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Telecommunication Accessibility and Local Economic Dynamics in Indonesia's 3T Regions

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Abstract

Background Telecommunication accessibility is a key driver of inclusive development, particularly in Indonesia's 3T (Disadvantaged, Frontier, and Outermost) regions, where geographical isolation and infrastructure limitations constrain economic opportunities. To reduce the digital divide, the Indonesian government has prioritized national programs such as the Palapa Ring and the deployment of Base Transceiver Stations (BTSs). This study examines how these initiatives influence telecommunication accessibility and local economic dynamics in East Nusa Tenggara (NTT).

Methods This study employed a qualitative case study approach. Data were collected through in-depth interviews with local government officials, telecommunication providers, community leaders, and end users, complemented by field observations and document analysis. The data were analyzed thematically to identify access conditions, structural challenges, and local economic responses to telecommunication development.

Results The findings indicate that expanding fiber-optic networks and BTS infrastructure has improved basic connectivity and reduced isolation in several 3T areas. Improved access supports micro, small, and medium enterprise activities, enhances access to digital education, and enables emerging digital-based livelihoods. However, benefits remain uneven due to persistent last-mile connectivity gaps, unstable network quality, low digital literacy, and limited affordability.

Conclusions Telecommunication infrastructure development in 3T regions is necessary but insufficient for inclusive local economic growth. Integrating infrastructure expansion with digital literacy programs, affordability support, and targeted last-mile interventions is essential to maximize socio-economic benefits.

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Introduction

The expansion of telecommunication infrastructure has become a central pillar of contemporary development strategies, particularly in the context of digital transformation, economic integration, and inclusive growth (Ndoen & Sayrani, 2024; Katz & Koutroumpis, 2018). From the perspective of development economics and infrastructure-led growth theory, telecommunication networks function as enabling infrastructure that reduces transaction costs, facilitates information flows, and expands market access across regions (Czernich et al., 2011; Van, 2020). Reliable telecommunication access enables the circulation of information, supports market connectivity, enhances productivity, and facilitates access to education, public services, and financial systems (World Bank, 2016; Goldfarb & Tucker, 2019). In developing countries with vast and heterogeneous territories, such as Indonesia, telecommunication infrastructure also plays a strategic role in reducing spatial inequality and strengthening national cohesion by integrating peripheral regions into national socio-economic systems (Foster & Briceño-Garmendia, 2019; ITU, 2022). However, despite significant progress at the national level, substantial disparities in telecommunication access persist, particularly in Indonesia's 3T regions (Disadvantaged, Frontier, and Outermost areas), indicating a structural gap between national infrastructure provision and localized accessibility outcomes (ITU, 2023).

Indonesia's 3T regions are characterized by complex geographical, demographic, and infrastructural conditions that pose unique challenges to telecommunication development. Many of these regions consist of archipelagic territories, mountainous landscapes, remote inland settlements, and sparsely populated areas that are difficult to serve through conventional infrastructure networks (Maneejuk & Yamaka, 2020). These physical constraints significantly increase the cost and complexity of deploying, maintaining, and operating telecommunication infrastructure (Estache & Fay, 2017; Foster et al., 2023). In infrastructure development theory, such conditions represent high fixed-cost environments with limited economies of scale, making market-based investment less attractive (OECD, 2021). As a result, telecommunication development in 3T regions is not merely a technical issue but a multidimensional development problem shaped by geography, policy choices, investment dynamics, and local socio-economic conditions (UNESCAP, 2020). In this study, these dimensions are analytically operationalized through indicators of physical accessibility, infrastructure availability, service reliability, and socio-economic utilization.

Beyond geographical barriers, telecommunication development in 3T areas is further constrained by limited fiscal capacity, low commercial attractiveness for private operators, and regulatory frameworks that have not fully addressed the structural disadvantages of remote regions. Private telecommunication providers often perceive 3T regions as high-risk, low-return investment areas due to low population density, limited purchasing power, and high operational costs (Syafii, 2018; OECD, 2021). From a political economy and market failure perspective, this situation reflects the inability of private markets to deliver socially optimal infrastructure investment in peripheral regions (Mazzucato & Semieniuk, 2018). Consequently, market-based mechanisms alone have proven insufficient to deliver equitable access, necessitating stronger state intervention through public investment, universal service obligations, and targeted policy incentives (ITU & World Bank, 2020). These governance-related factors constitute an essential analytical dimension in evaluating telecommunication accessibility in this study.

In response to these challenges, the Indonesian government has implemented a range of national programs to reduce the digital divide, most notably the Palapa Ring Program. This program was designed to establish a national fiber optic backbone connecting all regions of Indonesia, with a total network length of approximately 57,077 kilometers. The Palapa Ring is intended to serve as the foundational layer of national connectivity, linking the western, central, and eastern regions of the country. Nevertheless, despite the completion of the backbone network, significant access gaps remain in many 3T areas, underscoring the conceptual distinction between backbone connectivity and effective end-user access (Pradhan et al., 2014; World Bank, 2021).

Empirical data illustrate the persistence of these disparities. According to the Ministry of Communication and Informatics (Kominfo), as of 2023, approximately 12,548 villages and sub-districts across Indonesia still lacked 4G network coverage. The highest concentration of unserved areas is in Papua, with more than 6,000 villages, followed by Maluku, East Nusa Tenggara (NTT), and several parts of Kalimantan (Handoko, 2023). In many of these locations, communities continue to rely on outdated 2G networks or experience a complete absence of cellular signals, severely limiting their ability to participate in the digital economy (ITU, 2023). In this study, such conditions are treated as indicators of structural digital exclusion rather than temporary connectivity gaps.

Figure 1. Base Transceiver Stations

Source: Google (2025)

The persistence of limited access despite national backbone development highlights a critical structural issue: the gap between backbone connectivity and last-mile service delivery. While fiber-optic infrastructure connects major nodes at the national and regional levels, effective end-user access depends on the availability and functionality of supporting infrastructure, such as Base Transceiver Stations (BTS), a stable electricity supply, and adequate transportation networks (Broadband Commission, 2019; Galperin & Ruzzier, 2022). The Telecommunication and Information Accessibility Agency (BAKTI) has set a target of constructing 7,904 BTS units in 3T areas as part of its mandate to fulfill its universal service obligation. However, by mid-2023, only around 50% of this target had been realized,

indicating slow progress in addressing last-mile connectivity challenges. In analytical terms, this study treats last-mile connectivity as a core indicator linking infrastructure provision to actual accessibility.

Moreover, reports from BAKTI Kominfo emphasize that even when BTS facilities are constructed, they do not always function optimally due to unreliable electricity supply, high fuel costs, and logistical constraints in remote areas (Prasetyo, 2019). These conditions demonstrate that telecommunication infrastructure development in 3T regions is deeply intertwined with broader deficits in basic infrastructure, including energy and transportation, and cannot be addressed in isolation. Accordingly, infrastructure functionality and service continuity are incorporated as key indicators in assessing telecommunication accessibility.

A growing body of academic literature has examined telecommunication development in disadvantaged and remote regions, identifying key structural barriers and policy challenges. Syafii (2018) argues that geographical constraints and low return on investment (ROI) remain the primary deterrents for private telecommunication operators in 3T areas. Similarly, Dalimunthe (2025) finds that limited electricity supply and weak supporting infrastructure significantly hinder the provision and sustainability of telecommunication services, particularly in Papua and Maluku. Other studies emphasize the importance of policy incentives, subsidies, and public–private partnerships in mitigating investment risks and accelerating network expansion (Pratiwi & Purnama, 2022; ITU & World Bank, 2020). These studies inform the theoretical grounding and indicator selection used in this research.

Despite these contributions, existing studies exhibit several important limitations. First, much of the literature addresses telecommunication development from predominantly technical or geographical perspectives, often treating social, economic, and institutional dimensions as secondary factors (UNESCAP, 2020). Second, many studies adopt macro-level approaches, relying heavily on national statistics and aggregated indicators that obscure variations in access quality and user experience at the local level (Galperin & Ruzzier, 2022). Third, empirical research that systematically incorporates end-user perspectives, particularly those of communities living in remote villages, remains limited. This study addresses these gaps by employing accessibility, usability, and socio-economic utilization as interconnected analytical indicators.

The consequences of limited telecommunication access in 3T regions extend far beyond communication itself. Information isolation restricts communities' ability to access broader markets, obtain timely price information, and identify economic opportunities beyond their immediate surroundings. This constraint undermines the competitiveness of local products and limits the scalability of micro, small, and medium-sized enterprises (MSMEs) (De Stefano et al., 2018; Hjort & Poulsen, 2019). As digital platforms increasingly shape production, distribution, and consumption processes, limited connectivity places 3T regions at a structural disadvantage within the national economy (Goldfarb & Tucker, 2019; Welfare et al., 2024). In this study, MSME engagement and market access function as indicators of local economic impact.

Furthermore, inadequate telecommunication access hampers the development of the digital economy, including e-commerce, digital financial services, and online entrepreneurship (UNCTAD, 2021). Many communities in 3T regions are unable to utilize these platforms

effectively, preventing the full realization of local economic potential and widening disparities with urban areas. Limited connectivity also reduces the attractiveness of these regions for external investment due to high communication barriers and logistical costs. In addition, restricted access to online education and digital skills training constrains human capital development, reinforcing cycles of low productivity and economic marginalization (World Bank, 2020). These dynamics constitute the socio-economic dimension of the analytical framework applied in this study.

These conditions underscore the importance of telecommunication infrastructure as a strategic driver of inclusive development rather than merely a technical asset. Improving access in 3T regions has the potential to open new economic opportunities, expand markets for MSMEs, enhance productivity, and support digital transformation. However, achieving these outcomes requires more than infrastructure expansion alone; it demands an integrated approach that simultaneously addresses social readiness, economic capacity, and policy effectiveness.

Against this backdrop, this study seeks to address several critical research gaps by explicitly grounding its analysis in a multidimensional theoretical framework. First, it examines telecommunication development through technical, geographical, social, economic, and governance lenses simultaneously. Second, it prioritizes empirical insights from selected 3T regions by incorporating perspectives from local governments, telecommunication providers, and end users to capture lived experiences of access and utilization. Third, the study critically assesses the extent to which national programs such as the Palapa Ring translate into meaningful local benefits, particularly in relation to last-mile connectivity indicators and local economic outcomes. Finally, it contributes to the limited body of field-based research that evaluates the effectiveness of policy interventions and public–private partnerships in reducing structural digital divides.

Accordingly, this study is guided by the following research questions:

1. What structural, technical, and socio-economic challenges affect telecommunication accessibility in Indonesia's 3T regions?
2. How do existing telecommunication development programs, particularly the Palapa Ring and BTS deployment, influence access and utilization at the local level?
3. What are the implications of telecommunication accessibility for local economic activities, especially MSMEs and digital-based livelihoods in 3T areas?

By addressing these questions, this study aims to contribute to academic debates on digital inequality, infrastructure-led development, and regional disparities, while also providing policymakers with evidence-based insights. Ultimately, improving equitable telecommunication access in 3T regions is essential not only for narrowing the digital divide but also for fostering sustainable and inclusive economic growth across Indonesia.

Methods

This study adopts a qualitative case study approach to examine telecommunication accessibility and development challenges in Indonesia's 3T (Disadvantaged, Frontier, and Outermost) regions. A qualitative case study is appropriate for analyzing complex socio-technical phenomena shaped by interactions between infrastructure provision, geographical

constraints, policy frameworks, and social capacities (Yin, 2018; Creswell & Poth, 2018). In the context of 3T regions, telecommunication development cannot be adequately captured through aggregate indicators alone, as access quality, usability, and socio-economic impacts vary significantly across local settings and social groups.

The research was conducted in **purposively selected 3T** locations to ensure analytical relevance rather than statistical generalizability (Patton, 2015). Site selection was guided by three criteria: (1) geographical diversity (archipelagic and inland rural settings), (2) variation in levels of telecommunication access, and (3) exposure to national telecommunication programs, particularly Palapa Ring and BTS USO. The selected cases include two to three districts officially classified as 3T areas, with one focal village in **Kupang Regency, East Nusa Tenggara (NTT)**, representing a typical 3T context characterized by dispersed settlements, limited supporting infrastructure, and partial connectivity.

Informants were selected using purposive and criterion-based sampling to capture multiple perspectives relevant to telecommunication development and utilization. A total of 25 informants were involved, comprising district-level government officials, village authorities, telecommunication operators, community leaders, and end users. This multi-actor sampling strategy enabled triangulation across governance, provider, and user perspectives and ensured information-rich cases rather than numerical representativeness. The categories of informants, number of participants, and rationale for their selection are presented in Table 1.

Table 1. Research Informants, Sampling Technique, and Selection Rationale

Informant Category	Number of Informants	Sampling Technique	Rationale for Selection
District-Level Government Officials (Planning, ICT, Public Services)	5	Purposive sampling	Direct involvement in policy planning, coordination, and implementation of telecommunication development programs in 3T areas
Village Government Officials (Village Head and Staff)	4	Purposive sampling	Responsible for local governance and first-level implementation; possess detailed knowledge of village-level access conditions
Telecommunication Service Providers / Operators	3	Purposive sampling	Hold technical and operational knowledge regarding BTS deployment, maintenance, and service constraints
Community Leaders (customary/religious/youth	4	Purposive & criterion-	Represent collective community perspectives and

representatives)		based sampling	social dynamics influencing technology adoption
Community Members / End Users	9	Purposive sampling	Direct users of telecommunication services with diverse socio-economic backgrounds and usage patterns
Total Informants	25	—	Ensures multi-level, multi-actor, and information-rich perspectives

Source: Primary Data, 2025

Data were collected through in-depth semi-structured interviews, field observations, and document analysis, allowing methodological triangulation and enhanced analytical depth (Denzin, 2012). Interviews explored infrastructure provision, service reliability, utilization patterns, and perceived socio-economic impacts. Field observations assessed infrastructure conditions, signal availability, and electricity supply, while document analysis reviewed relevant regulations and official reports related to Palapa Ring and BTS USO programs. Data were analyzed using thematic analysis through iterative coding and interpretation of interview transcripts, observation notes, and documents (Braun & Clarke, 2019). Triangulation across data sources and informant categories was employed to enhance credibility and reduce interpretive bias. This analytical process enabled the identification of recurring patterns, structural constraints, and conditional outcomes shaping telecommunication accessibility and local economic dynamics in 3T regions.

Results and Discussion

Uneven Telecommunication Accessibility in 3T Regions: Empirical Conditions and Structural Barriers

Based on interviews, field observations, and document analysis conducted across several 3T (Disadvantaged, Frontier, and Outermost) regions, this study confirms that telecommunication accessibility remains highly uneven and structurally constrained. From the perspective of digital divide theory, this condition reflects a first-level digital divide, where disparities are rooted in unequal physical and infrastructural access rather than merely differences in usage (Van Dijk, 2020; ITU, 2022). Although national connectivity indicators suggest steady progress, empirical realities in Papua, Maluku, and East Nusa Tenggara (NTT) indicate that digital access at the local level remains far from equitable. Many villages continue to lack 4G coverage, while others experience highly unstable signals that severely limit meaningful internet use. In several remote locations, communities remain entirely disconnected from cellular networks, reinforcing long-standing patterns of spatial, social, and economic marginalization (World Bank, 2021; Galperin & Ruzzier, 2022).

Importantly, the findings indicate that inequality in telecommunication access is not merely inter-regional but also intra-regional and even intra-village. This intra-spatial variation corresponds to what recent studies conceptualize as micro-level digital exclusion, in which connectivity is unevenly distributed within small geographic units due to topography, infrastructure placement, and settlement patterns (OECD, 2021; UNESCAP, 2020). Within

the same village, access to telecommunication services may differ sharply depending on distance from BTS locations, elevation, or proximity to administrative centers. This spatial fragmentation of access creates what can be described as "micro digital enclaves," where connectivity is concentrated in limited zones while surrounding households remain digitally excluded. Such conditions challenge the normative assumption of universal service coverage and illustrate that telecommunication access in 3T regions remains conditional upon physical mobility and spatial privilege.

From an analytical standpoint, physical accessibility and spatial reach emerge as primary indicators of telecommunication inequality in the studied regions. Field observations show that residents in remote hamlets often must travel several hundred meters or even kilometers to reach locations with a stable signal, such as hilltops, roadsides, or areas near government offices. This pattern transforms connectivity into a location-bound resource rather than a household-level service. Consistent with infrastructure accessibility frameworks, access that requires physical displacement carries implicit opportunity costs in terms of time, labor, and safety (Foster et al., 2023). These costs disproportionately burden elderly individuals, women, people with disabilities, and economically inactive groups, thereby reproducing existing social vulnerabilities.

Interviews with local government officials and telecommunication operators consistently identify geographical constraints as the dominant structural barrier to infrastructure deployment. Mountainous terrain, limited road access, dispersed island settlements, and high exposure to extreme weather significantly increase both initial investment and long-term maintenance costs (Estache & Fay, 2017; OECD, 2021). In archipelagic settings, the construction and maintenance of BTS infrastructure require complex logistics involving maritime transport, heavy machinery, and extended project timelines. These logistical challenges frequently result in delays, cost overruns, and, in some cases, compromises in infrastructure quality. Such findings align with the infrastructure-led development literature, which emphasizes that geographic disadvantage systematically raises the marginal cost of service provision in remote regions (Foster & Briceño-Garmendia, 2019).

Beyond physical geography, the reliability of telecommunication services constitutes a second critical indicator shaping effective access. Digital connectivity in 3T regions is characterized not only by limited coverage but also by high variability in signal stability and service continuity, particularly during peak usage hours or adverse weather conditions. Many respondents reported that internet access fluctuates substantially across time, with congestion during evenings rendering services practically unusable. Research on quality-of-service dimensions highlights that unstable connectivity undermines functional access even when nominal coverage exists (Broadband Commission, 2019; Galperin & Ruzzier, 2022).

A major contributor to service unreliability is the limited availability of a stable electricity supply. Many BTS facilities in the 3T regions rely on diesel generators because grid electricity is unavailable. High fuel costs, supply chain disruptions, and logistical delays often result in reduced operating hours or temporary shutdowns. Previous studies demonstrate that energy insecurity is a decisive constraint on telecommunication performance in remote and rural settings (OECD, 2021; ITU, 2022). Field observations confirmed several cases in which BTS towers had been physically constructed but remained nonoperational due to power shortages or inadequate maintenance capacity. This condition illustrates that telecommunication infrastructure in 3T regions is deeply embedded within a broader ecosystem of basic

infrastructure deficits, where weaknesses in energy and transport systems directly undermine digital connectivity (Prasetyo, 2019).

Finally, these findings demonstrate that uneven telecommunication accessibility in 3T regions is best understood as a structural condition shaped by spatial, infrastructural, and service-quality constraints, rather than as a temporary lag in implementation. By aligning empirical evidence with indicators of physical accessibility, spatial reach, and reliability, this study provides a grounded explanation for why aggregate improvements in national connectivity statistics do not automatically translate into equitable access at the community level.

Palapa Ring and BTS Deployment: Progress, Performance, and the Last-Mile Gap

The development of telecommunications infrastructure in East Nusa Tenggara through the Palapa Ring program and large-scale BTS deployment represents one of the most ambitious national interventions to reduce regional connectivity disparities. From an infrastructure-led development perspective, Palapa Ring embodies a state-driven strategy to correct spatial market failure by providing backbone infrastructure in regions that are commercially unattractive for private operators (Foster & Briceño-Garmendia, 2019; ITU & World Bank, 2020). By the end of 2022, approximately 427 BTS had been constructed across NTT, primarily targeting villages previously categorized as blank spots. In parallel, the Palapa Ring East segment has installed approximately 4,450 kilometers of fiber-optic cable, forming the backbone of telecommunication connectivity for eastern Indonesia.

Empirically, these initiatives have reduced absolute isolation in a number of previously disconnected areas. Communities that previously relied on radio communication, sporadic courier services, or physical travel for coordination now possess at least intermittent access to voice and data services. Public institutions such as schools, health centers, and village offices report improved communication capacity, particularly for administrative coordination, access to government platforms, and interactions with district- and provincial-level agencies. These improvements are consistent with empirical findings showing that basic connectivity can enhance administrative efficiency and service coordination in remote regions (World Bank, 2020; UNESCAP, 2020). For local governments, improved connectivity has facilitated compliance with reporting obligations, digital data submission, and participation in national e-government systems.

However, despite these notable achievements, this study finds that the performance and quality of telecommunication services remain uneven and fragile at the local level. When assessed using indicators of service reliability and effective usability, the benefits of infrastructure expansion appear significantly constrained. Many remote villages continue to experience unstable signals, limited bandwidth, and frequent network disruptions, particularly during peak usage hours (Nasution et al., 2024). Interview data reveal that connectivity quality fluctuates significantly by time of day, with congestion during evenings rendering internet access effectively unusable for education, business activities, or public administration. This pattern aligns with the quality-of-service literature, which emphasizes that nominal access without adequate bandwidth and stability fails to produce meaningful digital inclusion (Broadband Commission, 2019; Galperin & Ruzzier, 2022).

A central analytical issue emerging from the findings is the persistence of the "last-mile" connectivity problem. While fiber-optic networks connect provincial and district-level

nodes, connectivity at the village and household levels depends primarily on wireless transmission via BTS infrastructure that is unevenly distributed and inconsistently maintained. In infrastructure theory, last-mile connectivity is the most expensive and technically challenging segment of network expansion, particularly in low-density, geographically fragmented regions (OECD, 2021). Field evidence shows that even when backbone connectivity is available, last-mile limitations severely limit everyday user experiences. This situation produces a structural paradox: national connectivity indicators improve in aggregate statistics, yet lived experiences of access remain constrained and unreliable.

Interviews with telecommunication operators and local officials indicate that last-mile challenges are driven by a combination of technical, financial, and institutional factors. BTS placement decisions are heavily influenced by terrain, land availability, and cost considerations, resulting in uneven spatial coverage within villages. Maintenance capacity is also limited due to logistical constraints, human resource shortages, and the high cost of servicing remote facilities. These findings are consistent with studies showing that last-mile failures are rarely purely technical problems but are deeply embedded in governance capacity and resource allocation decisions (ITU, 2022; Foster et al., 2023).

The energy dimension further exacerbates last-mile fragility. Many BTS facilities in NTT rely on diesel generators because grid electricity is unavailable. High fuel prices, transport delays, and equipment maintenance issues frequently disrupt service continuity. International experience indicates that unreliable energy supply significantly increases downtime and reduces the cost-effectiveness of telecommunication investments in remote areas (OECD, 2021). Field observations confirmed several cases in which BTS infrastructure was physically present but failed to deliver consistent service due to power shortages or generator malfunctions. This condition reinforces the argument that last-mile connectivity cannot be treated in isolation from broader infrastructure ecosystems.

From an analytical standpoint, the Palapa Ring program functions as a necessary but insufficient condition for effective digital inclusion in 3T regions. While backbone infrastructure is essential for enabling network extension, its developmental impact depends on complementary investments in last-mile distribution, energy reliability, and maintenance systems. As argued by Maneejuk and Yamaka (2020), the economic and social returns from telecommunication infrastructure depend on effective access, service quality, and sustained utilization rather than mere infrastructure availability.

Importantly, the findings suggest that infrastructure expansion without sufficient attention to service quality risks generating diminishing marginal returns. Residents who experience unstable or intermittent connectivity often revert to traditional communication practices and limit their digital engagement to essential or sporadic activities. This behavioral adaptation illustrates how unreliable connectivity undermines trust in digital infrastructure, reducing incentives for productive use (Van Dijk, 2020). Consequently, investments in backbone and BTS infrastructure may fail to translate into proportional gains in education outcomes, economic productivity, or public service effectiveness.

The persistence of the last-mile gap also has important implications for equity. Villages or households located closer to BTS installations or administrative centers benefit more consistently from improved connectivity, while peripheral hamlets remain disadvantaged.

This spatially uneven distribution of service quality reproduces intra-community inequalities and creates localized hierarchies of digital privilege (OECD, 2021; Galperin & Ruzzier, 2022). Rather than eliminating the digital divide, large-scale infrastructure programs may inadvertently reshape it into subtler, more localized forms.

Taken together, these findings indicate that telecommunications development in 3T regions cannot be evaluated solely by indicators of infrastructure rollout, such as kilometers of fiber-optic cable or the number of BTS towers. When analyzed through indicators of last-mile connectivity and service reliability, the limitations of current interventions become evident. The Palapa Ring has significantly reduced absolute isolation and laid the foundation for connectivity, but without sustained investment in local distribution networks, energy systems, and maintenance capacity, its transformative potential remains constrained.

In this sense, the last-mile gap should be understood not as a temporary implementation delay but as a structural bottleneck inherent to telecommunication development in geographically disadvantaged regions. Addressing this bottleneck requires a shift from infrastructure-centric planning toward an integrated model that prioritizes service quality, sustainability, and user experience as core performance indicators. Without such a shift, national connectivity gains risk remaining largely symbolic, translating into statistical improvements without commensurate advances in everyday digital inclusion.

Telecommunications, Local Economic Dynamics, and Conditional Developmental Outcomes

The expansion of telecommunication infrastructure in East Nusa Tenggara has begun to yield observable economic effects, particularly in relation to micro, small, and medium-sized enterprises (MSMEs). Improved connectivity enables certain local entrepreneurs to extend their market reach beyond immediate geographic boundaries, access price and demand information, coordinate logistics, and communicate with buyers and intermediaries. From an economic perspective, these findings are consistent with theories that conceptualize telecommunications as a transaction-cost-reducing infrastructure that can enhance market efficiency when minimum access thresholds are met (Hjort & Poulsen, 2019; De Stefano et al., 2018).

Field interviews with MSME actors indicate that digital platforms have facilitated the promotion of agricultural products, fisheries output, and small-scale processed goods via social media and messaging applications. Such engagement introduces new business opportunities that were previously inaccessible due to information asymmetry and high coordination costs. These results align with evidence suggesting that broadband access can generate productivity gains at the firm level, particularly for small enterprises operating in peripheral regions (World Bank, 2020; UNCTAD, 2021). However, the extent of benefit realization varies significantly across communities and social groups.

Connectivity has also supported the gradual adoption of digital financial services, including mobile banking, electronic payments, and digital wallets. For communities previously dependent on cash-based transactions and physical travel to banking facilities, access to digital finance reduces transaction costs, improves security, and enhances financial inclusion. Empirical studies show that the economic impact of telecommunications is amplified when combined with digital financial infrastructure, particularly in rural and underserved areas (Katz & Koutroumpis, 2018; World Bank, 2020). In agricultural and fisheries-based livelihoods, access to telecommunication services supports the use of weather forecasts, commodity price

updates, and coordination with buyers, contributing to incremental productivity gains and reduced uncertainty.

The education and public service sectors also exhibit emerging benefits from improved connectivity. Schools in connected villages have begun implementing digital examinations, online learning platforms, and electronic reporting systems. Teachers report improved access to learning materials, administrative resources, and professional networks, while students gain exposure to digital learning environments previously unavailable in remote settings. These developments reflect broader findings that digital connectivity can enhance service delivery and institutional capacity when infrastructure is paired with organizational readiness (UNESCO, 2021; World Bank, 2020). Public service delivery has improved through digital communication for data submission, administrative coordination, and access to government portals, contributing to greater efficiency and transparency (Tri et al., 2024).

Despite these positive trends, the distribution of economic and social benefits remains highly uneven and conditional. Digital inequality literature emphasizes that connectivity does not automatically produce inclusive growth; rather, its impact is mediated by complementary assets such as human capital, affordability, and institutional support (Goldfarb & Tucker, 2019; Van Dijk, 2020). Many households in 3T regions lack smartphones capable of supporting productive digital activities, while others share a single device among multiple family members. High data costs further constrain sustained engagement with digital platforms. As a result, the benefits of telecommunication access are often captured by a relatively small segment of the population, typically younger, more educated, or economically active individuals, reinforcing intra-community inequalities (Nasution et al., 2024).

Digital Literacy, Affordability, and Social Readiness as Mediating Factors

From a social and human capital perspective, low levels of digital literacy are among the most significant constraints on the transformative potential of telecommunication infrastructure in 3T regions. Field observations and interview data reveal that many residents remain unfamiliar with basic digital competencies, such as information search, online communication, digital transactions, and content verification. Human capital theory suggests that infrastructure-driven development yields limited returns in the absence of user capabilities to absorb and utilize new technologies productively (World Bank, 2020; OECD, 2021).

Digital skills are unevenly distributed across demographic groups. Younger residents and individuals with higher educational attainment demonstrate greater adaptability to digital technologies, whereas older residents and those with limited formal education often perceive digital tools as complex, risky, or irrelevant to their livelihoods. This generational and educational divide mirrors second-level digital divide dynamics, in which inequalities arise not only from access alone but also from differential skills and usage patterns (Van Dijk, 2020). Such disparities constrain inclusive participation in the digital economy and exacerbate existing gender and age-based inequalities, particularly affecting women and elderly populations.

Affordability constitutes an additional barrier to effective utilization. High device prices and data costs remain prohibitive for low-income households, even in areas with functional BTS infrastructure. Empirical studies indicate that affordability constraints transform connectivity into a selective resource rather than a universal public good, particularly in low-

income and peripheral regions (OECD, 2021; ITU, 2022). As Dalimunthe (2025) emphasizes, limited economic capacity remains a key determinant of persistent digital exclusion in Indonesia's eastern regions.

Government and donor-supported digital literacy programs exist but remain fragmented, short-term, and insufficiently integrated with local economic contexts. Training initiatives often focus on basic technical skills without sustained follow-up, mentoring, or alignment with livelihood strategies. Without continuous capacity-building and contextual adaptation, such interventions fail to produce durable behavioral change or economic empowerment (UNESCAP, 2020; Pradhan et al., 2024). Consequently, telecommunication infrastructure risks becoming an underutilized asset rather than a catalyst for structural transformation.

Policy, Governance, and the Multidimensional Nature of the Digital Divide

From a policy and governance perspective, the findings reveal a persistent misalignment between infrastructure deployment strategies and community-level outcomes. While national programs such as Palapa Ring prioritize infrastructure outputs, such as the number of BTS installations or kilometers of fiber optic cable, less attention is given to service quality, sustainability, and user experience. The governance literature underscores that infrastructure-focused metrics alone provide an incomplete measure of development success when not coupled with outcome-oriented indicators (ITU & World Bank, 2020; OECD, 2021).

Respondents consistently reported weak coordination between central and local governments in monitoring service performance and responding to operational issues. Feedback mechanisms remain limited, and local governments often lack formal authority or resources to address service disruptions. These institutional gaps constrain adaptive governance and reduce the responsiveness of telecommunication policy to localized needs (Galperin & Ruzzier, 2022).

Private sector participation in 3T regions remains limited due to high operational risks, low population density, and constrained purchasing power. Without adequate subsidies, risk-sharing mechanisms, or regulatory flexibility, telecommunication operators have little incentive to invest beyond minimum universal service obligations. These findings corroborate earlier studies that emphasize that telecommunications development in structurally disadvantaged regions cannot rely solely on market mechanisms and requires sustained state intervention (Syafii, 2018; ITU, 2022).

Taken together, the results demonstrate that telecommunication accessibility in 3T regions is a multidimensional phenomenon shaped by technical infrastructure, service reliability, human capacity, affordability, and governance arrangements. Consistent with infrastructure-led development and digital divide theories, connectivity functions as a necessary but insufficient condition for inclusive socio-economic transformation (Foster & Briceño-Garmendia, 2019; Maneejuk & Yamaka, 2020). Infrastructure expansion through Palapa Ring and BTS deployment has reduced absolute isolation, but persistent last-mile gaps, low digital literacy, affordability constraints, and governance weaknesses continue to limit developmental impact.

Connectivity in 3T regions should therefore be understood not as a binary state of "connected" versus "unconnected," but as a graduated spectrum of access, quality, and

usability. This layered understanding helps explain why improvements in national connectivity statistics are not always accompanied by proportional gains in local productivity or welfare. Field evidence shows that, in the absence of complementary investments in human capital and institutional support, connectivity tends to be used passively or consumption-oriented rather than as a driver of value creation.

Furthermore, uneven digital transformation generates new forms of inequality within communities. Individuals with greater access to devices, skills, and networks become early adopters who disproportionately capture connectivity benefits, while vulnerable groups remain excluded. This pattern illustrates how digital divides can be actively reproduced through uneven development processes rather than merely inherited from structural underdevelopment (Pradhan et al., 2024; Van Dijk, 2020).

From a governance perspective, the findings underscore the limitations of policy approaches that prioritize physical infrastructure indicators over service quality and user experience. Without robust feedback mechanisms, intergovernmental coordination, and adaptive regulation, gaps between national planning objectives and local realities are likely to persist. Sustained state intervention remains essential to ensure that telecommunication development in 3T regions is guided not solely by market logic but also by principles of social equity and inclusive development (Syafii, 2018; Dalimunthe, 2025).

Finally, telecommunication development in 3T regions must be positioned as an integral component of inclusive national development strategies. Digital infrastructure expansion should be systematically integrated with human capacity-building initiatives, affordability mechanisms, and governance reforms responsive to local contexts. Without such integration, connectivity risks remaining a statistical symbol of progress rather than a catalyst for substantive and sustainable socio-economic transformation.

Conclusion

This study concludes that the development of telecommunication infrastructure in Indonesia's 3T (Disadvantaged, Frontier, and Outermost) regions continues to face complex and structural challenges. Despite substantial national investments through programs such as the Palapa Ring and BTS deployment, equitable, reliable, and sustainable access has not yet been fully realized at the community level. Geographical constraints, inadequate supporting infrastructure, particularly electricity supply, high operational and maintenance costs, and persistent weaknesses in last-mile connectivity have created a gap between national infrastructure achievements and the everyday digital experiences of local communities.

The findings further demonstrate that improvements in backbone infrastructure do not automatically translate into meaningful access or inclusive socio-economic benefits. Network quality in many 3T areas remains unstable and spatially uneven, limiting the use of telecommunication services for productive activities. Low levels of digital literacy, limited household economic capacity, and affordability constraints significantly limit effective use, resulting in benefits captured by a relatively small, more advantaged segment of the population. As a result, telecommunication expansion risks reproducing existing inequalities and generating new forms of digital disparity if complementary social and institutional factors are not addressed.

This study contributes to the literature by offering an integrated analytical perspective that links infrastructure expansion, last-mile connectivity, social readiness, and governance within a single framework grounded in empirical evidence from 3T regions. While the qualitative case study approach limits generalizability, the findings highlight the conditional nature of the relationship between telecommunication infrastructure and local economic development. Future research should adopt mixed-method and longitudinal designs to assess long-term impacts and evaluate the effectiveness of policy instruments, digital literacy programs, and public–private partnership models in fostering more inclusive and sustainable digital development in marginalized regions.

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References

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Broadband Commission for Sustainable Development. (2019). *Broadband for sustainable development: Broadening the benefits*. International Telecommunication Union & UNESCO.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). SAGE Publications.

Czernich, N., Falck, O., Kretschmer, T., & Woessmann, L. (2011). Broadband infrastructure and economic growth. The Economic Journal, 121(552), 505–532. https://doi.org/10.1111/j.1468-0297.2011.02420.x

Dalimunthe, A. (2025). Infrastructure constraints and digital exclusion in eastern Indonesia: Evidence from Papua and Maluku. Journal of Regional Development Studies, 17(1), 45–62.

De Stefano, T., Kneller, R., & Timmis, J. (2018). Broadband infrastructure, ICT use, and firm performance: Evidence for United Kingdom firms. Journal of Economic Behavior & Organization, 155, 110–139. https://doi.org/10.1016/j.jebo.2018.08.020

Denzin, N. K. (2012). Triangulation 2.0. Journal of Mixed Methods Research, 6(2), 80–88. https://doi.org/10.1177/1558689812437186

Estache, A., & Fay, M. (2017). Current debates on infrastructure policy. World Bank Policy Research Working Paper No. 8380.

Foster, V., & Briceño-Garmendia, C. (2019). Infrastructure for growth and human development in Africa. World Bank Group.

Foster, V., Rana, A., & Chhabra, R. (2023). Infrastructure access and spatial inequality in low-density regions. World Development, 164, 106168. https://doi.org/10.1016/j.worlddev.2022.106168

Galperin, H., & Ruzzier, C. A. (2022). Digital inclusion and connectivity gaps: The last-mile challenge. Telecommunications Policy, 46(4), 102282. https://doi.org/10.1016/j.telpol.2021.102282

Goldfarb, A., & Tucker, C. (2019). Digital economics. Journal of Economic Literature, 57(1), 3–43. https://doi.org/10.1257/jel.20171452

Handoko, R. (2023). Digital infrastructure disparities and policy challenges in Indonesia's frontier regions. Policy Brief Kominfo, 12(3), 1–15.

Hjort, J., & Poulsen, J. (2019). The arrival of fast internet and employment in Africa. American Economic Review, 109(3), 1032–1079. https://doi.org/10.1257/aer.20161385
International Telecommunication Union. (2022). Measuring digital development: Facts and figures 2022. ITU Publications.
International Telecommunication Union. (2023). Global connectivity report 2023. ITU Publications.
International Telecommunication Union & World Bank. (2020). Connecting for inclusion: Broadband access for all. World Bank Group.
Katz, R. L., & Koutroumpis, P. (2018). Measuring the economic impact of broadband deployment. Telecommunications Policy, 42(3), 171–187. https://doi.org/10.1016/j.telpol.2017.09.007
Maneejuk, P., & Yamaka, W. (2020). Telecommunications infrastructure, economic growth, and regional development: Evidence from developing economies. Telecommunications Policy, 44(5), 101915. https://doi.org/10.1016/j.telpol.2019.101915
Mazzucato, M., & Semieniuk, G. (2018). Financing renewable energy: Who is financing what and why it matters. Technological Forecasting and Social Change, 127, 8–22. https://doi.org/10.1016/j.techfore.2017.05.021
Nasution, S. R., Putri, A. D., & Wijaya, H. (2024). Digital inequality in Indonesia's rural regions: Access, quality, and utilization gaps. Journal of Asian Public Policy, 17(1), 85–102. https://doi.org/10.1080/17516234.2023.2269112
Ndoen, F., Rohi, R., & Sayrani, L. P. (2024). Governance challenges in telecommunication service delivery in eastern Indonesia. Jurnal Administrasi Publik, 21(2), 233–250.
OECD. (2021). Bridging the digital divide: Policy insights. OECD Publishing. https://doi.org/10.1787/34e1f1e7-en
Patton, M. Q. (2015). Qualitative research and evaluation methods (4th ed.). SAGE Publications.
Pradhan, R. P., Arvin, M. B., Nair, M., & Bennett, S. E. (2014). Broadband infrastructure, innovation, and economic growth. Telecommunications Policy, 38(7), 567–584. https://doi.org/10.1016/j.telpol.2014.03.003
Pradhan, R. P., Mallik, G., & Bagchi, T. (2024). Infrastructure investment and inclusive digital growth in developing regions. World Development, 174, 106457. https://doi.org/10.1016/j.worlddev.2023.106457
Prasetyo, A. (2019). Energy constraints and BTS performance in Indonesia's rural areas. Jurnal Infrastruktur dan Kebijakan Publik, 8(1), 44–59.
Pratiwi, R., & Purnama, I. (2022). Public–private partnerships in ICT infrastructure development in Indonesia. Journal of Public Sector Innovation, 5(2), 101–118.
Syafii, M. (2018). Telecommunications investment barriers in Indonesia's 3T regions. Jurnal Kebijakan Komunikasi, 6(1), 15–32.
Tri, A. K., Suryanto, T., & Lestari, D. (2024). Digital public services and administrative efficiency in rural Indonesia. Public Administration and Development, 44(2), 169–184. https://doi.org/10.1002/pad.2014
UNCTAD. (2021). Digital economy report 2021: Cross-border data flows and development. United Nations Publications.
UNESCO. (2021). Reimagining our futures together: A new social contract for education. UNESCO Publishing.
UNESCAP. (2020). Inequality in Asia and the Pacific in the era of digital transformation. United Nations ESCAP.
Van Dijk, J. A. G. M. (2020). The digital divide. Polity Press.
Welfare, B., Nugroho, R., & Santoso, D. (2024). Digital platforms and MSME resilience in eastern Indonesia. Small Business Economics, 62(1), 89–107. https://doi.org/10.1007/s11187-023-00792-1
World Bank. (2016). World development report 2016: Digital dividends. World Bank

Publications.
World Bank. (2020). World development report 2020: Trading for development in the age of global value chains. World Bank Publications.
World Bank. (2021). Connecting for inclusion: Broadband access for all. World Bank Group.
Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE Publications.