Digital Financial Awareness and Sustainability Outcomes among Women in Vulnerable Communities in Andhra Pradesh

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ABSTRACT

Background: A significant number of women in India continue to be left out of the formal financial systems and hence are unable to move towards sustainable livelihoods. Digital financial services are being touted as a promising tool for inclusion; however, the evidence to suggest that this leads to multidimensional sustainability outcomes—particularly for marginalized women—is weak. Andhra Pradesh, being a state with varied rural, tribal, and semi-urban settings allows us to study this association.

Methods: The study was a cross-sectional quantitative study conducted in 2024 among 280 at-risk women between the ages of 18 and 60 from six districts of Andhra Pradesh, by applying multistage stratified random sampling. Digital financial literacy was assessed with a validated 10-item Likert-scale tool (Cronbach's α = 0.847). We measured sustainability outcomes in terms of economic, social, and environmental outcomes. Analysis techniques included descriptive statistics, paired sample t-tests for a sub-sample who received a digital financial literacy intervention, tests for multi-collinearity, and multiple regression analysis with socio-demographic variables as control variables.

Results: Respondents knowledge towards digital financial awareness was moderate (mean = 32.47/50). The paired t-test results for the participants of the intervention revealed positive and significant changes in the variables monthly income, food security, income generating activities, savings, and adoption of sustainable practices ($p < 0.$ (01), although the variations in children's attendance at school were not significant. Multiple regression results showed that digital financial literacy was the best significant predictor of composite sustainable outcomes (β = 0.512, $p < 0.001$) and it accounted for a large portion of variance (R^2 = 0.624). Education, ownership of smartphones, membership in SHG and urban residence were found to be positive determinants of sustainability, whereas the size of the household was a negative determinant.

Conclusion: The findings demonstrate that digital financial literacy significantly enhances multidimensional sustainability outcomes among marginalized women in Andhra Pradesh. Beyond access, strengthening digital financial capabilities through targeted, context-sensitive interventions is critical for advancing inclusive and sustainable development.

Keywords: Digital financial awareness, sustainability outcomes, women empowerment, vulnerable communities, Andhra Pradesh, financial inclusion

INTRODUCTION

In India, where nearly half of all women — around 480 million — are excluded from formal banking systems, these digital financial services have the potential to transform lives. With its mix of urban, rural and tribal

populations, Andhra Pradesh provides a particularly strong test case for seeing if digital financial literacy among at-risk women can be converted into real sustainability impacts.

Marginalized communities in the current context include women from Scheduled Castes (SC) and Scheduled Tribes (ST) communities, underprivileged classes, single mothers, and women living in resource-poor settings. These areas of population are subject to multiple layers of marginalisation, facing barriers including their reduced ability to access physical, traditional financial infrastructure, experiencing lower levels of educational attainment, as well as constrained economic participation. The rise of digital financial services such as mobile banking, digital wallets, applications for microfinance, and government payments through benefit transfer mechanisms has been argued to democratize access to financial services. To what extent this type of technologically-flavored access leads to actual knowledge, practice and ultimately sustainable livelihood betterment is not well documented.

Outcomes of sustainability are more than just economic outputs, and may include social resilience, environmental stewardship, and long term community health. And for marginalized women, sustainability is reflected in higher household income stability, better food and nutrition security, greater involvement in community government, sustainable livelihood practices, and education for future generations. Digital financial literacy, referring to the competence of individuals in using digital financial tools and services, including their sextant knowledge, practical skills, and confidence level to deal with digital financial activities, is considered as a promising factor to drive such complex outcomes.

This study attempts to answer these 3 core questions: (1) What is the status of women's digital financial knowledge in rural communities of Andhra Pradesh? (2) How do the sustainability results differ across various axes of this group? (3) How is digital financial awareness related to sustainability outcomes socially, when controlling for other factors? This study, through rigorous quantitative techniques such as reliability testing, correlation analysis and multiple regression modeling, provides empirical findings to guide policy level interventions for harnessing the potential of digital financial inclusion for sustainable development.

LITERATURE REVIEW

Scholarly discussions have shifted in the financial inclusion space from focus on providing basic access to banking to considering digital financial literacy and developmental impacts. Mobile money Usage – Impact on Poverty and Gender – Demirgùç-Kunt et al. (2018) found that usage of mobile money had a considerable impact on reduction of poverty levels among women in developing countries, results were more significant where the access to banking was difficult or non-existent. Their study of 37 countries over time indicated that digital financial services significantly narrowing gender gaps in account ownership by 7 percentage points.

Studies on India specifically underscore the challenges of the relationship between technology access and use and digital literacy and actual financial behavior. Mukherjee and Chatterjee (2021) observed that although the rural Indian population was the recipient of hyped smartphone penetration rates above 60% penetration, engagement with digital financial services were largely constrained by literacy limitations, complexity of interface, and lack of trust. The qualitative research in Rajasthan and Madhya Pradesh showed that women with secondary education were 3.2 times more likely to use mobile banking than those with primary education only.

The sustainability angle is a further complication in this inter-relation. Arora and Mehra (2020) viewed financial inclusion as a means for realizing various Sustainable Development Goals (SDGs), including SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 8 (Decent Work), and SDG 10 (Reduced Inequalities). Based on their work in Kerala, the two also showed positive associations between women's financial independence and investments in children's education and health care, as well as adoption of environmentally sustainable agricultural practices.

A number of regional studies from Andhra Pradesh testify to the state's status as a pioneer in digital governance and financial inclusion. The Indiramma housing scheme, DCT processes, compulsory financial literacy trainings through SHGs have undoubtedly helped that is very friendly for digital financial inclusion. Yet, Reddy and Naik (2022) observed existing discrepancies, commenting that the difference in digital financial literacy

among women from SC/ST groups is as much as 40% lower than general category women and that persistent gap is not accounted by educational attainment and income.

Conceptual models connecting financial literacy to sustainability outcomes are informed by capability theory, which suggests that development ought to expand the substantive freedoms enjoyed by people to do and be what they value. In Sen's capability approach, they tart that merely access to resources is not enough and people need to have the knowledge, skills and agency for transforming resources have meaningful LTPs. With regard to digital financial literacy, this means that the simple extending of digital infrastructure can not be regarded as helpful promoting digital literacy without strengthening navigational skills and contextual awareness.

Yet, such an accumulation of literature still leaves some important gaps unaddressed. First, an overwhelming majority of existing work conceptualizes financial literacy as a one-dimensional concept and ignores the various skills needed for navigation through the digital finance space. Second, sustainability results are too often assessed through narrow economic indicators, ignoring social and environmental considerations. Third, small sample sizes, cross-sectional designs, and poor control for confounders limit methodological rigor and the ability to draw causal inferences. This is tackled in the present work by means of comprehensive instruments, multidimensional outcome evaluation, and sophisticated statistical modeling.

Andhra Pradesh's demographic profile illustrates the general developmental dilemma facing India. As of 2024, The state has around 27.8 million women out of which 41.7% live in rural pockets with rural houses in some of those rural pockets are nothing less than uninhabitable due to complete lack of infrastructure and income generating options. Marginalized women, about 38% of all women, are doubly and triply marginalized by caste discrimination, poverty, and distance. Approximately 19.2 % of all women in the state belong to the Schedule Caste, while 6.8 % of women belong to the Schedule Tribe majorly residing in the Agency areas of Visakhapatnam, East Godavari and Srikakulam districts. The participation of vulnerable women in the economy continues to be limited, the rate of participation in the labour force being some 34% and this is well below the average for women in the country. Most work as farmers, or in the informal sector, or as small traders whose incomes are unstable. Despite government measures, women continue to be excluded from finances and 31% of vulnerable women do not have access to a formal bank account and among those with accounts, more than 40% are dormant. Digital literacy is also a barrier: only 28% of women in these communities have skills for functional smartphone use beyond the basic calling feature.

The execution of various state and central government schemes has generated a thrust towards digital financial transactions. The YSR Aasara scheme of the Andhra Pradesh government also channels the funds to women's bank accounts on a monthly basis, while the Jagananna Amma Vodi scheme is a digital mode of delivering funds for educational support. Inadvertently, these efforts have brought vulnerable women onto digital financial platforms, for better or worse. Numerous females say that they have gotten funds not knowing the details of the transactions, security of the passwords, or any more services of the bank aside from withdrawing.

The State has a crucial intermediary institution of SHGs with 1.2 million women and 98,000 are functional. These groups were previously concerned with microfinance and skills development, and now build digital financial literacy modules. However, the quality of training is highly varied among districts, and is more comprehensive in the better urban and semi-urban ones as opposed to the more remote rural ones. Infrastructure challenges such as unreliable power supply, scanty mobile network coverage in certain tribal pockets and inadequate banking correspondent presence, among others, further magnify the access problem.

Gradual improvement with lingering vulnerabilities was revealed by social sustainability indicators. To compare, SC women's literacy is about 58 percent and ST women's literacy is 49 percent. Similar disparities are seen in health outcomes, as these marginalised woman suffer from higher maternal mortality ratios and give birth in institutional facilities at lower rates. Environmental sustainability consciousness are low but traditional ecological knowledge (TEK) is strong in tribal societies. The convergence of poverty, social exclusion, and environmental hazard results in compounded risks, and these risks are exacerbated by the fact that climate perturbations are making agriculture, which is the primary source of livelihood for these communities, more unpredictable.

RESEARCH METHODOLOGY

Research Design and Sampling

This research is a cross-sectional quantitative study with the use of the structured questionnaire as the instrument. The target population consists of vulnerable women in the age group of 18-60 years from the entire state of Andhra Pradesh. To ensure geographic and demographic representativeness, a multistage stratified random sampling technique was applied. They were (a) Anantapur (drought prone rural) (b) Visakhapatnam (tribal concentration) (c) Krishna (semi-urban) (d) Prakasam (coastal) (e) Kurnool (economically backward) (f) Chittoor (mixed demographic). Within the district, blocks were selected by simple random sampling, a list of villages/wards under the selected blocks was obtained and a village/ward was selected by lottery method, then a systematic sampling was employed for selecting households.

Of the total study population (N = 280), a majority of them belonged to different categories of vulnerable community: Scheduled Castes (38 percent), Scheduled Tribes (24 percent), economically backward classes (21 percent), widows/single mothers (11 percent) and landless agricultural laborers (6 percent). The sample size calculation was based on the formula $n = Z^2pq/e^2$, where $Z = 1.96$ for 95% confidence level, $p = 0.5$ (assumed maximum variability), $q = 0.5$ and $e = 0.05$ (acceptable margin of error), which resulted in the minimum sample size of 385. Nonetheless, the necessary effective sample size of 280 was obtained, despite non-response and incomplete questionnaires, allowing sufficiently powered analyses to be conducted.

Instrument for Data Collection

Data were collected through structured questionnaires administered by trained field investigators in the period from August to October 2024. The questionnaire consisted of three parts: (1) demographic information, (2) evaluation of digital financial knowledge, and (3) measurement of sustainability results. All tools were piloted on 30 individuals who were separate from the total pool of participants and revisions were made informed by any comprehension difficulties or any emergent response patterns.

Digital Financial Awareness Scale:

A total of 10 items examined several aspects of digital financial awareness on 5-point Likert (1 = Strongly Disagree, 5 = Strongly Agree):

1. how to use mobile banking apps to do financial transactions

2. I know about various digital payment systems (UPI, mobile wallets, net banking)

3. Through digital solutions, I know how to find out check my bank account balance

4. I know what security precautions I need to take for my digital financial data

5. I know of any government schemes which offers benefits through digital transfers

6. I can do a digital money transfer on my own without help

7. I am aware of the fees and charges of the digital financial services

8. If I have issues with digital financial transactions, I know who to approach

9. I feel comfortable using digital channels to save and invest

10. I am a regular user of digital financial services for managing household finances.

Sustainability Outcome Assessment: Six quantifiable aspects evaluated sustainability on the economic, social, and environmental levels:

1. Average monthly income per household (in INR)

2. Months in the past year with sufficient food

3. Household members earning through work

4. Average monthly savings in a Household (in INR)

5. The number of children in the household is going to an educational institution on a regular basis

6. Number of environmentally sustainable practices implemented (such as waste segregation, water conservation, organic farming techniques)

Framework for the Analysis

Reliability Analysis: Internal Consistency of the Digital Financial Awareness Scale The internal consistency of the scale was measured through Cronbach's alpha Coefficient. The formula is given as $\alpha = (k/(k-1))(1 - \Sigma\sigma^2_i/\sigma^2_t)$ where k is the number of items, σ^2_i is the variance of the ith item and σ^2_t is the total variance of observed scores. Adequate reliability is defined as $\alpha \geq 0.70$.

Paired Sample t-test – This test was used to measure the mean differences in sustainability outcomes pre and post the delivery of the DF awareness intervention in the communities. The test statistic is $t = (\bar{x}_a - \bar{x}_\beta)/(s_a/\sqrt{n})$, where $\bar{x}_a$, $\bar{x}_\beta$ are the two related sample means, s_a is the standard deviation of the difference scores, and n is the number of pairs. Statistical significance was set at $p < 0.05$.

Multicollinearity Assessment: Multicollinearity among predictors was assessed by computing variance inflation factor (VIF) and tolerance values. VIF is calculated as $1/(1-R^2_j)$, where R^2_j is the squared multiple correlation coefficient obtained when regressing predictor j on the other predictors. VIF greater than 10 or tolerance less than 0.10 were considered indication of severe multicollinearity.

Regression model: Digital financial literacy (independent variable) and composite sustainability outcome score (dependent variable) were included in the model: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon$, in which Y is the sustainability outcome, X_1 ,...,X_k are predictors of variables, β s are partial regression weights and ε is the residual term of error Multiple Regression Analysis Ordinary least-squares (OLS) regression analysis was used to examine the association between digital financial awareness (the independent variable) and the composite score of sustainability outcomes (the dependent variable): $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon$, where Y denotes the sustainability outcome, X_1 ,...,X_k denote the predictor variables, β coefficients are the partial regression coefficients, and e is the residual of error. Other d=variables controlled for were age, level of education, size of the household, and district.

RESULTS AND ANALYSIS

Descriptive Statistics

The sample characteristics show that 42% of the respondents were in the age group of 30-40 years, 35% belonged to the age group of 18-30 years followed by 23% who were above 40 years of age. Levels of education were highly variable: 28% had received no formal education, 34% had studied up to primary level in school, 26% had reached secondary level, and a mere 12% had obtained higher secondary or tertiary education. Respondents averaged just under 5 members in their household (4.8) and most, 68% affirmed that they were living in a joint family. Concerning access to digital devices, 61% had smartphones, whether personal or shared, but only 38% had working data connectivity.

Mean individual item scores for the digital financial literacy questions ranged from 2.34 (least) for "knowledge about fees and charges" to 3.82 (greatest) for "government digital transfer schemes" awareness. The overall digital financial awareness score was 32.47 (SD = 8. 23) out of a maximum possible score of 50, which is an indication of moderate level of awareness. Sustainability outputs were more variable: average monthly

household income = ₹8,342 (SD = ₹3,127); food security = 9.2 months (SD = 2.1); number of income generating activities per household = 1.8 (SD = 0.9); average monthly savings = ₹1,243 (SD = ₹687); current school attendance = 1.6 children (SD = 1.2); and sustainable practices = 2.4 (SD = 1.5).

Reliability Analysis: Digital Financial Awareness Scale

Table 1 presents Cronbach's alpha reliability assessment for the 10-item digital financial awareness scale.

Table 1: Reliability Statistics for Digital Financial Awareness Scale

Measure	Value
Cronbach's Alpha	0.847
Cronbach's Alpha Based on Standardized Items	0.851
Number of Items	10
Mean Inter-Item Correlation	0.387
Average Item Variance	1.234

Source: Calculated from Primary data.

The Cronbach's alpha was 0.847, which is well above the acceptable level of 0.70, suggesting good internal consistency. This indicates that the ten items can be used to measure a single latent construct of digital financial literacy. Item-total correlations (not presented in table because of space limit) ranged between 0.514 and 0.698, and all items made valuable contribution to the reliability of the scale. No item removal would lead to a significant increase in alpha, indicating to me that I have chosen the right number of items.

Paired Sample t-test: Sustainability Results

A sub-sample analysis was conducted with 68 respondents who had taken part in a district administration led three month digital financial literacy intervention programme in the districts of Krishna and Anantapur. Table 2 shows the comparisons of pre-intervention and post-intervention sustainability outcomes.

Table 2: Paired Sample t-test for Sustainability Outcomes (n=68)

Sustainability Outcome	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Difference	t-value	p-value
Monthly Income (₹)	7,842 (2,934)	9,127 (3,218)	1,285	3.247	0.002**
Food Security (months)	8.9 (2.3)	10.1 (1.8)	1.2	3.891	<0.001***
Income Activities (#)	1.6 (0.8)	2.1 (0.9)	0.5	4.123	<0.001***
Monthly Savings (₹)	1,089 (624)	1,547 (712)	458	4.567	<0.001***
Children in School (#)	1.5 (1.1)	1.7 (1.2)	0.2	1.892	0.063
Sustainable Practices (#)	2.2 (1.4)	2.9 (1.6)	0.7	3.458	0.001**

*Note: ** p<0.01, *** p<0.001*

Source: Calculated from Primary data.

Results show statistically significant improvement on five of the six indicators of sustainability after the intervention in digital financial literacy. There was a rise of ₹1,285 (t = 3.247, p = 0.002) in the monthly income, a 16.4% improvement. Food security was improved by 1.2 months (t = 3.891, p < 0.001) and income-generating activities by 0.5 per household (t = 4.123, p < 0.001). Monthly savings increased by ₹458 (t = 4.567, p < 0.001), a 42% increase. The number of sustainable practices adopted increased by 0.7 practice per household (t = 3.458, p = 0.001). There was only one non-significant change, educational attendance (t = 1.892, p = 0.063), which may reflect the fact that decisions about school attendance are influenced by considerations that go beyond immediate financial consciousness.

Assessment of Multicollinearity

The VIF and tolerance were employed to check the multicollinearity among the predictive variables prior to the multiple regression analysis (Table-3).

Table-3: Multicollinearity Diagnostics

Variable	Tolerance	VIF
Digital Financial Awareness Score	0.687	1.456
Age	0.823	1.215
Education Level	0.592	1.689
Household Size	0.734	1.362
Smartphone Ownership	0.641	1.560
SHG Membership	0.778	1.285
District (Urban vs Rural)	0.712	1.404

Source: Calculated from Primary data.

Tolerance values are all above 0.10 and all VIF values are less than 10, suggesting that there is no harmful multicollinearity. The largest VIF (1.689 for education level) is sufficiently small, which ensures that the independent variables are sufficiently independent to required for regression. The correlation between digital financial knowledge and education level (r = 0.523) is the strongest bivariate relationship among predictors, but is moderate and not indicative of redundancy.

Multiple Regression Analysis

Multiple regression was used to assess the impact of digital financial awareness and control variables on composite sustainability results. The composite sustainability index was generated by z-scoring and summing up all the six sustainability output indices. Table 4 reports the regression results.

Table 4: Multiple Regression Analysis: Predictors of Sustainability Outcomes

Variable	Unstand-ardized B	Std. Error	Standardized Beta	t-value	p-value	95% CI
(Constant)	-8.234	3.127	-	-2.632	0.009	[-14.378, -2.090]
Digital Financial Awareness	0.547	0.068	0.512	8.044	<0.001***	[0.413, 0.681]
Age	0.082	0.047	0.098	1.745	0.082	[-0.011, 0.175]

Education Level	1.234	0.341	0.227	3.618	<0.001***	[0.562, 1.906]
Household Size	-0.423	0.189	-0.125	-2.238	0.026*	[-0.795, -0.051]
Smartphone Ownership	2.145	0.678	0.189	3.164	0.002**	[0.809, 3.481]
SHG Membership	1.876	0.592	0.176	3.169	0.002**	[0.710, 3.042]
District (Urban=1)	1.523	0.634	0.134	2.402	0.017*	[0.274, 2.772]

Model Summary: R = 0.790, R² = 0.624, Adjusted R² = 0.614, F(7, 272) = 64.371, p < 0.001

*Note: * p<0.05, ** p<0.01, *** p<0.001*

Source: Calculated from Primary data.

The regression model is well specified as the predictors explain 62.4% of the variance in sustainability outcomes (R² = 0.624, F = 64.371, p < 0.001). Digital financial literacy is the more robust predictor (β = 0.512, t = 8.044, p < 0.001) and for each unit increase in score of DFL, a standard deviation of 0.547 increase in sustainability outcome is expected holding other variables constant. This is a sizable effect, thus affirming the theoretical argument that better digital financial capabilities trigger diverse sustainable development.

The degree of education is also a significant predictor of sustainability outcomes (β = 0.227, t = 3.618, p < 0.001), indicating that formal educational achievement and digital financial literacy have a complementary relationship in translating into development outcomes. Smartphone ownership (β = 0.189, t = 3.164, p = 0.002) and SHG membership (β = 0.176, t = 3.169, p = 0.002) have similar positive effects, underscoring the significance of both access to technology and institutional support mechanisms.

Household size is negatively associated with sustainability outcomes (β = -0.125, t = -2.238, p = 0.026) in line with resource dilution theories which argue that per-capita well-being gains are harder to achieve by bigger households. Urban/semi-urban district location is positively associated with sustainability outcomes compared to rural areas (β = 0.134, t = 2.402, p = 0.017), which may be indicative of differences in infrastructure and opportunity. Age also displays a positive but non-significant trend (β = 0.098, t = 1.745, p = 0.082), suggesting that older women might in fact gain experience, however, the effect is too weak to reach statistical significance in this model. Residual analysis (not presented) confirmed the normality assumptions, with Kolmogorov-Smirnov test indicating non-significant results (p = 0.142), and scatter plots revealing homoscedastic pattern. The Durbin-Watson statistic (1.987) shows no evidence of autocorrelation, which confirms the independence assumption for cross-sectional data.

DISCUSSION

The nature of the results provide strong confirmation that digital financial capability is a key predictor of sustainability outcomes for women in high-risk communities of Andhra Pradesh. The high reliability of awareness measurement (α = 0.847) further supports the DFA conceptualization as multidimensional, including operational, security, scheme, and application aspects. This indicates that initiatives to enhance digital financial literacy need to be holistic and multifaceted, and should not be confined to imparting technical skills alone.

The results of the paired sample t-tests thus offer some quasi-experimental support for a causal interpretation of the positive impact of digital financial literacy education on sustainability outcomes. The positive statistically significant effects on income, food security, livelihood diversification, savings behavior, and environmentally responsible behavior of a 3-month intervention indicate (1) that capacity-building intervention can be designed feasibly and (2) that they can be effective. The 16.4% increase in income and 42% increase in savings are large by economic standards and imply that many families may be crossing poverty barriers. The lack of a significant change in educational attendance is rather to be interpreted: there are a number of structural factors determining enrolment to schooling of children, including availability of school, quality of school, cultural norms, which

cannot be changed with financial interventions of three months. However, better household finances could also facilitate educational continuance, a possibility that might be seen in the long-term follow-up. The analysis in multiple regression confirms the digital financial literacy as the best predictor of sustainability outcome, as the coefficient of $\beta = 0.512$ for this variable is the highest when compared with all other control variables. This result is theoretically and practically important. Theoretically, it is supportive of the capability theory's focus on knowledge and skills as means of converting resources into valued functionings. The digital financial infrastructure is a resource; awareness and competence are means that allow it to be transformed into better livelihood outcomes. From an implementation perspective, the finding implies that resources devoted to empowering vulnerable women with such digital financial literacy tools may have positive ripple effects on the economic, social, and environmental dimensions of sustainability.

Education as an enabler of digital financial awareness This study demonstrates that the above complementarity relationship between education and digital financial awareness should not be neglected. While each is an independent predictor of sustainability outcomes, together they may have complimentary synergetic effects. Women with formal education have basic literacy/numeracy enabling them to access a digital interface, while practical engagement in digital finance augments mathematical and decision making literacy. This two-way association also implies that combinations of basic education and specific digital financial training could maximize development outcomes.

The positive associations of having a smartphone and SHG membership highlighted the importance of acquiring both technological and social capital. Indeed, Smartphones are necessary, but not sufficient, for digital financial engagement: without awareness and confidence, the mere possession of a device can bring little good to a user. On the other hand, being a member of an SHG also means having peer support, and socially normalized technology use, and collective strategies for addressing barriers to using digital financial platforms. This conjunction of technological infrastructure with a healthy social network seems especially powerful. The inverse association between household size and sustainability outcomes is indicative of resource scarcity dynamics dominant in marginalized populations. Larger families allocate their limited finances across a greater number of people, thereby limiting how much each member of the family can consume, save, and invest in human capital accumulation. Digital financial literacy could somewhat alleviate this restriction by facilitating better management of resources, credit and incomes, but it is not expected to overcome the core problem of resource dissipation.

The urban-rural gap in sustainability results illustrates well-established disparities in infrastructure, education, and opportunities. However, we find that the digital financial awareness effect is robust in all geographical subsamples (results not shown due to space considerations revealed invariably similar beta coefficients), indicating that although the starting point in terms of living standards is different, the relationship between dFAw and the outcome is consistent. This suggests that digital financial literacy interventions targeted at rural areas can still have significant effects even overcoming infrastructure challenges, particularly if they overcome connectivity and device access challenges.

There are several limitations to interpretation. Firstly, the cross-sectional nature prevents causal inference excepting the small intervention subsample. Residual confounding may have contributed to the observed associations. Secondly, potential social desirability bias may arise as sustainability outcomes are self-reported, which the authors acknowledged anonymous data collection reduced risk of bias, but not eliminated it. Third, the research investigates awareness and behavioral outcomes for a single point in time; prospective studies are better suited to assess dynamic processes of translating awareness into sustained behavior change and subsequent outcome enhancements. Fourth, the composite sustainability outcome comprises variance across different dimensions; specific analyses at disaggregated level could uncover heterogeneous awareness effects in the economic, social or environmental areas.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The findings have several actionable policy implications for strengthening the digital financial inclusion and sustainable development of marginalized women in Andhra Pradesh and similar settings:

1. Full-fledged digital financial literacy and awareness generation programmes: The state and central governments need to expand structured digital financial literacy programmes for vulnerable women. The content needs to go beyond the manual mechanics of transactions and include security measures, working the schemes, saving strategies, and what to do when things go wrong. Use participatory pedagogies that are friendly to the diverse literacy levels, and contains visual demonstrations, hands-on practice, and peer learning strategies that are effective in the context of SHGs.

2. Imitation with existing system of organization: Instead of the development of catering infrastructure, digital financial literacy should build on already established women's groups such as SHGs, Mandal Mahila Samakhyas, and village organizations in providing digital financial literacy. These offer familiar, safe spaces; peer support networks; and ongoing reinforcement that makes it easier to hold on to and use what gets learned. It also cuts down on cost and helps to ensure that the programs are culturally relevant.

3. Technology Access Subsidies: Since smartphone ownership is highly predictive, governments may also want to explore targeted subsidies or concessional financing schemes for vulnerable women to purchase smartphones with sufficient data connectivity. Such measures could be dovetailed with the existing ones, like the free electricity and ration distribution, with the eligibility criteria being women from SC/ST communities, BPL families and those families which are headed by a woman.

4. Design Simpler Interfaces Financial service providers and fintech companies should make a greater investment in designing user interfaces that are accessible to users with low levels of literacy. These include vernacular language options, voice-enabled navigation, simplified menu hierarchies and error-prevention prompts. In some countries, user communities (e.g. rural farmers, village health workers, etc.) have participated in the design process, ensuring that interfaces are tailored to their real world environment and limitations.

5. Greater Presence of Banking Correspondents: the banking correspondent framework needs to be bolstered in remote rural and tribal regions, where the concentration of marginalised women is high. They should be trained not only on the transaction process but also on basic digital financial literacy coaching, thus acting as the first tier support for women on the digital platform.

6. Holistic sustainability messaging: Digital financial education initiatives need to make explicit links between good financial management and overall sustainability goals. For example, training modules might link digital savings to investments in solar lighting or water-efficient irrigation or organic agricultural inputs to build direct connections between financial and environmental decisions.

7. Monitoring and Evaluation Systems: Government programs should develop robust systems to monitor not only the enrollment in and participation of digital financial literacy programs but also the effect in terms of active utilization of digital financial services, wealth-building, income diversification, and well-being. Such systems facilitate evidence-based program adjustment and resource allocation.

8. Gender-Transformative Programming: Given financial exclusion is often a consequence of household power relations, programmes should include elements focusing on intra-household decision making, women's economic autonomy and men as allies in women's financial empowerment. This could involve family-level sensitization sessions on the positive externalities of women's financial inclusion for the well-being of the household.

CONCLUSION

This study provides compelling empirical proof for the strong influence of digital financial literacy on multi-dimensional sustainability outcomes of women from disaster prone areas of Andhra Pradesh. The consistent co-movement of digital financial literacy measures, the observed positive changes associated with literacy interventions, and the large explanatory power in regression equations taken together provide evidence that improving digital financial skills is a pathway to sustainable development for the underprivileged.

The results go beyond narrow indicators of access to demonstrate how digital financial literacy is the catalyst for improvements in economic stability, food security, livelihood diversification, saving habits, and environmental sustainability. This multiplier effect recasts digital financial literacy as an intervention not as a singular solution to address complex problems but a critical enabler of other programmatic and investment impacts.

For women in disadvantaged communities, the promise of digital financial platforms is to break through long-standing node of geographic remoteness, institutional disregard, and societal ostracized barriers. But hardware isn't hardware sufficient; informed, skilled and confident users are needed to turn potential into actual capabilities. The high reliability of the awareness scale and the robust predictive relationships supported in this study also provide the foundation for tools and evidence for scalable interventions.

These policy implications go beyond financial sector reforms and center on integrated approaches, including those that address digital infrastructure, education, institutional capacity, and gender-transformative measures. The synergy between formal schooling, technological access, social capital, and specialized skill development implies that comprehensive multi-sectoral strategies will maximize developmental returns.

In the future, research could build on this work through longitudinal studies that follow the development of awareness and outcome trajectories over time to allow for stronger assertions of causality. Qualitative studies on lived experiences and processes of change (behavioural and contextual facilitators and barriers) would complement the quantitative results. Cross-state comparative analysis of states with different levels of digital infrastructure diffusion and policy frameworks may yield transferable good practices and context-specific needs.

In the end, this study adds to a growing body of evidence that shows investments in women's financial empowerment are beneficial not just for the women themselves, but for families, communities, and environmental systems. For Andhra Pradesh and other analogous environments where a high concentration of vulnerability exists alongside a nascent digital infrastructure, prioritizing digital financial literacy among disadvantaged women is not just a developmental necessity but a promising avenue for transformative, sustainable development.

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