Digital Literacy Reduces Digital Divide Across Spatial and Socio Demographic Groups

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Abstract. General Background: Indonesia's digital transformation is closely linked to citizens' digital literacy, which plays a crucial role in ensuring inclusive participation in the digital society. Specific Background: Based on the Indonesia Digital Society Index (IMDI) 2025, national digital literacy scores have improved, yet disparities across regions and socio-demographic groups remain evident. Knowledge Gap: Despite these improvements, limited studies have comprehensively examined spatial patterns and socio-economic factors underlying digital literacy inequalities using IMDI 2025 data. Aims: This study aims to analyze spatial and socio-demographic determinants of digital literacy across six provinces representing major Indonesian islands. Results: Using quantitative and qualitative analysis, the study identifies correlations between digital literacy and spatial factors within three IMDI pillars—technology infrastructure and ecosystems, job and empowerment—as well as socio-demographic variables including education, gender participation, and regional income per capita. The findings show that provinces with stronger infrastructure, higher education levels, and active community engagement, such as West Java, Yogyakarta, and Bali, achieve higher literacy scores, while regions with limited access, lower participation in digital training, and socio-economic constraints, such as Papua and Maluku, demonstrate lower literacy levels. Novelty: This study introduces a Community-Driven Digital Literacy Acceleration (CD-DLA) model highlighting localized, participatory approaches to digital literacy development. Implications: The findings underscore the need for integrated strategies combining infrastructure expansion and community-based initiatives to achieve equitable digital literacy and reduce regional disparities in Indonesia.

Keywords: Digital literacy; Digital divide; IMDI 2025; Socio demographic factors; Spatial inequality

1 Introduction

Digital literacy has become one of the key foundations of Indonesia's shift toward a digital society. The IMDI 2025 report indicates some progress, but the gap between urban and rural regions remains evident [1]. This pattern is also seen in national studies, which note that digital transformation often repeats older regional inequalities, such as the difference between Java's 57% share of national GDP and the less than 3% contributed by Papua or Maluku [2].

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This research highlights the spatial and socio-demographic factors that shape these regional differences and offers community-based approaches to improve digital literacy outcomes. The importance of building strong digital skills is also reflected in studies on Indonesia's "Golden Indonesia 2045" vision, which positions digital competence as a core element of national human capital development [3]. This direction is consistent with Indonesia's Digital Transformation Agenda in the National Long-Term Development Plan and the Digital Indonesia Vision 2045, both of which identify digital government, digital economy, and digital society as priority areas that depend on digital literacy as a key foundation [4] [5].

The previous report of the Digital Literacy Index 2020-2022 further underlines that regional economic growth alone is inadequate to close the gaps. There is a clear gap in access to educational technology and ICT skills between urban and rural areas. Many regions still lag in basic digital infrastructure and skills, which makes it harder to prepare the workforce for the digital era [6]. It suggests that spatial factors such as infrastructure & ecosystems, jobs, and internet penetration play a more decisive role in shaping outcomes. Meanwhile, educational, empowerment, gender participation, and income are less influential.

This study seeks to measure regional differences in digital literacy utilizing IMDI 2025 data. This study assesses the connection between these differences and sociodemographic factors, including gender, infrastructure, income, and education. We analyze six provinces representing six major islands and differing levels of digital readiness across Indonesia to ensure the findings are applicable for policy initiatives. This concentrated sample allows us to identify the factors that significantly influence provincial variance and where targeted interventions would be most effective.

2 Literature Review

Digital literacy has transitioned from a fundamental skill set to a complex competence essential for comprehensive engagement in the digital economy and society. As described by Makhafola et al. [7], digital literacy covers not only the capability to access and use digital technologies but also the understanding, evaluation, and responsible, ethical creation of digital content. In Indonesia, the Ministry of Communications and Digital Affairs (Komdigi) defines digital literacy through four essential pillars: digital skills, digital ethics, digital safety, and digital culture [8]. These components are relevant to international frameworks such as the European Digital Competence Framework [9], which highlights information & data literacy, communication & collaboration, digital safety, content creation, and problem-solving..

Prior research conducted by van Dijk [10] and Hargittai [11] characterizes the digital divide as a comprehensive underlying meaning, involving inequalities in access, skills, and outcomes. While the expansion of infrastructure has mitigated access disparities, gaps in skills and results continue to exist, especially in regions facing socioeconomic challenges. Research on Indonesia's long-term development trajectory reveals that these disparities reflect deeper structural inequities caused by uneven regional development, with digital transformation benefiting regions with high institutional capacity and human capital [2]. Meanwhile, research on "Golden Indonesia 2024" demonstrates that digital literacy improves human resource competitiveness,

educational quality, and innovation ability [3]. The notion of community-oriented digital literacy programmes [12][13] emphasises the importance of social involvement and cultural adaptation in ensuring long-term digital inclusion.

Furthermore, empirical research conducted in developing nations indicates that factors such as income, educational attainment, and employment status significantly correlate with digital literacy. However, these factors are influenced by structural limitations, including infrastructure and governance [14] [15]. In Indonesia, the earlier report on the Digital Literacy Index for the years 2020-2022 revealed that western provinces, which are more urbanized, consistently achieve higher scores compared to the central and eastern regions. Concurrently, the evaluation for 2020–2022 underscores critical limitations in measurement and data: the Digital Literacy Index relies on self-reported competencies and does not account for non-internet users, potentially underrepresenting the difficulties encountered by marginalized and rural populations, especially in the over 3,000 villages lacking any internet connectivity [16] [17]. This analysis fails to consider various demographic groups, is heavily dependent on individual ratings, and excludes individuals without internet access. These shortcomings are closely aligned with the regional disparities identified by IMDI, suggesting that Indonesia's digital literacy scores may systematically exaggerate the capabilities of digitally advanced regions while obscuring deeper divides within at-risk populations.

These insights underscore the necessity for spatial and socio-demographic analysis utilising IMDI 2025. This study views digital literacy not only as an individual skill but as a communal capability shaped by education, infrastructure, and social ecosystems.

3 Methodology

The study applies a qualitative comparative approach, utilizing the digital literacy score from IMDI 2025 published data, particularly from six selected provinces that are viewed as representative samples of six prominent islands in Indonesia (i.e., Sumatra, Java, Bali-Nusa Tenggara, Kalimantan, Sulawesi, and Papua). This study also uses a quantitative approach, in particular the correlation analysis, to investigate the relationships between digital literacy and various spatial factors, infrastructure & ecosystems, employment and empowerment, as well as socio-demographic elements, including education, gender participation, and regional income. This mixed-method approach promotes both statistical and reflective-interpretative understanding of the current digital literacy level in Indonesia.

4 Results and Discussion

As illustrated in Table 1, the findings from IMDI 2025 reveal that Indonesia's national digital literacy score has attained 49.28, which is classified as "Good" [1]. Nevertheless, this national average conceals disparities in progress. The geographical distribution of scores indicates that significant gaps persist between regions with robust infrastructure and those that continue to face challenges related to connectivity, socio-economic factors, and inconsistent program implementation. This trend is consistent with

previous research indicating that digital transformation in Indonesia frequently perpetuates existing geographic inequalities, especially between Java and the outer islands [2].

Table 1. Inter-Island Comparative Analysis of IMDI 2025 Digital Literacy Score

Island	Example	IMDI 2025 Digital Literacy [1]	Distinctive Features
Sumatra	North Sumatra	44.69	Strong presence of universities and MSMEs adopting digital marketing; community-led training in Medan.
Java	West Java	52.37	High internet penetration, advanced e-learning ecosystems, and strong digital community networks (*Relawan* TIK, Startup Bandung, etc.).
Bali-Nusa Tenggara	Bali	50.80	Rapid urban development and industrial digitalization, yet rural access remains low.
Kalimantan	East Kalimantan	51.42	Balanced growth supported by local universities (UNHAS) and government-community literacy programs.
Sulawesi	South Sulawesi	50.97	Integration of digital tourism, inclusive digital literacy campaigns for creative workers.
Papua	Papua	43.24	Lowest literacy score; challenges in internet access, socio-economic limitations, and human capital readiness.

Table 1 shows the comparative digital literacy score of six provinces. The western and central regions are reportedly outperforming the eastern Indonesian regions. North Sumatra, a province situated on the island of Sumatra, has achieved a digital literacy score of 44.69. The ongoing advancement in literacy is supported by the presence of strong academic institutions and digital initiatives led by small and medium-sized enterprises (SMEs) in Medan. West Java, recognized as the most populous province on Java Island, boasts a digital literacy score of 52.37, marking it as the highest performer in the country. This success is attributed to well-established e-learning ecosystems and the networks of the Relawan TIK community. East Kalimantan is undergoing significant development due to the new capital (IKN) project; however, it still faces challenges regarding rural access, yet it maintains a relatively high digital literacy score of 50.80.

South Sulawesi has a digital literacy index of 51.42, reflecting the progress made through local initiatives supported by digital education at UNHAS and partnerships between local government and communities. In contrast, Bali's digital literacy index stands at 50.97, a result of digital adoption spurred by tourism and training programs within the creative industry. These regions benefit from enhanced institutional capacity and program continuity, which previous literature has identified as essential factors for

the adoption of digital skills [3]. Representing eastern Indonesia, Papua Province exhibits a comparatively low digital literacy index of 43.23, a situation exacerbated by limited connectivity, linguistic diversity, and a lack of local digital educators. This observation aligns with findings from [6], which emphasize that infrastructure alone does not ensure effective digital adoption, particularly in areas facing socio-economic challenges.

Regional patterns indicate that Java functions as Indonesia's digital center, showcasing the concentration of infrastructure, institutions of higher education, and government initiatives. Emerging regions such as Sumatra and Sulawesi demonstrate a trend towards decentralized development and local digital ecosystems, symbolizing the rise of secondary digital hubs. Bali exemplifies the integration of literacy through its tourism sector. The creative economy is pivotal in fostering digital adoption within the province. Furthermore, Bali's amalgamation of tourism, creative industries, and e-commerce literacy signifies a sustainable approach to digital skill enhancement.

Although the establishment of Indonesia's new capital (IKN) indirectly affects the readiness for digital literacy, East Kalimantan remains linked to industrial transformations related to this urban development. Consequently, the uneven access in rural areas underscores the necessity for localized digital inclusion strategies. In contrast, Papua illustrates the persistent gap between infrastructure availability and the effective utilization of skills. The performance of Papua suggests that without ongoing mentorship, local advocates, and content tailored to local languages, infrastructure, and cultural adaptation alone are insufficient.

Table 2. Relationship of Digital Literacy with Spatial and Socio-Demographic Factors

Variable	Description	Pearson Correlation Coefficient (r)	Interpretation
Infrastructure & Ecosystem [1]	Equitable access to digital infrastructure	0.83	Very strong positive – better infrastructure is strongly associated with higher digital literacy
Jobs [1]	Availability and growth of digital-related jobs and digital economy opportunities	0.78	Strong positive – provinces with better digital jobs index tend to have higher literacy
Empowerment [1]	% digital for productive purposes	0.55	Moderate–strong positive – empowerment (usage for productive purposes) supports literacy.
Internet Penetration Rate [20]	% of households with internet access	0.65	Strong positive – higher internet access relates clearly to higher digital literacy
Education Level [21]	Mean years of schooling (age 15+)	-0.65	Strong negative – quite surprising; provinces with slightly higher average schooling in your sample do not necessarily have higher IMDI Digital Literacy scores. It could be a data pattern specific to these 6 provinces.
Gender Participation [22]	% of women participating in digital training	-0.31	Moderate negative – in this small dataset, higher gender participation % is not yet aligned with higher literacy (this may need deeper interpretation).
Regional Income per Capita [23]	Average income per resident (IDR/month)	0.21	Weak to moderate correlation – economic status affects but does not determine literacy.

As seen in Table 2, correlation analysis demonstrates that infrastructure and ecosystems (r = 0.83) exhibit an extremely strong correlation, reflecting the digital literacy levels across six chosen provinces in the sample. This is succeeded by jobs (r = 0.78), internet penetration (r = 0.65), and education (r = -0.65), which also act as relatively strong predictors of digital literacy. Meanwhile, empowerment, which represents community engagement (r = 0.55), indicates a moderate effect on the level of digital literacy. Following this, gender participation (r = -0.31) and income (r = 0.21) show moderate to weak associations, suggesting that social inclusion policies and local financial income are less impactful in shaping digital literacy. The significance of gender disparity is also reduced. These results emphasize that the sustainable improvement of literacy depends not only on digital infrastructures and ecosystems but also on job opportunities, internet access, and education. Infrastructure remains a critical condition for digital inclusion, yet the jobs indicator reveals that areas with greater digital employment opportunities tend to foster stronger digital skills. Access to digital jobs can encourage households to invest in skill development, consistent with patterns observed in internet penetration. If access to technology is concentrated among wealthier groups, the digital era may intensify inequality rather than mitigate it. Those equipped with skills and access will benefit more, while others may be left further behind [6].

Several findings presented above also deviate from the original assumptions. The level of education exhibits a negative correlation. Within this limited sample, provinces that have a greater number of years of schooling do not necessarily achieve higher scores in digital literacy. One possible explanation for this phenomenon could be that the measure reflects the overall duration of education rather than the extent of exposure to digital education. For example, provinces with a lengthy average duration of schooling may still function within traditional educational frameworks that incorporate minimal digital tools. Furthermore, gender participation reveals moderate negative correlations as well. This does not suggest that the involvement of women diminishes digital literacy; instead, it may imply that provinces with higher female participation are frequently those that receive targeted interventions due to pre-existing disparities. These varied patterns underscore a significant implication. Addressing the digital divide cannot solely depend on demographic enhancements, such as extended schooling or increased training participation. Indonesia requires localized support systems and contextually relevant learning materials. These deficiencies highlight the necessity for a community-focused model that prioritizes local circumstances.

5 Future Research Direction

This research presents a framework intended for a prospective research agenda, referred to as the Community-Driven Digital Literacy Acceleration (CD-DLA) Framework. This model promotes digital inclusion through four strategic pillars: (1) Local Mapping – the identification of region-specific literacy requirements that can be derived from internet penetration and the socio-demographic conditions of a particular area, such as gender participation and regional income per capita; (2) Collaborative Hubs – partnerships among Komdigi, local governments, and digital communities, which can be illustrated by the infrastructure and ecosystem, as well as the empowerment and

employment opportunities provided by the government and digital communities, exemplified by the Garuda Spark initiative [24]; (3) Microtraining & Mentorship – practical learning customized to local contexts, as demonstrated by the national Digital Talent Scholarship (DTS) program [25], which can be tailored according to the educational level of the specific region; and (4) IMDI-Based Monitoring – ongoing assessment to guide policy and resource distribution. This strategy is in alignment with Indonesia's vision for digital inclusive development, "Digital Indonesia 2045", which emphasizes three primary agendas: inclusivity, empowerment, and sustainability [26].

6 Conclusion

The findings from IMDI 2025 indicate that Indonesia has made significant strides in digital literacy. However, our analysis indicates that this advancement is not uniform; certain regions are distinctly more advanced, while others fall behind. This disparity is evident not only in terms of infrastructure and access but also in the manner in which individuals utilize digital tools, the availability of employment opportunities, and the equity of community engagement.

To effectively reduce the digital divide issue, it is insufficient to depend solely on infrastructure or to presume that broader socio-economic improvements will inherently lead to enhanced digital skills. A crucial takeaway from this research is the absence of a comprehensive expansion program. Areas facing more profound structural challenges necessitate more than just standardized training initiatives. Consequently, bridging the digital divide requires the implementation of the CD-DLA model and ongoing assessment utilizing IMDI indicators. Integrating this methodology into both regional and national strategies can facilitate the conversion of investments—whether in infrastructure, training, or other educational initiatives—into tangible advancements.

Thus, realizing Indonesia's digital transformation and achieving the Vision 2045 objectives demands a comprehensive approach, which includes the enhancement of ICT infrastructure, the rectification of measurement and sampling biases, the fortification of education and community-level training, and the maintenance of cross-sector collaboration. This ensures that all Indonesians, irrespective of their geographical location or socio-economic background, can cultivate substantial digital literacy and engage fully in the digital society.

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