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Digital Financial Inclusion as A Catalyst for Blue Economy Development: The Role of Regional Development Banks in Strengthening Fisheries and Marine Sector Revenue in East Java

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ABSTRACT

Indonesia's blue economy holds significant potential for regional economic development, yet coastal and fisheries communities remain underserved by formal financial services. This study examines how digital transformation in Regional Development Banks (BPDs) can drive financial inclusion and enhance revenue generation in the marine and fisheries sector. Using Bank Jatim as a case study, this research employs a qualitative approach with in-depth interviews and document analysis involving stakeholders from banking, regional government, fisheries agencies, and coastal community representatives. Findings reveal that digital financial services—including mobile banking, digital payment systems for fisheries transactions, and regional tax digitization—significantly improve access to capital for small-scale fishers and aquaculture businesses while accelerating Regional Own-Source Revenue (PAD) collection from marine resource levies. The study proposes an integrated Blue Economy Digital Finance Model encompassing four dimensions: (1) digital infrastructure for coastal financial inclusion, (2) adaptive institutional governance linking banks, fisheries agencies, and coastal communities, (3) capacity building for digital literacy among fishing households, and (4) collaborative policy frameworks aligning blue economy goals with regional fiscal sustainability. This research contributes to the literature on blue economy financing and provides policy recommendations for leveraging digital banking to strengthen Indonesia's marine and fisheries sector development.

Keywords: blue economy; digital financial inclusion; regional development banks; fisheries sector; coastal communities; regional revenue

INTRODUCTION

Indonesia's marine and fisheries sector constitutes a cornerstone of the national blue economy, contributing approximately 7 percent to gross domestic product and employing more than 12 million people, the majority of whom reside in coastal communities (KKP, 2024). East Java Province, with a coastline extending over 1,162 kilometers and high marine biodiversity, is among Indonesia's leading fisheries regions, producing approximately 1.2 million tons of capture fisheries and aquaculture output annually (BPS Jatim, 2023). Despite this substantial economic potential, the sector continues to face persistent challenges in financial access, with more than 65 percent of small scale fishers and aquaculture operators remaining unbanked or underbanked (World Bank, 2021).

Financial exclusion in coastal areas, as highlighted by Béné et al. (2016) and FAO (2020), is closely associated with the dominance of cash based and informal transactions throughout fisheries value chains. These practices limit financial traceability, restrict access to formal credit, and constrain investment in modern fishing equipment, cold chain infrastructure, and sustainable aquaculture practices, thereby reinforcing a vicious cycle of low productivity and income stagnation. Insights from the study on reforming tax policies and transfer pricing strategies further reinforce this condition by demonstrating that economic behavior and firm characteristics, such as scale, institutional capacity, and formality, play a more decisive role in shaping compliance and economic outcomes than tax rates alone (Karunia et al., 2026). In the fisheries context, small scale coastal actors remain structurally excluded from formal financial and fiscal systems, which reinforces informality, revenue leakage, and weak regional tax governance. Addressing financial exclusion in coastal and marine communities therefore requires not only innovative financial service delivery models but also integrated fiscal and financial reforms that incentivize transaction formalization, enhance transparency, and support evidence based policymaking.

The global expansion of digital finance has demonstrated significant potential to address these challenges by extending financial services to rural and underserved populations (Pazarbasioglu et al., 2020). Mobile banking, digital payments, and fintech solutions have been shown to reduce transaction costs, improve economic resilience, and expand access to savings, credit, and insurance for low income households (Demirgüç Kunt et al., 2022). Within fisheries systems, digital financial services can facilitate catch documentation, strengthen market linkages, enable micro insurance against climate and weather risks, and support instant payment mechanisms connecting fishers directly with buyers (Belton et al., 2023). However, empirical evidence indicates that adoption in coastal areas remains limited due to infrastructure constraints, institutional fragmentation, and weak alignment between financial services and sector specific governance needs.

In Indonesia, Regional Development Banks occupy a strategic position in advancing digital financial inclusion within the blue economy. Unlike commercial banks, these institutions carry a dual mandate to ensure commercial sustainability while supporting regional development objectives, including the enhancement of Regional Own Source Revenue (PAD) (OJK, 2022). Bank Jatim, as East Java's largest regional bank with majority provincial government ownership, plays a central role in managing regional treasury functions, channeling credit to priority sectors, and facilitating digital payment systems for local taxes and levies (Bank Jatim, 2023). These institutional functions align closely with national and regional policy frameworks that position marine and fisheries development as a priority pathway for sustainable economic growth (Bappenas, 2020; KKP, 2022).

East Java's fisheries sector contributes significantly to provincial PAD through fisheries retributions, vessel licensing fees, aquaculture permits, and fish auction levies. In 2022, fisheries related PAD reached IDR 127 billion, accounting for 3.8 percent of total regional revenue (Disperkimtan Jatim, 2023). Nevertheless, revenue collection efficiency remains suboptimal due to continued reliance on cash based systems, limited monitoring capacity, and incomplete taxpayer coverage. Digitalization through banking platforms offers the potential to improve transparency, expand the tax base, and generate real time data for fisheries management and fiscal governance (Nakamura et al., 2020). Despite Bank Jatim's digital transformation initiatives since 2018, including mobile banking applications, digital payment gateways, and integration with regional financial management systems, penetration in coastal areas remains low. Field observations in Banyuwangi, Lamongan, and Situbondo indicate that fewer than 30 percent of fishers possess active bank accounts, while digital payment adoption in fisheries transactions remains below 15 percent (authors' preliminary survey, 2024). Against this backdrop, this study examines how digital financial services can be leveraged to support financial inclusion and blue economy development in East Java through an in-depth qualitative case study of Bank Jatim.

RESEARCH METHODS

This study employs a qualitative case study approach to examine digital financial inclusion initiatives supporting blue economy development in East Java, focusing on Bank Jatim's role as the regional development bank. The case study method is appropriate because it enables in-depth examination of complex social phenomena within real-world contexts, particularly suitable for exploring how digital finance intersects with fisheries sector development and regional governance (Yin, 2018).

Research Site and Participant Selection

The research was conducted in East Java Province, Indonesia, which was selected based on several strategic considerations. East Java plays a significant role in Indonesia's marine and fisheries economy, contributing substantially to regional and national output. In addition, Bank Jatim has a more advanced digital banking infrastructure compared to other Regional Development Banks (BPDs), making it a relevant case for examining digital financial services. The province also exhibits diverse coastal characteristics, ranging from major commercial fishing ports and small-scale fishing communities to intensive aquaculture areas. Furthermore, East Java has a number of regional policy initiatives that explicitly link digital finance with blue economy development, providing an enabling institutional context for the study.

Research participants were selected purposively to represent key stakeholder groups involved in digital finance and the fisheries-based blue economy. From the banking sector, five informants were interviewed, consisting of the Director of Information Technology and the Head of the Digital Banking Division at Bank Jatim, branch managers from Banyuwangi as a major fishing port town and Situbondo as an aquaculture center, and a credit officer specializing in fisheries lending.

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The regional government was represented by four informants, namely the Assistant for Economic Affairs of the East Java Provincial Government, the Head of the Regional Revenue Agency (Bapenda), the Head of the Marine and Fisheries Agency (Dinas Kelautan dan Perikanan), and the coordinator of the Regional Digitalization Acceleration Team (ETPD). Six informants were drawn from the fisheries sector to capture perspectives along the value chain, including a Fish Auction House (TPI) manager, the chair of a fishers' association, a small-scale capture fisher, a pond aquaculture operator, a fish trader or collector, and a cold storage facility operator. In addition, two expert informants were included to provide analytical perspectives, consisting of a blue economy researcher from a local university and a financial inclusion specialist from the Indonesia Economic Intelligence Research Institute.

Data Collection Methods

Data was collected using multiple methods to ensure triangulation and strengthen the validity of the findings. The primary method was in-depth semi-structured interviews conducted between January and March 2024. Each interview lasted approximately 60–90 minutes and was guided by protocols tailored to the specific stakeholder group. The interviews explored key themes such as patterns of financial service usage among coastal communities, barriers to the adoption of digital finance, institutional coordination between banks and fisheries-related agencies, regional revenue collection mechanisms for marine and fisheries levies, and stakeholder perceptions of the impacts of digital transformation. With the consent of participants, all interviews were audio-recorded, transcribed verbatim, and subsequently coded for thematic analysis.

In addition to interviews, a comprehensive document analysis was undertaken. This included a review of Bank Jatim's digital banking strategic plans and annual reports covering the period 2018–2023, the East Java Blue Economy Development Roadmap, regional regulations governing fisheries levies and tax collection procedures, and reports on the implementation of the Regional Digitalization Acceleration Team (ETPD). The analysis also drew on statistical data from the Marine and Fisheries Agency related to production, employment, and regional revenue contributions, as well as policy circulars issued by Bank Indonesia and the Financial Services Authority (OJK) concerning digital transformation of Regional Development Banks. Field observations complemented the interview and document data. Site visits were conducted in three coastal fishing communities Muncar fishing port in Banyuwangi, Brondong in Lamongan, and Pasir Putih in Situbondo. These visits focused on observing fish auction processes and associated payment systems, the operation of bank agents in coastal areas, the actual use of digital financial services by fishers, the accessibility of physical banking infrastructure, and community gathering spaces where financial transactions commonly take place.

Data Analysis

Data analysis followed the interactive framework proposed by Miles et al. (2014), which comprises three iterative and interconnected stages: data reduction, data display, and conclusion drawing and verification. This approach allowed the analysis to move back and forth between data, emerging interpretations, and theoretical constructs throughout the research process.

The first stage, data reduction, involved the systematic coding of interview transcripts, field notes, and documentary materials. Coding was conducted using a combination of deductive codes derived from the study's conceptual framework on digital finance and the blue economy, and inductive codes that emerged directly from the empirical data. The initial coding process generated 87 distinct codes, which were subsequently refined and consolidated into 23 thematic categories through constant comparison and iterative review.

In the second stage, data display, the refined thematic categories were organized into a series of analytical matrices and visual representations. These displays were designed to compare stakeholder perspectives on key issues, identify barriers and enabling factors for digital finance adoption, map institutional coordination mechanisms, and trace pathways linking digital financial services to regional revenue outcomes. Network diagrams were also developed to illustrate the relationships between digital banking services, actors in the fisheries sector, and flows of regional revenue. The final stage involved conclusion drawing and verification. Emerging patterns and relationships identified through the systematic analysis were interpreted in relation to the research questions and the broader conceptual framework. To enhance the credibility and robustness of the findings, verification was carried out through member checking with selected informants, triangulation across multiple data sources—interviews, documents, and field observations—and consultation with expert informants to assess the

plausibility of interpretations and their alignment with wider policy and institutional contexts.

Ethical Considerations and Study Limitations

Informed consent was obtained from all participants, with assurances of confidentiality and anonymity. Participants were informed of their right to withdraw at any time. Data are stored securely and accessible only to the research team.

Study limitations include: (1) geographic focus on East Java limits generalizability to other coastal regions with different socioeconomic conditions; (2) snapshot perspective during 2024 may not capture longer-term adoption dynamics; (3) self-reported data from fishers may be subject to recall bias regarding financial behaviors; and (4) limited quantitative data on actual transaction volumes and revenue impacts due to data access constraints.

RESULT AND DISCUSSION

Digital Finance, Blue Economy, and Regional Governance

The blue economy framework emphasizes the sustainable utilization of ocean and coastal resources to generate economic growth while maintaining ecosystem integrity and supporting coastal livelihoods (World Bank, 2017). In Indonesia, the blue economy encompasses capture fisheries, aquaculture, marine tourism, shipping, and marine-based industries, with fisheries remaining the largest source of employment for coastal populations (KKP, 2022). Achieving a sustainable blue economy therefore requires not only productivity enhancement, but also improvements in value chain efficiency, equitable distribution of economic benefits, and governance systems that prevent resource overexploitation (Voyer et al., 2018). Within this framework, access to financial capital emerges as a decisive enabling factor.

Empirical studies consistently identify financial exclusion as a structural constraint facing small-scale fisheries. Béné et al. (2016) demonstrate that access to affordable and appropriate credit enables fishers to invest in fuel-efficient engines, navigation technologies, preservation systems, and safety equipment, which simultaneously enhance productivity, income stability, and environmental sustainability. However, conventional banking models remain poorly aligned with fisheries livelihoods. Irregular income patterns, seasonal risk exposure, limited collateral, and geographic remoteness contribute to the systematic exclusion of fishing households from formal financial systems (FAO, 2020). As a result, many fishers rely on informal lenders and buyer-dependent financing arrangements that reinforce dependency and limit upgrading opportunities.

Digital financial services offer a potentially transformative pathway to address these structural barriers. Evidence from rural and remote contexts in Africa and Asia shows that mobile money, agent banking, and digital credit platforms can significantly expand financial inclusion by lowering transaction costs, reducing distance barriers, and enabling alternative approaches to credit assessment (Demirgüç-Kunt et al., 2022). In fisheries systems, digital finance can support safe savings mechanisms, facilitate instant buyer-to-fisher payments, enable micro-insurance against climate and weather risks, and unlock supply chain finance through digital traceability and transaction data (Belton et al., 2023; Nakamura et al., 2020; Pomeroy et al., 2021; Ferrer et al., 2021). These functions position digital finance not merely as a financial tool, but as an infrastructural backbone for modernizing fisheries value chains.

Nevertheless, the literature cautions that digital financial inclusion in coastal communities faces context-specific constraints. Limited digital literacy, particularly among older fishers, unreliable telecommunications infrastructure in remote islands, cultural preferences for cash-based transactions, and the seasonal variability of fisheries income all affect adoption and sustained use of digital services (Suri & Jack, 2016). These challenges suggest that technological availability alone is insufficient; institutional design, service customization, and local governance arrangements are critical determinants of success.

In Indonesia, Regional Development Banks are uniquely positioned to address these challenges due to their dual mandate of commercial viability and regional development support. Established as instruments of local economic development and regional fiscal management, BPDs maintain close operational ties with provincial and district governments, manage regional treasury accounts, and are expected to prioritize lending to strategic sectors including fisheries and aquaculture (OJK, 2022; BI, 2023). The BPD Transformation Program for the period 2015–2024 explicitly promotes digital capability development, regional partnerships, and sustainable finance integration, encouraging BPDs to design specialized financial products for underserved sectors.

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Despite this mandate, empirical evidence indicates that fisheries lending remains marginal within BPD portfolios, typically accounting for less than five percent of total credit and largely concentrated in relatively large-scale aquaculture operations rather than small-scale capture fisheries (Satria & Matsuda, 2020). This gap reflects both risk perceptions and high operational costs associated with serving dispersed coastal clients. Digital transformation, however, creates opportunities for BPDs to overcome these constraints through lower-cost delivery channels, data-driven risk assessment based on transaction histories, and agent banking models suitable for coastal and island contexts.

Beyond financial inclusion, digital finance also plays a strategic role in strengthening regional fiscal governance. Indonesia's push toward digitalization of regional tax and levy collection, including through the Regional Electronic Transaction System mandated by Bank Indonesia, has demonstrated improvements in collection efficiency, transparency, and real-time monitoring (BI, 2021; Nizar et al., 2020). In fisheries contexts, digital systems can enhance the collection of vessel licensing fees, fish auction house retributions, aquaculture permits, and marine tourism levies, thereby expanding regional own-source revenue while reducing leakage (Yulianto et al., 2022). However, implementation challenges persist, including resistance from actors accustomed to cash-based systems, limited digital infrastructure in fishing ports, and the need for institutional change management within local governments.

Taken together, the existing literature reveals a critical gap. While digital finance, blue economy development, and regional banking have been extensively examined as separate domains, limited research integrates these perspectives to analyze how Regional Development Banks can strategically leverage digital transformation to simultaneously advance financial inclusion for coastal communities and strengthen regional revenue governance. This study responds to that gap by advancing an integrated conceptual framework that situates digital banking within fisheries value chains and regional fiscal systems, emphasizing collaborative governance as the mechanism linking financial inclusion, sustainable fisheries development, and blue economy outcomes.

Current State of Digital Financial Inclusion in East Java's Fisheries Sector

Field data reveal a complex picture of digital finance penetration within East Java's coastal and fisheries communities. Bank Jatim has deployed several digital service channels theoretically accessible to fishers such as mobile banking application (JTrust Mobile), digital savings accounts with no minimum balance requirements, agent banking posts in selected coastal villages, and integration with regional government's digital payment gateway for fisheries levies. However, actual usage patterns indicate significant gaps between infrastructure availability and meaningful adoption. Among the fishing households surveyed during field visits (n=47, non-random sample), only 32% possessed active bank accounts with Bank Jatim or any formal financial institution. Of account holders, merely 21% had activated mobile banking services. Primary reasons cited for non-adoption included: perceived complexity of digital interfaces (43%), concerns about transaction security (38%), preference for cash due to immediate liquidity needs (31%), and limited smartphone ownership or data connectivity (27%).

A Branch Manager in Banyuwangi explained *"We have the technology infrastructure in place, but the challenge is the last mile actually getting fishers comfortable using digital services. Many still prefer keeping cash hidden at home rather than depositing in banks. Trust is an issue, and so is the learning curve for older fishers who've never used smartphones."*

Conversely, certain segments within the fisheries value chain demonstrate higher digital finance adoption. Fish traders and cold storage operators, typically more educated and with larger transaction volumes, actively use bank transfers and mobile payments for business operations. One fish trader reported: *"I receive payments from buyers in Jakarta through bank transfer immediately when fish is loaded on trucks. It's safer than carrying large amounts of cash and I can track everything digitally."*

Digital Finance Applications In Fisheries Sector Value Chains

Digital financial services intersect with fisheries value chains at multiple operational points, yet their effectiveness is shaped by the everyday realities of small-scale fishing economies. For fishers with irregular and seasonal incomes, digital savings accounts offer clear theoretical benefits, including protection from theft, gradual capital accumulation for equipment repairs, and the creation of financial histories that could support future credit access. In practice, however, uptake remains constrained by spatial and cost barriers. The need to travel to urban centers for small-value transactions often makes

formal banking economically irrational, reinforcing dependence on cash. Agent banking models piloted by regional banks such as Bank Jatim partially address this gap by bringing cash-in and cash-out services closer to landing sites through local shopkeepers, but limited agent density and weak liquidity management during peak fishing seasons continue to undermine reliability and trust.

Digital payments have also begun to reshape transactions at fish auction houses, which traditionally operate through cash and deferred payment arrangements that delay fisher income, obscure transaction values, and weaken regional revenue collection. The introduction of QRIS-based payments in selected auction sites demonstrates how digitalization can accelerate payment flows, automate levy calculations, and improve transaction transparency. Fishers benefit from faster settlement, while local governments gain more accurate and timely data. Nonetheless, adoption remains uneven, particularly among small buyers who prefer informal credit relationships and flexible cash arrangements, highlighting the social embeddedness of market practices that technology alone cannot easily displace.

Access to credit remains the most persistent constraint along the fisheries value chain. Despite the sector's substantial contribution to employment, formal lending to capture fisheries remains marginal, largely because conventional credit assessment frameworks are ill-suited to volatile incomes, depreciating vessel assets, and the absence of land-based collateral. Digital finance offers a pathway to mitigate these constraints through the use of alternative data, including transaction records from digital auctions, savings behavior, and payment histories. Yet these data sources remain largely untapped within regional bank credit systems, which continue to prioritize salaried income and formal business documentation. International experiences demonstrate that digitally enabled microcredit for fishers can achieve high repayment rates when transaction data and social collateral mechanisms are incorporated, but adapting such models in Indonesia requires regulatory flexibility, analytical capacity, and closer partnerships between banks, cooperatives, and fisheries institutions.

Beyond household finance, digital technology plays a strategic role in strengthening regional revenue governance derived from marine resources. Fisheries-related levies, licensing fees, and auction retributions have long suffered from inefficiencies and leakage under cash-based systems. The integration of bank payment gateways with fisheries transaction monitoring systems represents a significant governance innovation, enabling real-time calculation and direct remittance of levies to regional treasury accounts. Early implementation results suggest substantial improvements in reported transaction volumes, remittance speed, and data quality, supporting both fiscal performance and resource management. However, scaling these systems remains constrained by uneven digital infrastructure at smaller landing sites, limited administrative capacity, and resistance from actors accustomed to opaque cash-based arrangements. Taken together, these dynamics illustrate that digital finance in fisheries value chains is not merely a technical intervention but a governance process that reconfigures financial practices, institutional incentives, and power relations across coastal economies.

Digital financial services intersect with fisheries value chains at multiple operational points, yet their effectiveness is strongly shaped by the structural characteristics of small-scale fisheries and the governance context in which transactions occur. For fishers with irregular and seasonal incomes, digital savings accounts offer clear advantages over cash-based storage, including protection from theft, gradual accumulation of funds for major expenditures such as engine repairs and net replacement, and the creation of transaction histories that can support future credit access. In practice, adoption remains constrained by transaction costs and physical access barriers. As noted by one fisher, traveling to urban centers to deposit as little as IDR 50,000 often incurs fuel costs that exceed the value of the transaction, making formal banking economically inefficient. Bank Jatim's agent banking initiatives attempt to address this constraint by partnering with local shop owners in coastal villages to provide cash-in and cash-out services. However, agent network density remains limited, with one agent typically serving 3,000–5,000 people, compared to approximately 1:500 in urban areas, and liquidity constraints frequently emerge during peak fishing seasons when deposit volumes increase but agents lack sufficient vault cash.

Digital payment systems have begun to alter transactional practices at fish auction houses (Tempat Pelelangan Ikan, TPI), which traditionally rely on cash payments and delayed settlement arrangements, with buyers often paying weekly or monthly. This system places working capital pressure on fishers, delays regional retribution payments, and obscures actual transaction values from government oversight. Pilot digitalization initiatives at Muncar

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TPI in Banyuwangi have introduced QRIS-based payment terminals, enabling instant payments via mobile banking and e-wallets. Early results indicate improved transaction documentation, automated calculation of auction retributions, and faster income receipt for fishers, yet adoption remains limited to around 25% of total transactions. Resistance is particularly evident among small buyers who prefer maintaining informal credit relationships with fishers, illustrating that entrenched market norms continue to shape technology uptake (Nakamura et al., 2020).

Credit access remains the most persistent bottleneck in fisheries development. At Bank Jatim, fisheries lending accounts for only 4.2% of total credit portfolios and is concentrated primarily in aquaculture operations that can provide land certificates as collateral. Capture fisheries, which employ approximately 60% of the sector's workforce, receive minimal formal financing due to perceived risks associated with income volatility, weather uncertainty, asset depreciation, lack of land-based collateral, and limited verifiable financial records (FAO, 2020). Digital finance offers potential pathways to address these constraints through alternative data sources, including transaction records from digital fish auctions, mobile savings patterns, and utility payment histories. However, such data have not yet been integrated into Bank Jatim's credit scoring systems, which continue to rely on conventional indicators such as fixed income, land collateral, and formal business registration. International experience demonstrates the feasibility of alternative models; in Kenya, for example, fintech lenders leveraging mobile money transaction data have provided unsecured microloans to fishers with repayment rates reaching 94% (Ferrer et al., 2021). Replicating such outcomes in Indonesia would require regulatory adaptation, investment in data analytics capacity, and partnerships with fisheries cooperatives to operationalize social collateral mechanisms.

Beyond household-level finance, digital technology plays a strategic role in strengthening governance and regional revenue mobilization from marine resources. In East Java, fisheries contribute to locally generated revenue (Pendapatan Asli Daerah, PAD) through multiple channels, including TPI auction retributions typically set at 3–5% of transaction values, fishing vessel licensing fees, aquaculture permits, export documentation charges, and marine tourism levies (Yulianto et al., 2022). Historically, cash-based collection systems have resulted in low efficiency and significant leakage. As acknowledged by the Regional Revenue Agency (Bapenda), the absence of real-time digital systems has forced reliance on manual reporting that often underrepresents actual transaction volumes. Since 2021, digitalization initiatives integrating Bank Jatim's payment gateway with fisheries transaction monitoring systems have enabled automatic calculation of retributions and direct payments to regional treasury accounts. Implementation across 12 of East Java's 38 TPI sites has generated measurable improvements, including a 37% increase in reported auction volumes, an 89% reduction in remittance time from an average of 45 days to approximately 5 days, and higher-quality data to support seasonal and species-level fisheries management.

Despite these gains, scaling remains constrained by uneven internet connectivity, limited point-of-sale infrastructure at smaller TPI sites, and the need for capacity building and change management among local officials. Political economy factors also play a role, as increased transparency disrupts informal revenue-sharing arrangements embedded in cash-based systems, generating resistance from vested interests. Taken together, these findings underscore that digital finance in fisheries value chains is not merely a technical intervention but a governance process that reshapes financial behavior, institutional accountability, and power relations across coastal economies (World Bank, 2017; Voyer et al., 2018; Demirgüç-Kunt et al., 2022).

Institutional Coordination Mechanisms: Linking Banks, Fisheries Agencies, And Communities

Effective deployment of digital finance in fisheries depends less on isolated technological solutions than on the strength of institutional coordination linking banks, fisheries agencies, revenue authorities, and fishing communities. Evidence from East Java shows that coordination mechanisms exist but operate at varying levels of maturity and effectiveness. At the formal policy level, the 2023–2027 Regional Development Plan (RPJMD) explicitly positions the blue economy and digital financial inclusion as provincial development priorities, creating an enabling policy mandate. In response, the Fisheries Agency has established a Digital Transformation Working Group involving Bank Jatim, the Regional Revenue Agency (Bapenda), and representatives of fisherfolk organizations. This forum has facilitated dialogue on digital payment system design, coordinated training activities, and provided a platform to identify implementation bottlenecks. However, coordination remains largely

strategic rather than operational. As highlighted by an expert informant, meetings tend to be quarterly and event-based, leaving gaps in day-to-day problem solving when fishers encounter application failures, agents face liquidity shortages, or transaction systems malfunction. This limits the responsiveness of digital finance services and weakens user trust.

Beyond policy dialogue, spatial and operational integration has emerged as a practical coordination mechanism. In Banyuwangi, Situbondo, and Pasuruan, Bank Jatim has piloted co-location of agent banking services within or adjacent to fish auction houses (Tempat Pelelangan Ikan, TPI) and fisheries cooperative offices. This arrangement reduces transaction costs by allowing fishers to deposit cash from fish sales, pay vessel licensing fees, and access basic banking services in a single location. Field observations indicate that effectiveness varies significantly by local context. At Muncar port in Banyuwangi, where agent services operate inside the TPI compound and maintain extended hours aligned with fish landing schedules, usage rates are notably higher. In contrast, smaller landing sites where agents operate limited hours that do not match fishing routines show low utilization, underscoring that institutional coordination must extend to operational alignment with fisheries temporal patterns rather than relying solely on physical proximity.

Data governance represents a third, and currently weakest, coordination dimension. Digital payment systems generate transaction data with high potential value across institutions: fisheries agencies could monitor catch composition and volumes for stock assessment, regional revenue authorities could track levy collection in real time, banks could improve credit risk assessment, and researchers could analyze market dynamics. In practice, these benefits remain largely unrealized due to underdeveloped data sharing protocols. Bank Jatim does not systematically share transaction data with fisheries agencies, citing banking confidentiality regulations, while government datasets on licensed vessels and aquaculture permits are not integrated into banking systems to support credit appraisal. This institutional fragmentation constrains the ability to leverage digitalization for integrated governance outcomes. Addressing this gap requires the development of clear data sharing frameworks that allow the use of anonymized and aggregated data for management and planning purposes while safeguarding individual fisher privacy. Without such arrangements, digital finance risks remaining a transactional tool rather than evolving into an integrated governance instrument capable of supporting sustainable fisheries management, inclusive finance, and strengthened regional fiscal performance.

Barriers To Scaling Digital Financial Inclusion In Coastal Areas

Drawing on interview data, documentary analysis, and field observations, this study finds that barriers to scaling digital financial inclusion in coastal areas are complex, interconnected, and rooted in the socio-economic and institutional characteristics of small-scale fisheries. At the individual level, limited digital literacy and low levels of trust continue to constrain adoption. Older fishers, who remain a significant proportion of the capture fisheries workforce, often have minimal experience with smartphones and digital applications. Among younger fishers, ownership of digital devices does not necessarily translate into confidence in using financial technologies. Concerns related to account security, online fraud, transaction errors, and the lack of accessible problem resolution mechanisms contribute to widespread risk aversion. These perceptions indicate that trust in digital financial services develops through sustained social interaction, peer-based learning, and the presence of responsive customer support that operates in locally understood languages and formats.

User-level barriers to digital financial services in coastal and small island communities are compounded by persistent infrastructure limitations, including weak telecommunications networks, unstable electricity supply, and limited internet bandwidth, which undermine platform reliability and erode user trust through slow response times and failed transactions. Drawing on insights from Karunia et.al (2024), these challenges extend beyond technical deficiencies to reflect gaps in institutional coordination and digital collaboration, where inadequate alignment between infrastructure provision, service design, and user capacity constrains effective adoption. Infrastructure weaknesses also complicate service delivery for providers, particularly in agent banking operations that depend on real-time connectivity, efficient cash liquidity management, and functional point-of-sale systems. Although national digital infrastructure has expanded significantly in recent years, Karunia et.al (2024) highlights that the absence of strong cross-sector collaboration among government, financial institutions, technology providers, and local communities leaves coastal regions structurally disadvantaged compared to

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urban centers, reinforcing spatial inequality in access to digital financial services and limiting the broader performance gains expected from digital transformation.

In addition to access and connectivity challenges, significant barriers arise from the misalignment between digital financial product design and the lived realities of fishing communities. Most digital financial services are designed around urban income patterns that assume regular cash flows, stable employment, and high levels of literacy. In contrast, fishing households experience seasonal and highly variable incomes that make minimum balance requirements, monthly fees, and transaction charges disproportionately burdensome. Application interfaces that rely heavily on text, numerical inputs, and complex navigation further exclude users with limited formal education. Service availability also often fails to align with fishing schedules and landing times, reducing the practical usefulness of digital tools. These findings suggest that meaningful inclusion requires participatory design processes based on in-depth user research and continuous adaptation to local contexts.

Regulatory and policy environments also shape the scope and pace of digital financial inclusion in coastal areas. Financial regulations developed for conventional banking contexts can unintentionally restrict innovation in fisheries-oriented digital finance. Credit assessment frameworks that prioritize collateral and formal income documentation limit the ability of financial institutions to adopt alternative scoring models based on transaction histories or fisheries-related data. Requirements related to data sharing, banking secrecy, and agent banking operations introduce additional compliance burdens that are often ill-suited to low-density coastal settings. These regulatory conditions highlight the importance of policy dialogue aimed at creating enabling environments that balance risk management objectives with the need for flexibility and innovation.

Institutional capacity constraints further impede the expansion of digital financial services. Financial institutions frequently lack staff with sufficient understanding of fisheries livelihoods, seasonal income patterns, and sector-specific risks, resulting in standardized products that are poorly adapted to coastal users. Government agencies responsible for fisheries management, revenue collection, and social protection often face limitations in digital system operation, data management, and inter-agency coordination. Community-based organizations, including cooperatives and fisher associations, possess strong social legitimacy but frequently lack the technical skills and resources required to support digital facilitation and user training. Strengthening institutional capacity across these actors is therefore essential for sustainable scaling.

Finally, political economy dynamics play a critical role in shaping digital financial adoption. Greater transparency in financial transactions and revenue flows can disrupt existing informal practices and power relations within fisheries systems. Actors who benefit from opaque arrangements, such as informal fee collection, preferential lending relationships, or underreporting of catches, may resist digitalization efforts. As a result, barriers to adoption cannot be understood solely as technical or behavioral challenges. Effective digital financial inclusion strategies must engage with these underlying political and institutional interests in order to achieve lasting transformation.

Enablers and Success Factors

Alongside the barriers identified in the previous section, the research also reveals a set of enabling factors that significantly support the adoption and sustained use of digital financial services in coastal communities. These enablers operate at individual, social, institutional, and system levels, and their effectiveness lies not in isolated interventions but in the way they reinforce one another within local contexts. One of the most influential factors is the role of community champions. In locations where respected and visible figures such as fish landing site managers, cooperative leaders, and established fish traders actively use and publicly endorse digital financial services, adoption spreads more rapidly through social learning processes. The presence of trusted early adopters reduces perceived risk and uncertainty, while creating demonstration effects that make digital finance appear both legitimate and attainable for other community members.

Equally important is the presence of clear and tangible value propositions. Digital financial services gain traction when they address immediate and practical challenges faced by fishing households. Benefits such as reducing the risks associated with carrying cash, enabling faster receipt of payments after fish sales, and eliminating the need to travel long distances to access banking services are readily understood and strongly motivate uptake. In contrast, more abstract or long-term benefits, including the accumulation of digital credit histories or contributions to data-driven fisheries management, tend to resonate less with users

whose financial decisions are shaped by short-term livelihood pressures. This finding underscores the importance of framing digital finance in terms of concrete improvements to everyday economic activities.

Successful adoption is also closely associated with the availability of gradual and flexible entry pathways. Rather than requiring immediate engagement with complex digital products, effective initiatives allow users to build confidence incrementally. Initial exposure often involves simple functions such as checking account balances or receiving notifications, which help users develop familiarity and trust. Over time, users may progress to conducting transactions such as payments and transfers, and eventually to more advanced services including digital credit, savings, or insurance. Allowing individuals to advance at a pace aligned with their comfort and experience reduces anxiety and minimizes the risk of early disengagement.

The presence of responsive and locally accessible support systems further strengthens sustained usage. Communities that benefit from nearby assistance provided by trained bank agents, cooperative staff, or government extension officers who understand both digital finance and local livelihoods demonstrate higher levels of continued engagement. For populations with limited digital confidence, remote support mechanisms such as toll-free helplines or automated chat services are often insufficient substitutes for face-to-face guidance. Human support that is timely, contextualized, and delivered in familiar social settings plays a critical role in resolving problems and reinforcing trust.

Proposed Blue Economy Digital Finance Model

Building on empirical findings and insights from the blue economy and digital finance literature, the proposed Blue Economy Digital Finance Model conceptualizes digital transformation of Regional Development Banks as an integrated instrument to advance financial inclusion, strengthen fisheries value chains, and enhance regional revenue governance. The model is structured around four mutually reinforcing dimensions that together address technological, financial, institutional, and social constraints faced by coastal and fishing communities.

The first dimension emphasizes the need for coastal-adapted digital financial infrastructure that reflects the physical and socioeconomic realities of fisheries-dependent areas. Unreliable internet connectivity in remote coastal zones necessitates hybrid systems that can function during offline periods, with transactions batched and synchronized once connectivity is restored. Complementary solutions include the use of satellite internet in remote islands and partnerships with telecommunications providers to expand coastal coverage. Equally important is accessible interface design, with visual icons, voice-guided instructions in local languages, simplified transaction flows, and hardware adapted for older users or those with limited digital dexterity. Service delivery must rely on distributed access points, including agent banking facilities at fish landing sites, TPI locations, cooperative offices, and frequently visited village shops, supported by adequate cash liquidity and fisheries-specific training. Mobile banking units and strategically located ATMs further extend reach. These elements are unified through interoperable payment ecosystems that allow fishers to use a single digital account for receiving fish sale payments, paying fisheries levies, purchasing inputs, remitting household funds, and accessing government subsidies, aligned with national payment standards such as QRIS and ATM Bersama.

The second dimension focuses on adaptive financial products designed around fisheries livelihood dynamics. Flexible savings instruments without minimum balances or maintenance fees enable frequent small deposits and support goal-based saving for needs such as education, vessel maintenance, and cultural expenditures. Credit products are aligned with seasonal income cycles, offering repayment holidays during lean monsoon periods and higher installments during peak fishing seasons. Short-term working capital loans address daily operational needs, while longer-term asset financing for boats and engines can be supported through cooperative-based group guarantees. Credit assessment moves beyond conventional collateral by incorporating alternative data sources, including digital fish auction transaction histories, mobile airtime usage, cooperative membership records, and peer references, supplemented by psychometric indicators of repayment behavior. Risk mitigation is addressed through micro-insurance products bundled with credit, covering weather shocks, vessel damage, and health emergencies, including parametric insurance triggered by satellite-based weather data. Value chain finance mechanisms further connect fishers with traders, processors, and exporters through receivables financing, warehouse receipt systems, and digitally integrated logistics, payment, and traceability platforms.

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The third dimension establishes collaborative governance arrangements that link financial institutions, government agencies, and community organizations. Joint service planning and delivery are operationalized through integrated coastal service centers where banking, fisheries extension, revenue collection, and community development functions are co-located. Shared needs assessments and coordinated capacity-building programs simultaneously address financial literacy, enterprise development, and sustainable fishing practices. Data integration frameworks allow secure sharing of anonymized and aggregated information, enabling banks to access government records on licensed vessels and fishing rights for credit assessment, while fisheries agencies and regional governments gain real-time visibility into transaction volumes and levy collection. Collaborative product development is facilitated through innovation labs that bring together banks, fisheries experts, technology providers, and fisher representatives to co-design and test services under real coastal conditions. Integrated customer support systems combine in-person assistance, hotlines, and digital help functions, supported by cross-training between bank agents and fisheries extension officers. Policy coordination platforms at provincial, district, and community levels provide spaces for joint monitoring, evaluation, and advocacy for regulatory reforms that support digital finance and blue economy objectives.

The fourth-dimension centers on community capacity development and empowerment as a prerequisite for sustainable adoption. Contextualized digital and financial literacy programs use fisheries-relevant examples to build skills in smartphone use, mobile banking, digital security, and household financial management, reinforced through peer educators and intergenerational learning. Business development support strengthens record-keeping, cost analysis, quality control, and market access, while promoting value addition through processing, collective marketing, and diversification into complementary livelihoods such as seaweed farming and marine tourism, particularly for women in fishing households. Cooperative strengthening initiatives enhance financial management, digital system use, and collective bargaining power, enabling cooperatives to function as trusted intermediaries using social collateral. Financial access is explicitly linked to sustainable fishing practices, with incentives for selective gear use, compliance with co-management arrangements, and participation in traceability systems that enable premium market access. Finally, voice and representation mechanisms ensure that fishing community representatives participate meaningfully in digital finance and blue economy governance forums, supported by grievance redress systems that allow fishers to report problems, seek solutions, and hold service providers accountable, reinforcing trust and accountable governance within coastal digital finance ecosystems (Karunia et al., 2023).

CONCLUSIONS AND POLICY RECOMMENDATION

Conclusion

This study shows that Regional Development Banks can play a strategic role in advancing financial inclusion in coastal communities while strengthening regional revenue from marine and fisheries sectors, as demonstrated by the Bank Jatim case in East Java. Digital financial services including mobile banking, digital payments, agent banking, and alternative credit scoring can reduce geographic and income-related barriers faced by fishing communities, but only when they are explicitly adapted to coastal livelihoods, infrastructure constraints, and seasonal income patterns rather than urban banking models.

The findings confirm that digitalization of fisheries transactions and marine-related levies offers a concrete pathway to improve regional revenue performance. Integrated payment systems reduce revenue leakage, accelerate fund transfers, and improve data quality, thereby enhancing fiscal transparency and Regional Own-Source Revenue within blue economy sectors. However, sustainable impact depends on coordinated governance. Digital finance initiatives are most effective when banks, fisheries agencies, revenue authorities, cooperatives, and communities act in concert through shared data systems, joint service delivery, and coordinated capacity building. Barriers to adoption extend beyond technology. Institutional capacity gaps, political economy dynamics, cultural norms, and misalignment between financial products and fisheries livelihoods are as influential as infrastructure and digital literacy constraints. Addressing these challenges requires integrated interventions combining technological adaptation, institutional reform, and trust-based engagement.

In response, the proposed Blue Economy Digital Finance Model integrates coastal-adapted infrastructure, fisheries-specific financial products, collaborative governance, and community empowerment. The study contributes to digital finance and blue economy literature by demonstrating how financial inclusion can operationalize sustainability goals in resource-dependent sectors and by reframing Regional Development Banks as

catalysts for sustainable coastal development. While the findings are context-specific, they highlight that digital financial inclusion should be treated as a means to advance resilient livelihoods, effective resource governance, and equitable blue economy outcomes rather than as an end in itself.

Policy Recommendation

The policy Recommendation of this study indicate that scaling digital financial inclusion in coastal and fisheries-dependent regions cannot be achieved through isolated or technology-centric interventions. Instead, it requires a coordinated policy framework that aligns Regional Development Banks, subnational governments, and national regulators within a coherent blue economy governance agenda. Regional Development Banks play a pivotal role and must explicitly position small-scale fisheries and the wider blue economy as priority development sectors. This requires a strategic shift from conventional banking practices toward fisheries-specific financial products, sector-trained personnel, and performance metrics that value inclusion and livelihood outcomes alongside commercial viability. Sustained investment in digital infrastructure, data analytics, and staff capacity is essential, with particular emphasis on extending reliable, offline-capable digital services to dispersed coastal and small island communities rather than concentrating digital investment in urban areas.

Effective delivery depends on institutionalized cross-sector collaboration. Routine coordination among banks, fisheries agencies, cooperatives, fintech providers, and development partners can improve outreach, reduce transaction costs, and ensure product relevance. Adaptive lending models are especially critical, given the seasonal and risk-exposed nature of fisheries livelihoods. Alternative credit assessment using transaction data, cooperative-based group guarantees, and targeted risk-sharing mechanisms can expand access to finance while preserving prudential discipline. Gender-responsive service design must also be prioritized, recognizing women's central role in fisheries value chains and addressing persistent barriers related to mobility, asset ownership, and collateral. An enabling policy and governance environment is equally decisive. Subnational governments should embed digital finance within blue economy development strategies, set measurable targets for fisheries credit access and digital payment adoption, and leverage public sector digitalization as a demand driver. The digitalization of fisheries-related levies, licenses, and service fees can improve transparency, reduce revenue leakage, and familiarize coastal communities with digital transactions. However, evidence from West Lombok shows that infrastructure gaps, limited user adoption, and fiscal constraints continue to slow effective e-government implementation, underscoring the need for parallel investment in connectivity, institutional capacity, and user readiness (Karunia et al., 2023). Finally, coastal connectivity must be treated as essential economic infrastructure. Regulatory frameworks should provide sufficient flexibility for Regional Development Banks to innovate while safeguarding consumer protection and financial stability, including space for alternative credit scoring and fisheries-specific products. Clear data governance arrangements enabling secure and privacy-protected data sharing between banks and government agencies are critical to ensure that digital finance strengthens accountability, revenue management, and inclusive blue economy governance rather than reinforcing existing inequalities.

AUTHORS CONTRIBUTION STATEMENT

Hermita led the conceptualization of the study and was responsible for the methodology, investigation, data curation, original draft writing, and overall project administration. Nurliah Nurdin contributed through supervision and conceptual guidance and was involved in reviewing and editing the manuscript. Muhammad Taufiq supported the study by conducting formal analysis and validation and by contributing to the review and editing of the manuscript. R. Luki Karunia proided resources and visualization support and also participated in reviewing and editing the manuscript.

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