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Digital Poverty Map among Coffee Farmers in Pupuan and Wanagiri: A Comparative Regional Study

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ABSTRACT

This study aimed to examine the level of digital poverty among coffee farmers in two regions with different geographical and socioeconomic characteristics, namely Pupuan as well as Wanagiri. The analysis focused on three main indicators such as access to digital devices, digital skills, and productive use of technology. The results were categorized into varying degrees of digital poverty to give an understanding of the situation of each region. The findings showed that coffee farmers in Pupuan generally fell into the low digital poverty category across all three indicators. The farmers had sufficient devices, operating skills, and a strong motivation to use digital technology for economic activities such as marketing coffee via social media, monitoring market prices, and taking part in online training, respectively. This productive use of technology had contributed to increased income and competitiveness. Farmers in Wanagiri tended to be in the middle range of digital poverty, specifically concerning skills and productive use. As access to devices was relatively good, technology use was mostly limited to basic communication or entertainment. Low motivation, limited knowledge, and a lack of modified training were the main barriers to maximizing the economic benefits of digital technology. These findings signified that reducing the digital divide required interventions by providing devices, infrastructure, and focusing on improving skills, motivation, and localized institutional support. Incorporated efforts were expected to promote inclusive digital transformation for farmers in rural areas.

Keywords: *Poverty; Digital Poverty; Digital Poverty Map.*

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ABSTRAK

Penelitian ini menganalisis tingkat kemiskinan digital pada petani kopi di dua wilayah dengan karakteristik geografis dan sosial ekonomi yang berbeda, yaitu Pupuan dan Wanagiri. Analisis dilakukan dengan mengukur tiga indikator utama: akses terhadap perangkat digital, keterampilan digital, dan pemanfaatan produktif. Hasil pengukuran selanjutnya dikategorikan ke dalam degree of digital poverty dan level of digital poverty untuk memberikan gambaran komprehensif tentang kondisi masing-masing wilayah. Hasil penelitian menunjukkan bahwa petani kopi di Pupuan umumnya berada pada kategori low digital poverty pada ketiga indikator. Mereka memiliki perangkat yang memadai, keterampilan untuk mengoperasikannya, serta motivasi tinggi untuk memanfaatkan teknologi digital dalam aktivitas ekonomi, seperti pemasaran kopi melalui media sosial, memantau harga pasar, dan mengikuti pelatihan daring. Pemanfaatan teknologi yang produktif ini mendorong peningkatan pendapatan dan daya saing. Sebaliknya, petani di Wanagiri cenderung berada pada kategori middle digital poverty, terutama pada aspek keterampilan dan pemanfaatan produktif. Walaupun akses perangkat relatif baik, penggunaan teknologi sebagian besar terbatas pada komunikasi dasar atau hiburan. Rendahnya motivasi, keterbatasan pengetahuan, dan minimnya pelatihan berbasis kebutuhan lokal menjadi faktor penghambat utama dalam mengoptimalkan manfaat ekonomi dari teknologi digital. Temuan ini menegaskan bahwa pengurangan kesenjangan digital memerlukan intervensi yang tidak hanya berfokus pada penyediaan perangkat dan infrastruktur, tetapi juga peningkatan keterampilan, motivasi, serta dukungan kelembagaan yang kontekstual. Upaya terintegrasi diharapkan dapat mendorong transformasi digital yang inklusif bagi petani di wilayah perdesaan.

Kata kunci: *Kemiskinan; Kemiskinan Digital; Peta Kemiskinan Digital.*

INTRODUCTION

Information and communication technology (ICT) is playing a crucial role across various sectors, including agriculture, in the current digital age. Digital technology enables farmers to access the latest information on weather, market prices, agricultural innovations, and broader marketing opportunities. Relating to this, the article "Smart Farming 4.0 to Realize Advanced, Independent, and Modern Indonesian Agriculture" explains that the Ministry of Agriculture has adopted technological advances by launching Smart Farming 4.0. Several smart farming technologies, such as blockchain, help trace the supply chains of agricultural products, while smart irrigation systems, agri-drone sprayers for pesticide application, and other programs are also part of this initiative (Rachmawati, 2021). The development of this sector is closely connected to the strong support of the government for motivating coffee farmers. However, not all groups in communities have equal access, skills, or capabilities to use technology, leading to issues of digital poverty.

Coffee plantations are major components of the agricultural sector and a significant driver of the local economy in Bali Province. Balinese coffee is recognized for high economic and cultural importance, making it a leading commodity exported to both domestic as well as international markets. Moreover, Balinese Arabica coffee has been a major export for several years (Sarjana, Darmawan, & Astiti, 2017). The rapid growth is closely connected to the strong commitment of the government to maintain stable coffee production, which

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helps preserve its status as a major export item. Efforts such as inspiring coffee farmers to adopt new technology are needed to sustain production levels and support economic growth (Irawan, 2023). Despite this potential, significant challenges remain related to access and use of digital technology among the farmers.

The digital divide among coffee farmers in Bali comes from several factors, including limited digital infrastructure, low digital literacy, economic constraints, and regional disparities. The Indonesian Digital Society Index (IMDI) recorded a national score of 43.18, signifying that the country is still in the early stages of digitalization, specifically in rural areas (Koswara et al., 2024). This study focuses on how farmers in remote regions often have limited access to internet networks and technological devices, but those in more developed areas enjoy better access. The gap can impact the ability of farmers to boost productivity, expand markets, and improve economic well-being. Supporting this, a study titled "Identifying Limiting Factors for Feasible Productivity Improvement for Smallholder Farmers in the Coffee Sector in Indonesia" shows that the coffee production structure of Indonesia still relies heavily on smallholder farmers, who manage 92.26% of the total coffee plantation area. The average land ownership of the farmers ranges from 0.4 to 1.6 hectares. This implies that most coffee farmers in the country operate on a small economic scale, leading to relatively low productivity compared to other countries. The study also shows that these limitations are influenced by technical, financial, and institutional factors (Tran, Nathan, Ilmma, Burkiewicz, & Wisana, 2021).

Digital poverty hinders the ability of farmers to keep up with developments in modern agricultural technology. Farmers without access to digital information tend to fall behind in adopting more efficient and sustainable cultivation methods. As a result, coffee farmers struggle to compete in an increasingly competitive market. Relating to the explanation in the article "Digital Technology Innovation for Poverty Alleviation in Highland Agriculture During the COVID-19 Pandemic," the use of RiTx digital technology can lower fertilizer maintenance costs (Krismono & Nasikh, 2022), providing farmers with an advantage in selling prices. RiTx digital technology represents a breakthrough in agriculture, specifically for measuring rainfall intensity and assessing plant nutrient needs. A similar finding is presented in the Analysis of the Impact of Technology Use and Increasing Coffee Farmers' Income in Sangir District, South Solok Regency. The study shows that combining technology with increased knowledge offers a solution to improve the welfare of coffee farmers (Oktaviandi & Persaulian, 2025). Therefore, understanding the level of digital poverty among coffee farmers is crucial for reducing inequality and promoting digital inclusion in the coffee farming sector.

Differences in digital poverty levels across regions in Bali show an imbalance in the distribution of digital resources. Areas with sufficient infrastructure and strong policy support tend to have better access, while remote or less developed areas face various challenges. Comparative studies across regions can offer a comprehensive view of the variations and factors driving digital poverty.

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This study aims to map the level of digital poverty among coffee farmers in Bali Province, focusing specifically on Pupuan and Wanagiri, as well as comparing the two regions. The analysis will identify differences in access to technology, digital skills, and technology use in agricultural activities across various regions in Bali. By understanding the digital divide patterns, this study intends to offer policy recommendations to reduce digital poverty among coffee farmers and promote digital inclusion in the agricultural sector. Furthermore, the analysis is also expected to uncover the main barriers farmers face in accessing and using digital technology, including economic, social, and cultural factors, as well as policies that are not yet fully supportive of digital inclusion.

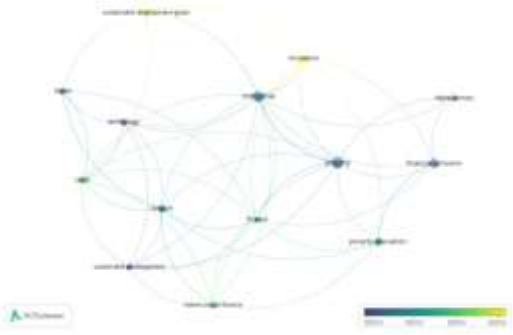

Figure 1. Bibliometric analysis using VOSviewer with keywords "digital poverty", Indonesia
Source: processed results of studies

Based on the analysis using VOSViewer above, studies on digital poverty have not yet become a separate node. This signifies that studies on digital poverty are still relatively few. The VOSViewer image also shows that analyses on Indonesian poverty in the past five years have focused on themes such as financial inclusion, fintech, and innovation. This visibly signifies a study gap in viewing digital poverty as a novelty.

This study is novel by first conceptually adapting digital poverty indicators to examine lack before addressing the digital divide or literacy levels, which are typically studied separately. Second, by empirically comparing digital poverty levels in two different regions, namely Pupuan and Wanagiri. Therefore, this study is expected to provide a new contribution to understanding digital poverty, which has previously been viewed as a digital divide or limited digital literacy.

METHOD

This study used a qualitative method with a comparative case study process. The method aims to explore in depth the experiences, challenges, and factors contributing to digital poverty in both regions. The selection of the two locations was based on several considerations, namely geographic conditions and the scale of coffee production. Geographic conditions reflected geographical differences that affected the quality as well as the availability of internet connectivity and networks. In addition, this study focused on small-scale, traditional coffee production that remained widely practiced in both regions.

The analysis focused on four dimensions of digital poverty, including Devices and Connectivity, Capacity, Motivation, Support, as well as Participation. Data collection was conducted during the process of the analysis in the following ways. (1) On-site interviews to understand the experiences and challenges of farmers with technology, as informants were selected using purposive sampling. In addition to coffee farmers, interviews were also conducted with village officials. (2)

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Observation, and (3) Documentation study, including collecting documents, such as agricultural digitalization policies, device ownership data, and training programs in both regions.

In incorporating GIS mapping, interview results were processed using a thematic method to identify experiences, barriers, and strategies in accessing digital technology. The analysis categories were structured based on the four dimensions of digital poverty reviewed previously. Data on internet access and device ownership were then entered based on the secondary data.

RESULTS AND DISCUSSION

Mapping digital poverty was a crucial step in understanding the extent to which communities, particularly coffee farmers in rural areas such as Pupuan and Wanagiri, could access, use, and benefit from ICT. Digital poverty extended past the inability to purchase digital devices and comprised limitations in connectivity, digital skills, motivation to use technology, and the availability of support. This concept was associated with the understanding of Barrantes that digital poverty reflected limitations in using ICT to achieve essential socioeconomic functions, such as education, livelihoods, and social participation. According to Barrantes, accurately measuring digital poverty required a multidimensional method that combined aspects of infrastructure, skills, and opportunities for ICT use (Barrantes, 2007).

Data from the Bali Central Statistics Agency (BPS) in 2023 showed that approximately 35.8% of households in Tabanan and 41.2% in Buleleng lacked stable internet access (Badan Pusat Statistik, 2025). On the other hand, the results of the National Socioeconomic Survey (Susenas) signified that farmers aged 50 and above dominated rural areas of Bali, and this age group had a very low level of digital literacy (Badan Pusat Statistik Indonesia, 2023). In "Digital Divide Due to Demographic Conditions Among Rural Communities", the digital divide was higher in rural communities than in urban areas because of the opportunity to feel the impact of infrastructure development first (Oktavianoor, 2020). In this context, coffee farmers in Pupuan and Wanagiri faced unique challenges, including geographical isolation, limited telecommunications infrastructure, and an unequal distribution of digital skills training.

Digital poverty mapping served as a crucial starting point for designing evidence-based policy interventions that bridged the digital divide and ensured sustainable digital inclusion in the agricultural sector. In this context, a four-dimensional method, namely device access and connectivity, digital capacity, motivation, and support and participation, served as a comprehensive tool for identifying the digital vulnerability of rural communities.

A. Devices and Connectivity

Digital connectivity networks and devices were the primary foundation for achieving access to information and communication in the modern era. The availability of adequate network infrastructure, through cellular or wired internet services, enabled communities to connect to information sources, public services, and economic opportunities more quickly as well as efficiently. The quality of connectivity was often influenced by

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geographic factors, population density, and available infrastructure capacity. According to BPS data, Bali showed differences in internet access availability across regions.

Table 1. Number of Villages/Sub-districts by Regency/City and Cellular Phone Internet Signal Recipients in Bali Province 2021

Source: Central Statistics Agency

Table 1 showed the number of villages/sub-districts in each regency/city in Bali and the percentage of those receiving cellular phone signals in 2001. The table showed that the majority of villages/sub-districts in Bali, out of a total of 660, had received 4G signals. The regencies with the most villages receiving 4G were Buleleng (129) and Tabanan (122). Meanwhile, the regency with the fewest villages receiving 4G was Denpasar City, due to small administrative area. Even though Buleleng and Tabanan had the largest number of villages receiving 4G, the areas still had the highest number of villages receiving only 3 G signals. This condition signified that the gap in network quality persisted, directly contributing to digital poverty. Low-quality internet access limited the ability of communities to use digital services such as online education, e-commerce, remote healthcare, and digital-based economic opportunities. The findings of "How the Internet Affects Productivity" confirmed that the internet actually increased productivity in many cases, specifically when used to redesign business models (Hannula & Lonnqvist, 2011). Similarly, the study "The Effect of Availability of Digital Facilities at Home on Work Productivity" found that access to digital technology at home, such as internet connectivity and digital devices, significantly improved work productivity (Saputra, Nasip, & Sudiana, 2021). The outcome implied that connectivity was about the presence of a network, the quality, and the readiness of supporting infrastructure at the household level.

Device ownership, such as a smartphone, computer, or tablet, was a crucial prerequisite for optimal connectivity. This study found that coffee farmers in Pupuan showed higher levels of digital device ownership compared to farmers in Wanagiri. Some Wanagiri farmers still owned mobile phones, which could only be used for texting and making calls. Following the discussion, coffee farmers in Pupuan possessed more than one smartphone, implying a gap in technological adaptation. Farmers with adequate devices tended to have easier access to market information, adopt cultivation innovations, and expand online sales networks. Farmers with limited devices were overlooked in capitalizing on digital economic opportunities, widening the productivity gap between regions. The major findings in "The Impact of Mobile Phone Ownership on Farmer Income: Evidence from Microdata in Indonesia" showed that mobile phone ownership significantly improved the welfare of farmers in Indonesia (Fazaalloh, Prestianawati, & Athoillah, 2024).

Digital capacity, or digital skills, was a major factor in determining levels of digital

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poverty. Digital skills comprised all skills related to digital technology, from basic literacy to generic skills for all workers and specialized abilities for information technology professionals (Saputra & Nugroho, 2021). Concerning coffee farmers, these skills comprised operating digital devices, accessing and understanding market information, using online marketing platforms, and leveraging technology to support production as well as distribution processes.

The results showed differences between coffee farmers in Pupuan and Wanagiri. In Pupuan, digital literacy was in the low digital poverty category. This signified that most farmers possessed adequate skills in operating digital devices, accessing coffee price information, participating in online training, and marketing personal products through social media or e-commerce platforms. The condition contributed to high levels of productive use, making digital technology a tangible instrument for increasing income. This finding followed a study by Adhitya Wardhana et al., who showed that farmers with middle- to upper-income levels optimally used the internet and mobile phones to access information on production, market prices, digital marketing, and agricultural credit, improving the welfare of farmers (Wardhana, Fauzy, Anggana, & Kharisma, 2024). Another study by Mokhtar et al. also confirmed that digital literacy skills in the agricultural sector increased product competitiveness and accelerated the adoption of modern agricultural technology (Wan Mokhtar, Izhar, Zaini, & Hussin, 2022). This followed the concept of the second-level digital divide by Van Dijk, showing that differences in digital skills directly affected technology use, even when device access was available (Dijk, 2019).

Farmers in Wanagiri were in the middle digital poverty category in terms of digital skills. Despite having good access to devices, the skills of the farmers were still limited to basic uses such as telephone communication. The use of technology for productive purposes, such as marketing, finding new buyers, or exercising business management applications, remained uncommon. As a result, the economic benefits of digital technology had not been fully realized. This phenomenon of passive digital use was common in rural communities. The availability of devices and connectivity was not often accompanied by the ability or motivation to use gadgets productively. A study of the digital communication competencies of millennial farmers in Indonesia found that digital communication competencies, which included motivation, knowledge, and digital skills, significantly improved the performance of farmers in using ICT for information, marketing, as well as decision-making (Sasmita, Saleh, Priatna, & Muljono, 2024). Furthermore, infrastructure and digital literacy gaps in rural areas played a significant role in limiting productive digital use. A study in Africa showed that the adoption of ICT services in the agricultural sector was limited by poor infrastructure and low user capabilities, including among farmers, as well as a lack of adequate training programs (Ayim, Kassahun, Tekinerdogan, & Addison, 2020), hindering farmers from escaping digital poverty. Limited infrastructure and capabilities prevented farmers from participating in training that could improve

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personal well-being. Furthermore, digital use, particularly the ability to access information and conduct transactions, helped farmers overcome mobility barriers and expand access to markets as well as financial services. Without adequate digital skills, these technologies were used passively in the mentioned areas. The article "Digital skills and consumption inequality of farmer: Mechanisms, regional insights, and policy implications" explained that the adoption of digital skills had been shown to reduce consumption inequality, enabling farmers to access markets, finance, and non-farm employment through digital platforms, but only when farmers could use the technologies productively (Liu et al., 2025).

C. Motivation

Motivation played a crucial role in determining the extent to which individuals were willing and able to use digital technology productively. According to self-determination theory, motivation was divided into two categories, namely intrinsic motivation, which came from an internal desire to grow and learn, as well as extrinsic motivation. This arose from external forces such as the economy, market demands, or government policies (Dunn & Zimmer, 2020). In the context of the analysis, farmers in Pupuan tended to have a higher motivation to adopt digital technology productively. This was evident in access to digital tools, skills, and use of digital technology in economic activities, consisting of marketing coffee through social media, monitoring market prices, as well as participating in online training. The motivation was possibly driven by the need to maintain competitiveness and capitalize on increasing digital market opportunities. A study by M. Lisa Yeo and Catherine M. Keske confirmed that the use of digital technology in agriculture increased productivity, efficiency, and sustainability of agricultural businesses (Yeo & Keske, 2024). Therefore, the motivation of farmers to use technology increased by recognizing that technology could improve agricultural profits and simplify existing processes.

Farmers in Wanagiri showed relatively low motivation to use technology productively. Wanagiri farmers tended to use digital devices only for basic communication or entertainment. This reflected the existence of a second-order digital divide, where motivation and ability to be used remained largely limited despite access to devices. According to a literature review at MDPI, digital technology adoption in the agricultural sector was influenced by perceived economic benefits, ease of use, and institutional support including training as well as government subsidies (Cui & Wang, 2023). When farmers did not perceive direct benefits or ease of use of technology, adoption tended to be low.

A systematic review of Agriculture 4.0 showed that a lack of digital skills and limited infrastructure were major barriers to technology adoption. This study also signified the importance of institutional support, such as community-based training and subsidy programs, to strengthen the motivation of farmers to use digital technologies productively (Fragomeli, Annunziata, & Punzo, 2024). Studies on digital agriculture adoption confirmed that technology adoption was more possibly when farmers perceived it as economically profitable and easy to use. Trust in the technology and words from recommenders was also an

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important moderating factor (Yeo & Keske, 2024).

D. Digital Poverty Mapping

The analysis of digital poverty levels among coffee farmers in Pupuan and Wanagiri was conducted by evaluating three main indicators, namely access to digital devices, digital skills, and productive utilization. These indicators showed how much farmers had the resources, ability, and willingness to use digital technology to support personal economic activities. The data collected were then categorized into different degrees and levels of digital poverty, offering a detailed view of the position of each region on the digital poverty spectrum.

Table 2. Digital Map of Poverty of Farmer in Pupuan

NO	INDICATOR	DEGREE OF DIGITAL POVERTY	LEVEL OF DIGITAL POVERTY
1	ACCESS TO DIGITAL DEVICES	LOW DIGITAL POVERTY	CONNECTED
		MIDDLE DIGITAL POVERTY	
2	DIGITAL SKILLS	LOW DIGITAL POVERTY	
		MIDDLE DIGITAL POVERTY	
3	PRODUCTIVE USE	MIDDLE DIGITAL POVERTY	
		MIDDLE DIGITAL POVERTY	

Source: Processed Data

Concerning Pupuan Farmers, all three indicators showed low digital poverty during the analysis. This signified that most farmers had sufficient access to digital devices, operating skills, and the ability to use the devices effectively. The usage level was shown by individual ability to monitor coffee prices, participate in online training, and market products through social media as well as e-commerce platforms. In general, the digital poverty level in Pupuan was in the wealthier digital poverty category. This showed that farmers were at the higher end of the digital poverty spectrum.

Table 3. Digital Map of Poverty of Farmer in Wanagiri

NO	INDICATOR	DEGREE OF DIGITAL POVERTY	LEVEL OF DIGITAL POVERTY
1	ACCESS TO DIGITAL DEVICES	LOW DIGITAL POVERTY	WEALTHY DIGITAL POVERTY
2	DIGITAL SKILLS	LOW DIGITAL POVERTY	
3	PRODUCTIVE USE	LOW DIGITAL POVERTY	

Source: Processed Data

Among Wanagiri farmers, a significant portion was in the middle digital poverty category, although some were in the low category for access to digital devices and skills. This situation showed limited access to stable devices, limited digital skills, and minimal use of technology for productive purposes. Many farmers used technology mainly for personal communication or entertainment, not optimally for marketing, finding buyers, and managing digital businesses. The digital poverty level in Wanagiri was in the connected category, signifying the farmers had connectivity but were not yet able to fully use it.

The differences showed that strategies for using technology were crucial factors, even though both regions had access to digital tools, motivation, and skills. Pupuan farmers had taken advantage of digital opportunities to improve competitiveness and income. Meanwhile, Wanagiri farmers still needed interventions such as local training, infrastructure support, and real-world success stories to improve motivation and inspire technology adoption.

The modification in levels of digital poverty was observed from the perspective of coffee farming communities. More coffee farmers in Pupuan had joined coffee farming

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groups, and those in Wanagiri were not entirely unaffiliated. Although many had joined, Wanagiri coffee farmers still needed to engage more with the communities and strengthen institutions compared to Pupuan.

Concerning infrastructure, Pupuan benefited from the 5G network expansion in Tabanan Regency, which started in 2021. Meanwhile, Wanagiri, with its more hilly terrain, frequently experienced signal problems and slow internet speeds, significantly limiting access.

CONCLUSION

In conclusion, studies showed a significant difference in digital poverty levels between farmers in Pupuan and Wanagiri. Farmers in Pupuan generally fell into the low digital poverty category, with sufficient access to devices, strong digital skills, and active use of technology for economic activities, including online marketing, monitoring market prices, as well as participating in online training. This positioned Pupuan at the wealthier digital poverty level, reflecting a relatively high level of digital inclusion. Farmers in Wanagiri tended to be in the middle digital poverty category, specifically in skills and productive use. Although device access was fairly available, technology use was mostly limited to basic communication or entertainment, with low adoption motivation. This positioned Wanagiri at the connected level, signifying that the farmers had connectivity but was not yet fully using technology to improve personal well-being. The findings showed that addressing digital poverty in the agricultural sector was not sufficient to provide devices and infrastructure.

Based on the findings, the government should expand and improve internet infrastructure in rural areas, specifically in regions with challenging topography, such as Wanagiri, to ensure reliable connectivity. Communities of farmers and organizations could start digital learning groups that enable members to exchange experiences and knowledge related to technology use, and leverage shared digital platforms for collective marketing, broadening market reach, and improving bargaining power for coffee prices.

There were several practical implications and recommendations for local governments, farming communities, supporting institutions, MSMEs, academics, and advanced studies. Local governments, including the Ministry of Communication and Digital, urgently need to expand and improve internet networks in rural areas, specifically in regions with significant geographical challenges, such as hills or mountains. Coffee farming communities and organizations could use digital platform-based collective marketing. This could improve effectiveness and efficiency for coffee farmers with limited capital. MSMEs and other supporting institutions should offer training on business management, digital marketing, and coffee product branding to raise awareness. Finally, academics and other studies could develop a quantitative measurement model for digital poverty levels using more comprehensive GIS mapping.

Efforts to address the digital divide became visible and more measurable when viewed through numerical data. Digital poverty was no longer simply viewed as a gap or lack of digital device ownership or digital literacy. As an alternative, digital poverty was

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a combination of lacking digital devices and network connectivity, the ability and inability to effectively use the gadgets.

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