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**Digital Financial Inclusion as a Catalyst for Sustainable Livelihoods:
Determinants and Outcomes in Rural Communities**

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Abstract: This paper examined the relationship between digital financial inclusion and sustainable livelihoods among rural communities, aiming to determine how access to digital financial services influences household income, financial resilience, savings behavior, and overall livelihood sustainability. The study employed a quantitative cross-sectional design with data collected from 782 households across 30 rural villages in three districts, selected through multistage stratified random sampling. Primary data were gathered via structured questionnaires, and analyses included multiple linear regression, structural equation modeling (SEM), and correlation tests. The regression model explained 68.4% of the variance in sustainable livelihood outcomes, with digital payment usage ($\beta = 0.39$, $p < 0.001$), financial literacy ($\beta = 0.34$, $p < 0.001$), mobile banking adoption ($\beta = 0.29$, $p < 0.001$), and internet accessibility ($\beta = 0.22$, $p = 0.002$) emerging as significant predictors. SEM confirmed a good model fit ($\chi^2/df = 2.08$, CFI = 0.95, RMSEA = 0.047), and a strong positive correlation between digital financial inclusion and livelihood outcomes was observed ($r = 0.74$, $p < 0.001$). Households adopting digital financial services showed marked improvements, including an 18.6% increase in income, a 24.3% rise in savings, and a 27.8% expansion in formal credit access. These findings indicate that digital financial inclusion serves as a robust catalyst for sustainable livelihood development in rural settings. The novelty of this research lies in its integrated framework linking multiple dimensions of digital inclusion to comprehensive livelihood indicators. This study contributes empirical evidence for policymakers and development practitioners, highlighting the need to invest in digital infrastructure, expand internet connectivity, and deliver targeted financial literacy programs to foster inclusive rural development and long-term socioeconomic sustainability.

Keywords: Digital Financial Inclusion, Sustainable Livelihoods, Rural Communities, Financial Accessibility, Socioeconomic Development

Introduction

In rural areas of developing economies, problems of poverty and the lack of adequate formal financial service as well as vulnerability to economic shocks are often chronic issues. The sustainable livelihood framework provides a 'holistic' way of viewing how a household can mobilise capital (human, social, natural, physical and financial) in order to adopt livelihood strategies that lead to sustainable livelihood outcomes (Scoones, 1998). In this context, availability of suitable financial services has been found to be one of the essential pillars of investments in productive activities, consumption smoothing and risk management (Zeller, 2003). However, traditionally, brick and mortar banking has been less efficient in accessing rural areas given the high cost of transactions, limited infrastructure, and a lack of information (Mookerjee et al., 2025). The dramatic growth of cell telephony and electronic innovation has opened up new roads for bringing monetary services to new clients, such as those who are not currently engaged with the economic sector through conventional ways (Modiba et al., 2024). By using affordable digital means to provide access to financial services, including payments, savings, credit, and insurance, digital financial inclusion has become a possible game-changer for rural development (Suleiman et al., 2025). The results generated so far from sub-Saharan Africa, South Asia and Latin America showed that mobile money reduces transaction costs, enables more money transfers, and increases household savings rates (Atta-Ankomah et al., 2024). In addition, digital platforms of government benefit transfers have shown promise for delivering better efficiency and transparency of social protection schemes (Kadaba et al., 2023).

But the current state of evidence on the links between digital financial inclusion and positive sustainable livelihood outcomes remains fragmented (Hussain et al., 2025). Some studies have not captured the whole scope of study since they either included the impact of financial inclusion on a couple of indicators (either income or consumption), (Wang & He, 2020) or only on a few dimensions of financial inclusion (mobile banking only), (Kashid et al., 2025). We need a more holistic view that considers a range of other dimensions of digital inclusion - digital payment use, mobile banking engagement, financial capability, and internet access and use - and assesses the impact of these factors in reducing livelihood fragility. This imbalance was corrected in our prior work (above summarised), which had a quantitative cross-sectional design, obtained at the household level with 782 individuals in 30 villages in three districts. The main focus of the study conducted was to find out how digital financial inclusion can trigger financial resilience, financial condition, saving and income growth of rural people and consequently improve overall livelihood sustainability. We took for granted that digital financial inclusion was a good and positive asset that could provide a valuable inclusionary effect on the livelihood results and all the digital dimensions had a different effect on the livelihood results. Therefore, the findings of our interim analysis confirm this hypothesis, and the four variables considered (digital payment usage, financial literacy, mobile banking adoption and internet accessibility) account for 68.4% of the variance in sustainable livelihood outcomes, with all variables statistically significant.

There are three contributions in this research. First, it brings a holistic empirical perspective which links several dimensions of digital financial inclusion with a sustainable livelihoods construct. This integration introduces a more nuanced understanding on what services are more likely to be transformative in the digital realm. Secondly, the study contained a relatively large and representative rural sample, thus providing more solid quantitative evidence, thus enhancing external validity of what was found to similar contexts. Third, the results present actionable information for policy makers and practitioners. The strong positive correlation between digital inclusion and livelihoods outcomes ($r = 0.74$) suggest the need for investment in the digital infrastructure of rural areas, improvements in internet connectivity and more comprehensive financial education programmes to fully realize the benefits of digital financial services to development.

The rest of this paper will proceed as follows. Based on literature surveyed in Section 2, the relevant literature in the scope of sustainable livelihood, financial inclusion and the emerging digital financial ecosystem in rural areas is mentioned. In section three the methodology of this study is explained including sampling, data gathering, data preparation and data analysis. This section 4 has presented the results of descriptive statistics, regression and structural equation. This theory and the past empirical studies provide implications for this research in Section 5. Finally, policy implications and suggestions for further study are suggested in Section 6.

Literature Review

The concept of sustainable livelihood has been key in the development literature since the early 1990s, and is underpinned by the idea of a holistic approach to understanding household livelihood strategies and the use households make of combination of their asset inputs in their pursuit of a sustainable livelihood and in achieving desired livelihood outcomes (Scoones, 1998). The sustainable livelihoods approach emphasises the use of five types of capital (social, natural, human, physical and financial) and the overlap of vulnerability contexts, institutional arrangements and livelihood strategies, and their impact on household well-being (Scoones 1998). In this context, financial capital is one of the most facilitating capital as it could convert to different capital and could be used for investing in productive activities, education, health, and risk mitigation (Zeller, 2003).

Thus, financial inclusion has been deemed a crucial policy agenda for inclusive development, especially in rural areas, where the financial system is less developed. Among the various determinants, high transaction costs in rural communities because of small value transactions, access disadvantage based on geographic structure of the bank branches, the lack of formal identification systems, the lack of credit histories, and low financial inclusion literacy are factors contributing to traditional financial exclusion (Mookerjee et al., 2025). There is indeed a lot of evidence that a large number of rural households in developing countries relied on informal financial services before formal ones became available, such as rotating savings and credit associations, on money-lenders and on family networks (Zeller 2003).

Mobile phones and other ICTs have ushered in a revolution in rural financial service deliveries over the past 20 years. Mobile money, digital payment systems, and agent banking networks have significantly contributed to the improvement of access to formal financial services by reducing the financial and geospatial barriers to accessing formal financial services (Modiba et al., 2024). The benefits of mobile money adoption on household welfare are evidenced by the plethora of research, particularly in East Africa. For example, studies in Kenya have shown positive effects of interoperable mobile money services, such as M-PESA on reducing income volatility, increasing savings, and reducing the impact of negative economic shocks at the household level (Atta-Ankomah et al., 2024). Similarly, studies in Ghana revealed that digital financial services also contributed to livelihood differentiation, as the rural households were better placed to exploit non-crop livelihoods and had better access to information on market activities (Atta-Ankomah et al., 2024).

Talking more broadly, digital financial inclusion is about a set of services including digital payment, digital banking, digital credit, digital insurance, and digital government benefit transfers (Suleiman et al., 2025). All of these services may have the potential to contribute to livelihoods sustainability in various ways. The use of digital payments can lower the cost of transactions and enhance the speed of commercial exchange which can lead to higher incomes of smallholder farmers and rural entrepreneurs (Hussain et. al et al., 2025). For finance, the use of mobile-banking services enables household savings to become easier and safer, which helps households to strengthen their financial resilience to shocks (Kadaba et al., 2023). Digital credit can be provided for working capital loans to facilitate agricultural

inputs and credit for investment in micro businesses, thereby enhancing productivity and income (Kashid et al., 2025). Moreover, using digital technologies to deliver welfare benefits has been shown to improve the efficiency of the delivery; reduce leakage; and make it easier to enhance the regularity of the welfare transfer received by the household, and thereby increase household security (Kadaba et al., 2023).

Thus, there is increasing empirical evidence linking the digital financial inclusion – livelihoods nexus, particularly in China and South Asia. Digital financial inclusion was found to significantly reduce the precarious situation of the poor and help mitigate income fluctuations, as well as credit access, for Chinese rural household (Wang & He, 2020). In an study that has applied livelihoods (sustainable) framework approach, researchers have pointed out varied combinations of elements of digital inclusive finance, assets of the farmer's household or context of the institution that facilitate common goodprospa of farmers (Hussain et al., 2025). Empirical research from Pakistan also underscores the significance of digital financial inclusion in fostering sustainable agriculture, revealing insights from research on its impact on environmentally responsible farming practices (Hussain et al., 2025).

However, there are quite a few gaps in the literature. First, several studies have looked at single dimensions of digital financial inclusion while most have ignored looking at the multifaceted nature of digital financial inclusion. Some studies, for instance, estimate the impact of mobile money alone (Atta-Ankomah et al., 2024) or that of digital credit alone (Kashid et al., 2025). This disaggregated approach may miss the co-impacts of adoption of two or more digital financial service simultaneously. Second, most of these studies have been conducted in some of these countries (primarily in East Africa, China and S. Asia) and would be unlikely to be applicable in countries with different institutional and infrastructural characteristics. Third, very few studies obtained sustainable livelihood outcomes as a composite index with the inclusion of multiple indicators, and only included income and consumption or saving as a single indicator (Suleiman et al., 2025).

The aforementioned gaps were filled through a study that used an integrated framework to look at four dimensions of digital financial inclusion: use of digital payment platforms, adoption of mobile banking, financial literacy and internet accessibility to capture their collective impact on a composite Sustainable Livelihood Index. This was to reflect the multi-level and multi-faceted nature of independent and dependent variable in this way that there might be more comprehensive and robust analysis of digital inclusion-livelihood sustainability relationship. Disaggregation of the effects of each dimension of the digital made it possible to discuss the impact of individual parts of the digital portfolio on rural livelihoods and thus make more specific policy recommendations than previous research.

Methodology

Research Design and Analytical Framework

The quantitative cross-sectional approach was employed in this study in order to examine the empirical relationship between digital financial inclusion and sustainable livelihood outcomes of rural households. The cross-sectional design was selected because it enables the evaluation of a set of determinants of digital financial inclusion along with a set of determinants of livelihood sustainability at a specific point in time in order to gauge ‘what is happening’ in terms of digital financial inclusion and its association with livelihood determinants of sustainability. The analytical analysis framework was designed to drill down on two main constructs: Digital financial inclusion (comprising four dimensions – digital payment usage, mobile banking adoption, financial literacy and internet accessibility); Sustainable livelihood outcome (comprising five sub-instruments – household income, savings behaviour, formal credit usage, financial resilience and livelihood diversification).

Study Area and Sampling Strategy

Three purposively selected districts in this research resulted in the surveying of 30 rural villages. These districts were chosen to represent diversity of digital infrastructure development and economic activity and geography across the region. A three-stage stratified random sampling was used to provide representativeness of the sample. Random selection of villages based on the population size of the three districts was done as the first stage of selection under stratification based on administrative blocks. This was followed by stratification of the selected villages households by occupation (agriculture, wage labour, small business and others) to incorporate livelihood diversity which is the second phase. Lastly, household-level sampling interval was systematically sampled from the list within each village and urban area, which was derived from the local administration records, for villages and urban areas, respectively. The target sample size was determined using medium expected magnitude of effect, statistical power 0.80 and static-tistical alpha level 0.05 and by a 10% increase on the resulting sample size, to allow for anticipated non-response or incomplete records, if these arise. After excluding incomplete questionnaires and data cleaning, a total of 782 valid questionnaires were obtained after excluding incomplete questionnaires, thus, an effective rate of 97.75% was obtained.

Data Collection Instruments

The instrument for data collection was a well-structured questionnaire, and face to face interview with the target group (household heads or the adult house hold members who made the major's financial decisions) was conducted and primary data was collected. The questionnaire was organised into sections and collected the following domains: Knowledge of demographic characteristics – age, gender, education and household size; Household Income – amount of income received in the past month from all sources; Occupation – primary and secondary activity of the available time; Smartphone ownership, internet access – owns a smartphone and internet availability; Financial transactions using digital technologies – frequently and ever made a mobile payment of money, use digital wallet and has a bank account with internet access; Financial Literacy – composite index for the reported knowledge related to 'interest rate', 'compound interest', 'inflation' and 'risk diversification'; Savings behaviour – has formal savings account and savings in formal account; Obtained formal digital credit in the past 12 months and government benefit transfers – received a welfare payment through digital means; Livelihood diversification – number of sourcing livelihood activities and indicators of household resilience – reported ability to meet an emergency expense, food security status and asset ownership. Depending on the specific construct, items were measured using a Likert Scale, a binary Scale, or by actual numbers.

A pilot test of the questionnaire was done in a village other than the one that was selected for the final sample with 50 households. Financial literacy questions were vetted through minor changes in the wording of questions and clarifying examples, to show feedback from the pilot testing. Cronbach Alpha was used to determine internal consistency for multi-item constructs, and exceeded 0.70 on the pilot data. The whole sample was subjected after the eight weeks to the final questionnaire, with each interview having an average length of one hour (45-60 minutes). Government benefit transfer data, formal credit access data and credit institutions' data also were collected and applied to validate self-reported data.

Variable Construction and Data Preprocessing

We used a systematic preprocessing pipeline for the raw data prior to the statistical analysis to assure data quality and comparability. Initial questionnaires which had over 20% of the responses blanked were not taken into consideration in the analysis. The other questionnaires had missing values filled in

using “median method” in order to keep the data distributional property, and it is not affected by the effect of the outliers. Secondly, data were coded and data validation was done to test the ranges of data given and the skip patterns entered checked for consistency. Third: winsorization to the nearest non-outlier value occurred using the Interquartile Range (IQR) method: values < or > were winsorised to the closest non-outlier value. Fourth, to assure the comparability of all the indicators in units and range scales all the continuous variables were normalized with the Min–Max method. The formula for normalization for a variable measured in samples, of which is the minimum value measured and is the maximum, is: . Fifth, Cronbach Alpha was used to test the reliability of the composite indices, and the values for Digital Financial Inclusion Index (0.82) as well as Sustainable Livelihood Index (0.79) was above the reaccepted threshold of 0.70.

The Digital Financial Inclusion Index (DFII) is a dimensionally secured weighted composite of four indexes: frequency of use of a digital payment, the intensity of the mobile banking index, score of financial literacy index, and the internet accessibility index. The sub-indicators were given equal scores, and their independence was theoretically argued when relating to the overall score of inclusion. Similarly, the Sustainable Livelihood Index (SLI) was derived, as a harmonised combination (all factors are equally weighted) of five sub-indicators: livelihood diversification count: the number of livelihoods used: savings rate: the ratio of savings/Income: financial resilience score: self-reported ability to meet negative shocks by selling assets or reducing expenses: formal credit access: binary indicator whether household reported for formal digital credit or not; and household income growth over the period of the study. Both indices have a range between 0 and 1, in which higher scores represent a greater level of digital inclusion or more sustainable livelihoods.

Statistical Analysis

The analytical approach was carried out in a few stages. Further, they were followed by computation of descriptive statistics (mean, SD, frequency and percentage) to describe the sample and distribution of the important variables. Second, Pearson correlation analysis has been done to determine the level of bivariate association between Digital Financial Inclusion index, its four sub-components and Sustainable Livelihood index. Third, a Multiple Linear Regression model was estimated using the data from the SLI as dependent variable, and the four dimensions of digital inclusion: digital payment usage (), mobile banking adoption (), financial knowledge () and internet connectivity () as independent variables as well as controlling for other demographic details: age, gender, educational attainment, household size. The regression equation is:

$$SLI = \beta_0 + \beta_1 DPU + \beta_2 MBA + \beta_3 FL + \beta_4 IA + \gamma Z + \epsilon$$

The adoption of digital payment, is the adoption of mobile banking, is financial literacy, is Internet connectivity, is a vector of control variables and is the error term. The value of standardised beta-coefficients were reported for direct comparison of the importance of each variable. Fourth, the method used in testing the theoretical models was Structural Equation Modelling (SEM) with Amos Software by Maximum Likelihood analysis method to show the latent structure of Digital financial exclusion and inclusion. A second order latent measurement model was developed, where the four variables were measured indicators of digital financial inclusion, which is a second order latent variable. Chi-square-to-degrees-of-freedom ratio (), Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI), in addition to Root Mean Square Error of Approximation (RMSEA), during model fit assessment were used as acceptable fit. Further, the chi-squared test was used to analyse categorical relationships between digital service use and other categories (e.g., gender, and digital banking use and non-use) and the independent sample t-test was used to compare mean scores for SLI between categories (e.g, digital banking users

versus digital banking non-users). SPSS Version 29, AMOS and MS-Excel, R Version 4.3 software were used to analyse the data.

Results

These results come from an analysis of experiences and data gathered from 782 rural households across 30 villages and provide some empirical evidence of the relationship between digital financial inclusion and the ability to sustain livelihoods. The analysis is conducted in three steps: 1) an analysis of the usage of digital financial services and its impact on livelihood improvements, 2) a Multiple Regression (MR) analysis, and 3) a Structural Equation (SE) analysis to test the fit of the model and to try to explain the determinants.

Participant Characteristics and Digital Access

A total of 18 questionnaires were not used in the final analysis and 782 questionnaires applying to some 766 households were used. In the case of gender representation of the respondents, the findings showed that the financial decision-makers in households had a significant gender disparity with males accounting for 61.4% and females for 38.6%. The mean age of respondents was 42.7 years (SD = 11.3); this is a relatively middle-aged population who are the most likely to be in charge of household money in rural areas. Education wise, there were approximately 47.8% educated up to Secondary level, 32.4% educated up to Primary level and 19.8% without any education.

Regarding digital access, the findings indicated high levels of mobile access penetration, in sampled rural communities. 86% of all households reported having a smartphone and 68.5% indicated internet connectivity – primarily through a cellular data network. There was also high penetration in digital banking with a mobile banking apps and internet banking for 64.9% of households. These demonstrate that the basic digital infrastructure is gradually getting available in remote rural areas and a large number of the population (~27%–35%) is still not integrated in the digital finance ecosystem.

Looking at the more concrete use of individual digital financial services, data revealed that 71.2% of households were regularly using digital payments platforms, as either mobile money transfers, point-of-sale (POS) digital transactions or online bill payments. The convenience and lower transaction costs associated with digital payments might be linked to the uptake rate, compared to the previous cash payment. 64.9% reported using the mobile financial services for bank needs and 58.3% reported that they had received benefits of government welfare programmes online. 46.7% of households had formal digital credit, suggesting a moderate (but notable) acceptance of digital credit lending services.

Varying digital access characteristics were then looked at across different demographic groups. Chi-square test showed that there was a significant association between gender and the use of digital payment ($df(1) = 18.92$ ($P < 0.01$); the rate of use of digital payment among male was higher than among the female participants (76.8% vs 62.1%). Similarly, male respondents (78.2%) were much more likely to have a smartphone than female respondents (63.4%). The educational level also correlated strongly with access to digital: 82.1% of the secondary or higher education group had a smartphone and 75.6% used digital payment tools compared to 48.2% and 51.3% respectively of the no formal education group. These differences reflect the on-going rural digital divides with gender and education factors being relevant in determining technology access, consistent with the findings of previous studies on gender inequities in digital financial services access (Modiba et al., 2024).

Access to the internet was very much related to age, with younger (aged 18-35) having 84.5% access to the internet, while 36-50 aged people said they had 62.1% and those older than 50 said they had 41.2%. The age range suggests that younger age groups are less averse to new technologies, and that in

the future, possible further adoption of digital financial services could be easier to realize thanks to cohorts' ageing. Participant descriptions of participant demographics and digital access indicate a general trend of a more and more willing community to engage in digital technologies, though marked differences exist in the uptake, which can be observed across genders, age bands and level of education. These patterns form the basis for the next analyses in relation to the digital inclusion and livelihood outcomes.

Digital Financial Service Usage and Livelihood Improvements

This subsection will further explore the link between the uptake of digital financial services and actual changes in household livelihood outcomes in more detail, focusing on the individual services. Data indicated that there were households for whom the use of DfS was active and there was some improvement observed in various indicators of livelihood sustainability. The average income of the digital service users' household increased 18.6% and average household savings by 24.3% over the baseline period on the time of the survey. The number of households with access to formal credit grew 27.8% and the financial resilience score (which reflects a household's ability to deal with economic shocks) improved by 21.5%. There was an increase of 16.9% in livelihood diversification, which is the number of different sources of livelihood activities each household practiced.

A Pearson correlation analysis was performed to systematically examine these relationships on a global scale, between the Digital Financial Inclusion Index (DFII) & the Sustainable Livelihood Index (SLI). In general, results of this analysis can be used as initial evidence if there is a correlation between digital inclusion and sustainable livelihood types and the result of sustainable livelihoods and the result of correlation both have a value of less than 0.05 which indicates that there is a correlation while both results have a value of > 0.05 which is statistically significant. This overall correlation did not stop it from being disaggregated and analysed the linkages between dimensions of digital inclusion and the composite livelihood index. Digital payment usage correlated at with the SLI, internet accessibility at and financial literacy at. Results were statistically significant at the level for all the digital components, meaning that each one of them is effective and makes its own contribution to improving livelihoods, although to different extents. The second strongest single correlate was the use of digital payments: as well as the access to electronic payments, getting electronic payments is also a potentially transformative service for rural households.

Additional evidence came to light in comparing the groups. Independent samples t-test was used for the mean SLI scores of the households that used and did not use mobile banking services. Users of mobile banking were significantly different with higher mean SLI (Mean = 0.67) as compared to non-users of mobile banking (Mean = 0.41). A similar trend was found for the use of Digital Payment Platforms: the mean SLI value for those who regularly used Digital Payment Platforms was 0.69 (SD = 0.14), while the mean SLI value for those who did not regularly use Digital Payment Platforms was 0.38 (SD = 0.19). The Takeaways highlight the real benefits of participation in a digital financial system in terms of sustainability of livelihoods. Accessibility of government welfare benefits via digital platforms also seemed to be important: a mean SLI score of 0.44 (SD = 0.20) for households served via traditional means of distribution (cash) was lower than for those served through digital channels (0.66, SD = 0.16).

A quantitative comparison of livelihood outcomes of households who took the formal digital credit and the ones who didn't take the formal digital credit was carried out to get a more detailed view of the changes. Households with access to digital credit exhibited a 22.1% increase in their mean household income while households without access to digital credit had 15.4% increase in mean household income and the rate of saving for both the types of households was above average but also differed greatly from

one group to another (9.8% of the income increase against 14.5% of the increased income for households with and without access to digital credit, respectively). These statistics indicate that digital credit can help households to build income and savings, which includes the working capital needed to undertake productive activities, thus boosting their total income and savings. It's worth highlighting, however, that this is an associational finding, and that we cannot confidently say that households with greater incomes were necessarily more likely to qualify for—and thus choose—digital credit products, leading to a potential selection effect.

Livelihood diversification and Digital inclusion were also explored in detail. The mean number of livelihood activities by a household who reported the use of at least 3 DfS was 3.4 (SD = 1.1) while that of the households who did not reported the use of at least 3 DfS was 2.1 (SD = 0.9). This aligns with how digital financial services save costs on accessing market information and paying for provision of goods and services, among other income-generating activities (Atta-Ankomah et al., 2024). The data, in turn, generally suggest a picture of a digital financial system that make possible low-income households with more access to it a wider and more diversified sets of livelihood strategies.

Predictive Analysis and Model Fit

The digital dimensions were subsequently added in terms of a predictive model: regression analysis was performed to assess the independent impact of all the digital dimensions on the livelihood outcomes after controlling for the impact of confounding factors, and after important bi-variate relationships between the digital dimensions and livelihood outcomes had been identified. A multiple linear regression was estimated where the Sustainable Livelihood Index (SLI) is the dependent variable and the four pillars of digital financial inclusion, namely digital payment usage, mobile banking use, financial literacy and Internet access were key independent variables, along with the control variables of age, gender, education and size of the household.

Based on the results of the regression analysis, it was found that the sustainable livelihood outcomes had significant variation attributable to the digital financial inclusion dimensions. The overall model was highly significant with an adjusted R^2 of 0.684 which means about 68.4% of the variability in the SLI was accounted for by the predictors in the model. The elevated explanatory influence highlights the pivotal role of digital financial services within the rural communities studied, to livelihood sustainability.

The results of standardized regression coefficients (β) gave some insights of the relative importance of each of the digital dimensions. The most significant predictor observed was increased usage of a digital payment and its increased extent of use with a standardized $\beta = 0.39$ ($p < 0.001$). Each one SD increase in frequency and extent of using digital payments was associated with a 0.39 SD increase in the SLI (holding all other factors constant). The second in-line impactful predictor was financial literacy—financial knowledge and understanding of financial concepts ($\beta = 0.34$, $p < 0.001$), as this was critical to successful use of the digital services by households. Internet accessibility, also an important predictor, had a relatively lower β of 0.22 ($p < 0.001$); mobile banking, on the other hand, had a β of 0.29 ($p < 0.001$). The relatively lower coefficients of the internet accessibility might be due to the fact that internet could be a prerequisite that many livelihoods digital services must take place and the effect of internet on livelihood outcomes needs the use of specific applications such as digital payment and mobile banking.

The only demographic control variable that positively and significantly related to the SLI was level of education ($\beta = 0.12$, $p < 0.001$) and was in line with the human capital theory and the implication was that better educated individuals can implement a new technology and access financial resources. Gender also had a significant influence, Household Heads being a male household being one (HHM)

had a slightly higher score on SLI, when taking into account levels of digital inclusion ($\beta = 0.08$, < 0.001). The multivariate model showed age and household size to be not statistically significant determinants of livelihood outcomes (); indicating that their stressors on livelihood outcomes are quite indirect, through the patterns of digital adoption.

Following this, Structural Equation Modeling (SEM) was used to further assess and validate the theoretical framework and determine the latent structure of digital financial inclusion. As the relationships between the different latent DFIs and their respective observed indicators do not need to be tested individually under the SEM approach and the same paths can be tested concurrently, SEM approach was found to be useful for both the estimation of the convergence between the different latent DFIs and their respective observed indicators, and also estimating the path from the different latent DFIs to the latent SL outcome. Digital financial inclusion was modeled as second order latent (reflective) factor and reflected by four observed dimensions and direct path was observed from second order latent to SLI.

The overall goodness-of-fit indices of the model tolerated a good fit between the proposed model and the observed data. The ratio of chi-square to degrees of freedom was 2.08 (indicating a maximum of 3.0 is recommended), which indicated low amount of difference between the predicted and observed covariance matrices. CFI and TLI value were resulted as 0.95 and 0.94 respectively, which was consistent with 0.9 as a common criterion. In addition, the Root Mean Square Error of Approximation (RMSEA) is 0.047 and below 0.05, which is a tough indication of a good approximation to the population covariance matrix. The results of the model fit are high, thus showing that the conceptualization of the multidimensional digital financial inclusion is valid and as a whole can have the role to improve livelihood sustainability.

The slopes of 0.72 () of the standardized path of this latent digital financial inclusion factor to the SLI is consistent with the strong bivariate association of 0.74 mentioned above. The result validates the main hypothesis that digital financial inclusion is actually a great enabler for sustainable livelihoods. All the four observed indicators had significant factor loadings 0.81 (using digital payments), 0.76 (banking by mobile), 0.68 (financial literacy), and 0.61 (internet access). While the pattern of loadings remained the same as the regression coefficient, the scores for the digital payment usage was the highest with respect to the latent construct, followed by mobile banking adoption, financial literacy and internet accessibility.

Overall, the regression and SEM results suggest the same theory: digital financial inclusion, defined by the four pillars of using technology for sustainable livelihoods, plays an important role in rural communities. As per the regression Model 68.4% variance in livelihoods is explained by the variance in the factors in the model while SEM confirms the Structural Validity of the digital inclusion construct and a strong and acceptable direct link between digital inclusion and livelihood sustainability. Overall, the analysis confirms that targeted interventions on each of the digital inclusion components can lead to significant gains for these households with regard to their earnings, savings, and credit, their financial preparedness, and the diversification of their livelihoods.

Discussion

The results of the investigation have numerous theoretical and practical impacts on the way digital financial inclusion is related to the sustainable livelihoods of rural population. Theoretically, the value of strong path that is predicted in this structural equation model ($\beta = 0.72$) gives a strong empirical support to the conceptual model that see the digital financial inclusion as a multidimensional factor that could help in making livelihoods sustainable. This finding demonstrates that access to digital financial services (DFS) and not only to financial services – the ones traditionally measured as access to

branches—is unique and a great catalyst to household resilience and income generation. Furthermore, the differences in factor loadings between the four factors suggest that the theoretical concept of digital financial inclusion is not distinct, but that digital payment usage (factor loading = 0.81) and mobile banking adoption (factor loading = 0.76) are more fundamental to that of financial inclusion, whilst internet accessibility (factor loading = 0.61) and financial literacy (factor loading = 0.68) are not. The hierarchical classification of this classification indicates that the theoretical conception of financial inclusion through digital means cannot only be based on access to infrastructure, but also on how this infrastructure is used, aspect that has not yet been mentioned in the literature (Cámara & Tuesta, 2014).

The implications of these findings for policy and development practice with regard to rural economic development are quite large. Given that it was the use of digital payments that impacted livelihoods most, areas of insufficient digital payments coverage - underserved rural areas - should be the focus of policy attention in order to increase the role of digital payments as a livelihood. Governments have the authority to encourage mobile money, specifically by removing costs from mobile money transactions, facilitating mobile money registration, and one key hurdle—interoperability—among mobile money providers. In second place after digital payment use, a coefficient of 0.34 further shows that financing investments and support to the infrastructure is insufficient without financial literacy. Therefore, there is a need to create and arrange dedicated financial education courses which can strengthen the financial literacy of the rural population to access the digital account and get acquainted with mortgage specifications and against predatory lending. Programmes could extend the beneficial effect of digital infrastructures by enabling the use of services with informedness through community based trainings or mobile learningApps. Furthermore, the results of the chi-square tests indicate that digital access rates are indeed related to gender, which means that interventions should be gender sensitive – for instance focus on gender sensitive trainings, have a female extension agent, and include a gender based approach in digital products used in rural financial decision making.

A few methodological limitations should be highlighted to interpret the results and conclusions of this study. First, from a single point of time of a study, it is not possible to draw any clear inferences of a cause-and-effect relationship, although the Regression results and the results of SEM indicate strong relationship between the financial inclusion in digital technologies and the livelihoods outcomes. It is also plausible to believe that more sustainable livelihood households have greater ability to access digital financial services and that unobserved factors or exposure (e.g. type of entrepreneurial firms, social networks) each influence the success of the livelihood and the adoption of digital financial services. These causal pathways would have to be separated using longitudinal data collection with repeated measures. Second, being confined to within three districts, in the same region, in rural areas only, may limit the extend ability of the results to other rural areas with different social-economic identity, culture or digital infrastructures development. Digital finance products may be adopted in very different ways in rural populations living in conflict zones, or where the telecommunications industry is weak (for technical reasons) and/or where the regulatory environment for digital finance differs. Third, all the variables from the income, savings behavior, and financial education categories are self-measured which could result in “recall” and “social desirability” biases. Relations between digital inclusion and the livelihood outcomes may be over-exaggerated because respondents may have overstated their income, knowledge of finance, and/or understated their access to informal financial outlets. Fourth, the research did not capture the quality of digital payment use, or how deep the use was, which was also relatively binary: two homes were said to be “digital payment users” even though one might have a handful of digital payments in their entirety and another might have many digital payments. In the future investigations, more refined estimates of engagement intensity may be used.

Due to the limitations of this study, and the content of the substances used, several research directions emerge: Longitudinal panel studies (observing the same households over successive years) are urgently needed that would enable a temporal order and these would help to better understand the dynamic effects of digital financial inclusion on livelihood trajectories. To give an example, early adoption of digital payments could be linked to the impact on earnings over a span of five years, or a given timeframe when the impact effects reach saturation as a result of the saturation of technology adoption. Furthermore, the impact of the contextual variables not considered in this study which may affect access to, and use of, digital financial services, such as geographic remoteness, community social capital, presence of formal financial service providers and formal regulation of digital financial services should be investigated in future studies. The analysis of the context factors (how they make a difference and what they add, and remove, in terms of the impact of digital inclusion) would help offer more targeted policy recommendation. Furthermore, there is a need for qualitative study that would explore more deeply into the experiences of the last mile households in relation to using digital technology, especially for women and less educated people, to understand the social and cultural issues that may not be captured in quantitative surveys. Under-studied areas are the effect of digital financial inclusion on intra-household bargaining dynamics, the potential to increase indebtedness of vulnerable households as a result of use of digital services and the role of peer effects and social learning in driving adoption. Lastly, a study of the variables of financial inclusion and their interplay with institutions in different countries can contribute to understanding which ones most significantly contribute to enhancing non-financial benefits through digital financial inclusion. A comparative between countries study can therefore help determine if the robust effects identified in this study are unique or if it is a generalized rural path towards sustainable rural livelihoods.

Conclusion

This study intended to examine the effect of Digital Financial Inclusion (DFIn) in influencing sustainable livelihoods outcomes of rural communities by investigating whether and how (Digital Financial Inclusion –DFIn) is a determinant of sustainable livelihoods outcomes of rural communities. The findings provide a clear response, one which is also statistically robust: the multidimensional nature of the concept of digital financial inclusion – which measures digital payments usage, mobile banking usage, financial literacy and internet access – results in a well-defined and reliable positive link between it and expanded household incomes, saving accumulation, formal credit access, financial resilience, and livelihood diversification. The model explained 68.4% of the variation in livelihood outcome and the latent path coefficient of the structural equation model was strong (0.72), thus giving strong empirical evidence in support of the theoretical approach of DFS for supporting rural development. This study builds on the current literature by not only considering financial inclusion but also providing a comprehensive and multi-faceted analysis showing the varying impacts of each of the specific dimensions of digital services—particularly financial literacy and the use of digital payments—on livelihood sustainability. The work thus clarifies the fact that digital finance goes beyond infrastructure and that this potential can only be realised through informed active usage of services.

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