs. By conceptualizing adopter categories and diffusion patterns, the theory enhances the understanding of the factors influencing adoption behavior and the dynamics of innovation diffusion within a social context (Nooteboom, 1994).

Moreover, the recommendations for stakeholders to enhance technology adoption and digitalization among MSEs in Yogyakarta emphasize a tailored and holistic approach. First, segment-specific engagement strategies are essential to address the unique behaviors of innovators, early adopters, early majority, late majority, and laggards. Innovators should be incentivized through exclusive access to pilot programs and cutting-edge tools, while early adopters can serve as community influencers with their success stories amplified to encourage broader adoption. The early majority requires evidence-based value propositions, including practical training and Return on Investment (ROI) demonstrations. For the late majority, simplifying adoption processes and building trust through community leaders is critical, whereas laggards need gradual integration and accessible solutions addressing cultural or psychological barriers.

Infrastructure investment is another cornerstone, particularly in expanding affordable Internet access, creating digital hubs with shared resources, and developing integrated digital ecosystems tailored to MSEs' needs. Capacity-building initiatives must complement these efforts, focusing on modular training programs, peer learning networks, and localized content to improve digital literacy. Government policies can further accelerate adoption through subsidies, simplified regulations, and public-private partnerships that ensure affordable and reliable technological solutions. Advocacy campaigns, leveraging local media and showcasing success stories, will also build awareness of digital opportunities and their benefits.

Moreover, sector-specific customization is vital, as MSEs in different industries, such as retail and manufacturing, face unique challenges. Collaborative workshops and targeted interventions can address these disparities effectively. Continuous monitoring mechanisms and feedback systems will allow stakeholders to refine strategies dynamically, ensuring their relevance and effectiveness. Lastly, integrating a sustainability focus on digitalization efforts will help MSEs to achieve long-term growth and environmental responsibility, with tools to measure productivity gains and promote eco-friendly practices. By addressing these areas comprehensively, stakeholders can foster greater digital adoption, resilience, and competitiveness among MSEs.

Furthermore, the allocation of project costs towards awareness building, training, and infrastructure emerges as a critical determinant of successful digitalization efforts. This strategic allocation reflects an understanding of the multifaceted nature of digital adoption, emphasizing the importance of addressing informational, skill-related, and infrastructural barriers (Paiva et al., 2024). While the alternative categorization system with different percentages presents an intriguing perspective, further elucidating the rationale behind these percentages will enhance clarity and understanding (Vega et al., 2018). Delving deeper into the factors influencing the distribution of adopter categories can provide valuable insights into the nuances of technology adoption dynamics. In considering additional avenues for exploration, the research can delve into the role of government initiatives and support programs in facilitating digital adoption among MSEs (Asrani & Kar, 2022; Pantano & Vannucci, 2019; Takahashi et al., 2024). Understanding the impact of policy interventions on adoption rates and technological uptake can offer valuable insights for policymakers and stakeholders. Moreover, exploring potential variations in adoption patterns across different sectors within MSEs, such as retail versus manufacturing, can provide valuable context-specific insights into the determinants of digital adoption and its implications for sectoral dynamics.

Lastly, investigating the long-term impact of digitalization on the sustainability and growth of MSEs in Yogyakarta represents a critical avenue for future research. Examining factors such as productivity gains, market competitiveness, and access to new opportunities can shed light on the transformative

potential of digitalization for MSEs. It can also inform strategies for fostering sustainable growth and development.

CONCLUSIONS

The research identifies several challenges faced by MSEs in Yogyakarta when adopting digital technologies, including financial constraints, limited Internet access, lack of digital literacy, and inadequate access to technology. Despite these obstacles, there is a discernible positive digitalization trend among MSEs in the region. This trend is primarily driven by the imperative to adapt to the challenges posed by the pandemic and the growing recognition of the benefits associated with digital technologies.

To effectively support technology adoption among MSEs in Yogyakarta, stakeholders must implement targeted and actionable strategies tailored to different adopter categories. For innovators, providing early access to digital tools, financial incentives, and pilot programs can encourage experimentation. Early adopters, who often act as community influencers, should be engaged as digital ambassadors through workshops, media campaigns, and exclusive networking events to promote their success stories. The early majority can be supported through practical demonstrations, user-friendly resources, and training sessions that highlight the return on investment in digital technologies. For the late majority, leveraging trusted community leaders and offering low-cost and simplified solutions can address their skepticism and ease the transition. Finally, laggards can benefit from personalized support plans, subsidies, and culturally sensitive campaigns to address resistance to change.

Infrastructure development is another critical area, requiring expanded access to affordable high-speed Internet and the establishment of digital hubs equipped with shared tools, technical support, and high-speed connectivity. To build the digital capacity of MSEs, stakeholders should design modular training programs focusing on digital skills such as e-commerce and social media marketing, while also fostering peer-learning networks and developing localized and accessible content. Government policies must play a pivotal role by offering financial incentives like grants, low-interest loans, and tax benefits, alongside simplifying registration and compliance processes. Partnerships with private sector players can create affordable packages for essential digital tools and services. Sector-specific strategies are vital to addressing unique challenges across industries.

Conducting needs assessments and developing tailored solutions, such as inventory management systems for retailers or supply chain platforms for manufacturers, will ensure relevance and efficiency. Awareness campaigns featuring local success stories and leveraging influencers can further build trust and credibility, fostering a positive perception of digital adoption. To ensure long-term sustainability, stakeholders should integrate tools that help MSEs to monitor productivity and operational efficiency while promoting eco-friendly technologies through subsidies and discounts. Continuous monitoring and feedback mechanisms are essential to understanding the challenges faced by MSEs, enabling adaptive strategies and sustained support.

Despite its contributions, the research has certain limitations. Notably, it does not delve into the role of government initiatives in facilitating digital adoption among MSEs. Additionally, potential differences in adoption patterns between sectors within MSEs, such as retail versus manufacturing, remain unexplored. Moreover, the long-term impact of digitalization on the sustainability and growth of MSEs in Yogyakarta has not been thoroughly examined. Future research endeavors can address these limitations and expand the understanding of digital adoption dynamics among MSEs. Investigating the impact of government policies and support programs on digital adoption rates can provide valuable insights into the efficacy of policy interventions in fostering technology uptake within the MSE sector. Similarly, exploring potential variations in adoption patterns across different MSE sectors can offer context-specific insights into the determinants of digital adoption and its implications for sectoral dynamics. Additionally, examining the long-term effects of digitalization on the sustainability and growth of MSEs in Yogyakarta will contribute to understanding the transformative potential of digital technologies within the MSEs.

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