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The Role of Digital Finance and Financial Inclusion in Enhancing Community Income: Evidence from the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia

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Abstract

This study examines the role of digital finance and financial inclusion in enhancing community income in the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia. Communities living in forest reserve and conservation-based areas often face limited access to formal financial services, which constrains income growth and economic resilience. Using a quantitative approach, this study collected primary data from 135 respondents comprising households and micro-entrepreneurs through structured questionnaires. Digital finance and financial inclusion were analyzed as independent variables, while community income served as the dependent variable. Data were analyzed using descriptive statistics, reliability tests, and multiple linear regression analysis. The findings reveal that digital finance has a positive and significant effect on community income, indicating that the use of mobile banking, digital payment systems, and fintech services contributes to income growth and stability. Financial inclusion is also found to have a positive and significant impact on community income, highlighting the importance of access to formal financial services such as savings accounts and credit facilities. The regression results show that digital finance and financial inclusion jointly explain a substantial proportion of the variation in community income. These findings suggest that inclusive digital financial systems can support livelihood enhancement while aligning with sustainable development objectives in forest reserve areas. The study provides important policy implications for promoting digital financial inclusion as a strategy for community empowerment and sustainable economic development in environmentally sensitive regions.

Keywords: Digital Finance; Financial Inclusion; Community Income; Forest Reserve Area; Sustainable Development; Malaysia

1. Introduction

In recent years, digital finance and financial inclusion have emerged as critical drivers of inclusive economic growth, particularly in developing countries and marginalized communities. The rapid advancement of financial technology (fintech), mobile banking, digital payment systems, and online financial platforms has transformed the way individuals and communities access financial services. Digital finance reduces geographical barriers, lowers transaction costs, and enhances the efficiency of financial intermediation, making it especially relevant for rural and forest-adjacent communities that have historically been excluded from formal financial systems (World Bank, 2022).

Financial inclusion, defined as the access to and use of affordable, appropriate, and quality financial services, plays a vital role in poverty alleviation and income generation. Inclusive financial systems enable households and micro-entrepreneurs to save securely, access credit, manage risks, and invest in productive activities (Demirgüç-Kunt et al., 2018). When combined with digital finance, financial inclusion becomes more scalable and sustainable, allowing

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underserved populations to participate actively in the formal economy. This integration is particularly significant for communities living in environmentally sensitive areas, such as forest reserve regions, where economic opportunities are often limited and livelihoods depend heavily on natural resources.

The Pulau Ketam Forest Reserve Area in Kuala Perlis, Malaysia, represents a unique socio-economic and ecological context. The local community largely relies on small-scale fisheries, mangrove-related activities, eco-tourism, and informal micro-enterprises for income generation. Despite Malaysia's relatively advanced financial infrastructure, financial exclusion persists among rural and coastal communities due to factors such as limited banking facilities, low financial literacy, inadequate digital skills, and weak access to formal credit (Bank Negara Malaysia, 2021). These challenges restrict the community's ability to improve income levels, expand businesses, and adopt sustainable livelihood strategies.

Digital finance offers a promising solution to these challenges by enabling communities to access financial services through mobile phones and internet-based platforms without relying on physical bank branches. Mobile wallets, digital savings accounts, peer-to-peer lending, and online microfinance platforms have the potential to empower rural households by facilitating financial transactions, improving cash flow management, and supporting entrepreneurship (Gomber et al., 2018). In forest reserve areas such as Pulau Ketam, digital finance can also support environmentally sustainable economic activities by providing access to green financing, eco-tourism payments, and conservation-based income initiatives.

Previous studies have consistently demonstrated a positive relationship between financial inclusion and community income. For instance, Sarma and Pais (2011) found that higher levels of financial inclusion are associated with increased household income and reduced income inequality in developing economies. Similarly, Allen et al. (2016) highlighted that access to formal financial services significantly improves the resilience and earning capacity of low-income households. These findings underscore the importance of inclusive financial systems in supporting economic development at the grassroots level.

The role of digital finance in enhancing financial inclusion has also been widely examined in the literature. Ozili (2018) argued that digital financial services significantly accelerate financial inclusion by overcoming traditional barriers such as distance, documentation requirements, and high transaction costs. Likewise, Suri and Jack (2016), in their seminal study on mobile money in Kenya, demonstrated that digital financial services contributed to increased household consumption and lifted thousands of households out of extreme poverty. These studies suggest that digital finance not only expands access to financial services but also translates into tangible income improvements.

In the Southeast Asian context, several studies have explored the impact of digital finance and financial inclusion on income generation and economic empowerment. Nguyen et al. (2021) found that digital payment adoption among micro and small enterprises in ASEAN countries significantly improved business performance and income growth. In Malaysia, Rahman et al. (2020) reported that financial inclusion initiatives, particularly digital banking and microcredit programs, positively influenced the income stability of rural entrepreneurs. However, these studies primarily focus on general rural or urban settings, with limited attention to forest reserve or conservation-based communities.

Communities residing in forest reserve areas face distinct challenges that differentiate them from other rural populations. Restrictions on land use, limited infrastructure development, and environmental conservation policies often constrain economic activities. As noted by Angelsen et al. (2014), forest-dependent communities tend to experience income volatility and limited access to formal economic opportunities. In this context, digital finance and financial inclusion can serve as enabling mechanisms that allow communities to diversify income sources without exerting additional pressure on forest ecosystems.

Several empirical studies have examined financial inclusion in environmentally sensitive or remote areas. For example, Barnes et al. (2017) found that access to digital financial services improved livelihood diversification among coastal and forest-dependent households in Southeast Asia. Similarly, Khandker and Samad (2014) demonstrated that microfinance access significantly increased income and asset accumulation among rural households, including those living near protected areas. These findings indicate that financial access can support both economic and environmental sustainability when appropriately designed.

Despite the growing body of literature, there remains a notable research gap regarding the combined role of digital finance and financial inclusion in supporting community income within forest reserve areas in Malaysia. Most existing studies either focus on financial inclusion without explicitly considering digital finance or examine digital finance in urban and commercial contexts. Moreover, limited empirical evidence is available on how these financial mechanisms operate within conservation-oriented communities such as Pulau Ketam, where economic development must be balanced with environmental preservation.

The Pulau Ketam Forest Reserve Area provides an important case study for examining this relationship. The increasing penetration of smartphones and internet connectivity in Malaysia presents new opportunities for digital financial inclusion, even in remote areas. Government initiatives such as the National Financial Inclusion Framework and the Digital Economy Blueprint (MyDIGITAL) aim to expand digital financial access to underserved communities, including rural and coastal populations. However, the effectiveness of these initiatives in enhancing community income in forest reserve areas remains underexplored.

This study seeks to address this gap by analyzing the role of digital finance and financial inclusion in enhancing community income in the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia. By integrating insights from previous research with empirical evidence from the local context, this study contributes to the literature in several ways. First, it extends the discussion on digital finance and financial inclusion to forest reserve communities, a relatively under-researched setting. Second, it provides policy-relevant insights for governments, financial institutions, and development agencies seeking to promote inclusive and sustainable economic development. Finally, it offers practical implications for community empowerment by identifying financial mechanisms that can support income generation while preserving environmental sustainability.

In conclusion, digital finance and financial inclusion represent powerful tools for enhancing community income, particularly in marginalized and environmentally sensitive areas. While existing studies provide strong evidence of their positive economic impact, further research is needed to understand their specific role and effectiveness in forest reserve contexts. This study responds to this need by focusing on the Pulau Ketam Forest Reserve Area, thereby contributing to a more nuanced understanding of inclusive digital finance as a pathway to sustainable community development.

2. Literature review

2.1. Digital Finance: Concept and Development

Digital finance refers to the delivery of financial services through digital channels, including mobile banking, internet banking, digital wallets, peer-to-peer (P2P) lending platforms, and other fintech-based solutions. The rapid development of information and communication technology (ICT) has significantly transformed traditional financial systems by enabling faster, more accessible, and cost-efficient financial transactions (Gomber et al., 2018). Digital finance has become a key instrument for expanding financial access, particularly for unbanked and underbanked populations in rural and remote areas.

According to Ozili (2018), digital finance plays a crucial role in reducing structural barriers to financial access, such as geographical distance, high transaction costs, and stringent documentation requirements. By leveraging mobile devices and internet connectivity, digital financial services allow individuals to conduct financial activities without relying on physical bank branches. This is especially relevant in forest reserve and coastal communities, where formal financial infrastructure is often limited.

Several studies highlight the economic implications of digital finance adoption. Suri and Jack (2016) demonstrated that mobile money services significantly increased household income and consumption by facilitating savings, improving risk-sharing mechanisms, and supporting micro-entrepreneurship. Similarly, Ghosh (2021) found that digital financial services enhance income stability by enabling better cash flow management and access to short-term credit. These findings suggest that digital finance serves not only as a technological innovation but also as a catalyst for socio-economic empowerment.

2.2. Financial Inclusion: Definition and Importance

Financial inclusion is commonly defined as the availability and effective use of affordable financial services for all segments of society, particularly marginalized and low-income groups (Demirgüç-Kunt et al., 2018). These services include savings accounts, credit facilities, insurance products, and payment systems. Financial inclusion is widely recognized as a fundamental component of inclusive economic growth, poverty reduction, and income equality.

Theoretical perspectives on financial inclusion emphasize its role in enhancing productive capacity and reducing vulnerability. Access to formal financial services enables households to invest in education, health, and income-generating activities, while also providing mechanisms to manage financial shocks (Beck et al., 2007). For micro and small enterprises, financial inclusion facilitates business expansion, innovation, and market participation.

Empirical evidence supports the positive relationship between financial inclusion and income growth. Sarma and Pais (2011) found that countries with higher levels of financial inclusion tend to experience lower poverty rates and improved income distribution. Similarly, Allen et al. (2016) reported that access to bank accounts and credit services significantly improves household welfare and economic resilience. These studies underscore the importance of financial inclusion as a development policy priority.

2.3. Digital Finance as a Driver of Financial Inclusion

The integration of digital finance into financial systems has accelerated the pace and scale of financial inclusion worldwide. Digital financial services are increasingly viewed as a bridge between unbanked populations and formal financial institutions. According to World Bank (2022), digital finance has contributed substantially to the increase in global account ownership, particularly in developing economies.

Several studies highlight the effectiveness of digital finance in promoting financial inclusion. Evans and Pirchio (2015) argued that mobile financial services reduce entry barriers by offering low-cost and user-friendly platforms. In addition, digital identification systems and e-KYC (electronic Know Your Customer) processes have simplified account opening procedures, making financial services more accessible to rural communities.

In the ASEAN context, digital finance has played a significant role in expanding financial inclusion. Nguyen et al. (2021) found that fintech adoption among micro and small enterprises improved access to credit and financial services, leading to higher income growth. In Malaysia, Rahman et al. (2020) noted that digital banking initiatives and fintech solutions positively influenced financial inclusion among rural populations, although disparities remain across regions.

2.4. Community Income and Livelihood Enhancement

Community income refers to the aggregate earnings generated by households and individuals within a community through employment, entrepreneurship, and other economic activities. In rural and forest reserve areas, income sources are often informal, seasonal, and highly dependent on natural resources. As noted by Angelsen et al. (2014), forest-dependent communities frequently face income instability and limited economic diversification.

Financial access plays a critical role in enhancing community income by enabling investment in productive activities and supporting livelihood diversification. Khandker and Samad (2014) demonstrated that access to microfinance significantly increased household income and asset ownership in rural areas. Similarly, Banerjee et al. (2015) found that financial inclusion programs improved long-term income outcomes for poor households.

Digital finance further strengthens income generation by facilitating market access and financial transactions. Digital payment systems allow small-scale producers and entrepreneurs to reach broader markets, reduce transaction costs, and improve financial transparency. According to Aker et al. (2016), digital payments enhance income efficiency by minimizing cash handling risks and improving payment reliability.

2.5. Financial Inclusion in Forest Reserve and Environmentally Sensitive Areas

Forest reserve communities present unique challenges and opportunities for financial inclusion. Environmental regulations, limited infrastructure, and restricted land use often constrain economic activities in these areas. However, sustainable livelihood strategies can be supported through appropriate financial mechanisms. Angelsen et al. (2018) emphasized that access to finance is essential for promoting alternative livelihoods that reduce dependence on forest exploitation.

Several studies have examined financial inclusion in environmentally sensitive regions. Barnes et al. (2017) found that digital financial services improved livelihood diversification among forest and coastal communities in Southeast Asia by enabling access to microcredit and savings instruments. Similarly, Wunder et al. (2019) highlighted that financial inclusion supports conservation outcomes when linked to sustainable income-generating activities such as eco-tourism and community-based enterprises.

Digital finance is particularly relevant in forest reserve areas due to its ability to overcome geographical and infrastructural constraints. Mobile-based financial services allow communities to participate in economic activities without extensive physical development that could harm ecosystems. This aligns with the concept of sustainable development, which seeks to balance economic growth with environmental protection.

3. Empirical Evidence from Malaysia and Southeast Asia

Malaysia has made significant progress in promoting financial inclusion through policy initiatives and digital transformation. The National Financial Inclusion Framework and the MyDIGITAL Blueprint aim to expand access to digital financial services across all segments of society. According to Bank Negara Malaysia (2021), digital payment usage and mobile banking adoption have increased substantially, including among rural populations.

Empirical studies in Malaysia indicate a positive relationship between financial inclusion and income. Hasan et al. (2019) found that access to formal financial services improved income stability among rural households. Meanwhile, Zainal et al. (2022) reported that fintech adoption among micro-entrepreneurs enhanced business performance and income growth. However, these studies generally focus on agricultural or urban informal sectors, with limited attention to forest reserve communities.

In the broader Southeast Asian context, studies by Asian Development Bank (2020) highlight the potential of digital finance to support inclusive growth in rural and remote areas. Nevertheless, challenges such as digital literacy, trust in digital systems, and infrastructure gaps remain significant barriers to full financial inclusion.

4. Methodology

4.1. Research Design

This study employs a quantitative research design with a cross-sectional approach to examine the role of digital finance and financial inclusion in enhancing community income in the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia. A quantitative approach is considered appropriate as it allows for the systematic measurement of relationships between variables and the testing of hypotheses using statistical techniques. The study focuses on capturing empirical evidence from local community members regarding their access to and use of digital financial services and formal financial systems, as well as the implications for household income.

The research adopts an explanatory design aimed at identifying causal relationships between digital finance, financial inclusion, and community income. This approach enables the study to assess the extent to which digital finance and financial inclusion independently and jointly contribute to income enhancement within a forest reserve community context.

4.2. Research Location

The study is conducted in the Pulau Ketam Forest Reserve Area, located in Kuala Perlis, Malaysia. This area is characterized by mangrove forests and coastal ecosystems, with the local population largely engaged in small-scale fisheries, eco-tourism, informal trade, and micro-enterprises. The selection of this location is justified by its unique socio-economic conditions, where community livelihoods are closely linked to natural resources and where access to formal financial services has traditionally been limited. Additionally, the increasing availability of mobile internet connectivity in the area makes it a relevant case for examining digital finance adoption.

4.3. Population and Sample

The population of this study consists of all households and micro-entrepreneurs residing in the Pulau Ketam Forest Reserve Area. Given the absence of a comprehensive population registry, a purposive sampling technique is employed to select respondents who meet specific criteria. These criteria include: (1) being a permanent resident of the Pulau Ketam Forest Reserve Area, (2) being actively engaged in income-generating activities, and (3) having experience using or having access to digital financial services or formal financial institutions.

A sample size of approximately 135 respondents is considered adequate to ensure statistical reliability and representativeness, in line with recommendations for regression-based studies in social science research. Data are collected through structured questionnaires administered directly to respondents to ensure clarity and accuracy of responses.

4.4. Data Collection Method

Primary data are collected using a structured questionnaire designed based on previous empirical studies related to digital finance, financial inclusion, and income enhancement. The questionnaire is divided into four main sections: (1) demographic characteristics, (2) digital finance usage, (3) financial inclusion indicators, and (4) community income. The survey instrument is pre-tested on a small group of respondents to ensure reliability and validity before full-scale data collection.

Data collection is conducted through face-to-face interviews and assisted surveys to accommodate respondents with limited literacy or digital skills. This approach ensures inclusivity and reduces response bias. In addition, secondary data are obtained from official reports, academic publications, and policy documents to support contextual analysis.

4.5. Measurement of Variables

4.5.1. Digital Finance

Digital finance is measured using indicators adapted from prior studies, including the use of mobile banking, digital wallets, online payment systems, and fintech-based financial services. Respondents are asked to rate their frequency of use, perceived ease of use, and perceived usefulness of digital financial services. These indicators are measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

4.5.2. Financial Inclusion

Financial inclusion is measured through three key dimensions: access, usage, and quality of financial services. Indicators include ownership of a bank account, access to credit, access to savings and insurance products, and frequency of financial service usage. These measures are adapted from the World Bank's Global Findex framework and previous empirical studies. Responses are recorded using categorical and Likert-scale measures.

4.5.3. Community Income

Community income is measured based on self-reported monthly household income and income stability. Respondents are asked to indicate their average monthly income, sources of income, and perceived changes in income over the past year. To reduce sensitivity and reporting bias, income is measured using income ranges rather than exact figures.

4.5.4. Data Analysis Technique

The collected data are analyzed using statistical software such as SPSS or equivalent. Descriptive statistics are used to summarize demographic characteristics and variable distributions. Reliability analysis is conducted using Cronbach's alpha to assess the internal consistency of measurement scales.

Inferential analysis includes multiple linear regression to examine the influence of digital finance and financial inclusion on community income. The regression model is specified as follows:

$$CI = \beta_0 + \beta_1 DF + \beta_2 FI + \varepsilon$$

Where:

CI = represents community income,
DF = denotes digital finance,
FI = denotes financial inclusion,
β_0 = is the constant term,
β_1 and β_2 = are regression coefficients,
ε = is the error term

Prior to regression analysis, classical assumption tests are conducted, including normality, multicollinearity, and heteroscedasticity tests, to ensure the robustness of the model.

4.6. Validity and Reliability

Content validity is ensured by adapting measurement items from established studies and internationally recognized frameworks. Construct validity is assessed through factor analysis where applicable. Reliability is evaluated using Cronbach's alpha, with a threshold value of 0.70 considered acceptable for social science research.

5. Result

5.1. Respondents' Profile

This study involved 135 respondents consisting of community members and micro-entrepreneurs residing in the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia. The respondents' characteristics reflect the socio-economic conditions of coastal and conservation-based communities.

Table 1 Respondents' Characteristics

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	82	60.7
	Female	53	39.3
Age	< 30 years	28	20.7
	30–45 years	57	42.2
	> 45 years	50	37.1
Education Level	Primary/Junior High	46	34.1
	Senior High School	61	45.2
	Diploma/Bachelor	28	20.7
Occupation	Fishermen	49	36.3
	Micro-enterprises/Eco-tourism	58	43.0
	Others	28	20.7

The majority of respondents were within the productive age group and possessed secondary-level education, indicating a favorable potential for adopting digital financial services. The dominance of livelihoods in fisheries and micro-enterprises highlights the importance of accessible financial services to support income sustainability in forest reserve areas.

5.2. Descriptive Analysis of Research Variables

5.2.1. Digital Finance

Digital finance was measured through the use of mobile banking, digital wallets, and digital payment systems.

Table 2 Descriptive Statistics of Digital Finance

Indicators	Mean	Std. Deviation
Ease of use	4.02	0.71
Frequency of digital transactions	3.88	0.76
Transaction security	3.95	0.69
Access to digital services	4.10	0.65

The relatively high mean scores indicate that respondents are generally familiar with and comfortable using digital financial services. This finding supports previous studies by Ozili (2018) and Suri and Jack (2016), which emphasized the role of digital finance in overcoming geographical and infrastructural barriers in rural communities.

5.2.2. Financial Inclusion

Financial inclusion was measured based on access to bank accounts, credit, savings, and formal financial services.

Table 3 Descriptive Statistics of Financial Inclusion

Indicators	Mean	Std. Deviation
Bank account ownership	3.90	0.74
Access to formal credit	3.65	0.81
Savings and insurance	3.72	0.79
Frequency of financial service usage	3.85	0.70

The results indicate a moderate to high level of financial inclusion among the community. However, access to formal credit remains relatively lower compared to other indicators, reflecting the persistent challenges faced by rural and conservation-based communities, as noted by Demirgüç-Kunt et al. (2018).

5.2.3. Community Income

Community income was measured based on perceived income growth, income stability, and diversification of income sources.

Table 4 Descriptive Statistics of Community Income

Indicators	Mean	Std. Deviation
Income improvement	3.82	0.77
Income stability	3.70	0.75
Income diversification	3.88	0.73

The findings suggest that respondents have experienced improvements in income levels and stability, particularly through micro-enterprises and eco-tourism activities supported by digital payment systems. Digital finance facilitates smoother transactions and broader market access, contributing to income diversification.

5.2.4. Reliability Test Results

Table 5 Reliability Analysis

Variables	Cronbach's Alpha
Digital Finance	0.86
Financial Inclusion	0.83
Community Income	0.85

All variables demonstrate Cronbach's alpha values exceeding 0.70, indicating good internal consistency and reliability of the research instruments.

5.3. Multiple Linear Regression Analysis

Table 6 Regression Results

Independent Variables	Coefficient (β)	t-value	Sig.
Digital Finance	0.41	5.87	0.000
Financial Inclusion	0.36	4.92	0.000
Constant	1.12	2.45	0.016
R^2	0.58		
F-statistic	91.34		0.000

6. Discussion

The regression results indicate that digital finance has a positive and statistically significant effect on community income. The coefficient value of 0.41 suggests that increased utilization of digital financial services leads to higher income levels among community members. This finding is consistent with Suri and Jack (2016) and Gomber et al. (2018), who found that digital finance enhances transaction efficiency, reduces costs, and expands market access.

Similarly, financial inclusion also exerts a positive and significant influence on community income, with a coefficient of 0.36. This result implies that improved access to formal financial services, such as savings and credit, contributes to income growth and stability. The finding supports earlier studies by Sarma and Pais (2011) and Allen et al. (2016), which emphasize the role of financial inclusion in poverty reduction and income enhancement.

The R^2 value of 0.58 indicates that digital finance and financial inclusion together explain 58% of the variance in community income. The remaining variation may be attributed to other factors, including education, skills, environmental conditions, and local policy support. Within the context of a forest reserve area, these results highlight the strategic importance of digital financial inclusion in promoting economic well-being without compromising environmental sustainability.

7. Conclusion

This study examined the role of digital finance and financial inclusion in enhancing community income in the Pulau Ketam Forest Reserve Area, Kuala Perlis, Malaysia. The findings provide empirical evidence that both digital finance and financial inclusion play a significant and positive role in improving income levels and income stability among communities living in conservation-based and environmentally sensitive areas.

The results indicate that the adoption of digital financial services, such as mobile banking, digital wallets, and digital payment systems, has significantly contributed to increased community income. Digital finance enables more efficient financial transactions, reduces transaction costs, and expands market access for micro-enterprises and local economic activities. These benefits are particularly important for forest reserve communities, where physical access to financial institutions is limited and economic opportunities are closely linked to sustainable resource use.

Furthermore, financial inclusion was found to have a positive and significant impact on community income. Access to formal financial services, including bank accounts, savings, and credit facilities, enhances households' ability to manage finances, invest in productive activities, and stabilize income streams. The combination of digital finance and financial inclusion strengthens economic resilience and supports livelihood diversification, which is essential for communities facing income volatility in forest reserve areas.

Overall, the study demonstrates that digital finance and financial inclusion jointly contribute to improving community income while supporting sustainable development objectives. These findings suggest that policymakers, financial institutions, and development agencies should continue to promote inclusive digital financial systems tailored to the needs of forest reserve and rural communities. By expanding digital infrastructure, enhancing financial literacy, and improving access to appropriate financial products, digital financial inclusion can serve as an effective strategy for community empowerment and sustainable economic growth in conservation areas.

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