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Gender-Inclusive Digital Literacy and Socioeconomic Resilience Among Smallholder Farmers: The Moderating Role of Trust in Technology in Food-Insecure Regions

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Abstract

Smallholder farmers in food-insecure regions face structural constraints that undermine household resilience, including gender disparities, limited digital access, and low trust in technology. This study develops and tests the Gender-Inclusive Digital Literacy for Women Empowerment (GIDL-WE) model to examine how gender inclusion, digital literacy, and trust in technology interact to influence socioeconomic resilience. Using survey data from 350 women in smallholder farming households in Central Kalimantan, Indonesia, the research employs Partial Least Squares–Structural Equation Modeling (PLS-SEM) for analysis. Results indicate that gender inclusion significantly enhances inclusive digital literacy ($\beta = 0.285$, $p < 0.000$), while digital literacy unexpectedly exerts a negative effect on socioeconomic resilience ($\beta = –0.217$, $p < 0.000$). Trust in technology has moderates the digital literacy–resilience link ($\beta = 0.176$, $p < 0.000$), suggesting that digital literacy yields benefits only when supported by high trust levels. The model explains 28.3% of the variance in socioeconomic resilience and demonstrates a satisfactory global fit (GoF = 0.39). These findings highlight the centrality of trust as a catalyst for translating digital inclusion into resilience, offering empirical insights for designing gender-responsive digital interventions in agriculture.

Keywords

Women empowerment, digital literacy, technology trust, social resilience, rural households.

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Introduction

Agricultural transformation in the Global South is increasingly intertwined with digital innovation. However, smallholder farmers, particularly those residing in food-insecure regions, continue to face systemic constraints such as climate change, market volatility, and exclusion from digital infrastructure (Bryan and Garner, 2022; Huyer and Partey, 2020). These vulnerabilities are not evenly distributed: women farmers, in particular, experience compounded disadvantages rooted in structural gender inequalities that limit their agency in decision-making and access to technology (Ali et al., 2016; FAO, 2011a).

While rural women are central to both food production and consumption, their roles remain underrecognized and underrepresented in the digital agricultural agenda. Studies have shown that socio-cultural norms often marginalize women from technology training, access to devices, and digital communication platforms (Ishaq and Memon, 2016; Jaim and Hossain, 2011). This gendered digital divide has a direct bearing on agricultural performance and household resilience, particularly where digital tools mediate access to markets, inputs, information, and social services (Li et al., 2025).

Empirical evidence from Kalimantan, Indonesia, reflects this gap. Although 71% of farming households are categorized as food secure, their resilience is fragile undermined by limited access among women to training programs, digital technology, and institutional support (Winarti et al., 2024, 2025). Notably, women's leadership in farming households contributes significantly over 30% to food security and empowerment

outcomes. Yet, the lack of a gender-responsive digital ecosystem impedes the full realization of their potential.

The adoption of digital agriculture is not solely a function of access or technical literacy but is also deeply influenced by psychological factors such as trust in technology. Women farmers are often hesitant to engage with digital tools due to concerns over data privacy, device security, and the perceived reliability of applications (Han et al., 2022; Li et al., 2023). As a moderating factor, trust can either facilitate or inhibit the relationship between digital literacy and resilience outcomes.

Despite the growing body of literature on digital agriculture and gender, existing models tend to be normative, qualitative, or overly fragmented. Few studies have empirically examined the structural links between inclusive digital literacy, gender inclusion, and socioeconomic resilience within a comprehensive analytical framework. Even fewer have incorporated trust in technology as a moderating variable shaping these relationships (Bathaiy et al., 2021; Kumari et al., 2025; McGuire et al., 2022).

This study addresses these gaps by proposing a novel structural model: the Gender-Inclusive Digital Literacy for Women Empowerment (GIDL-WE) framework. Using a Partial Least Squares–Structural Equation Modeling (PLS-SEM) approach, this research investigates how inclusive digital literacy affects the socioeconomic resilience of farming households, the extent to which gender inclusion fosters digital empowerment, and how trust in technology moderates these effects. The model seeks to offer empirical insights for designing more equitable, inclusive, and sustainable digital interventions in agriculture.

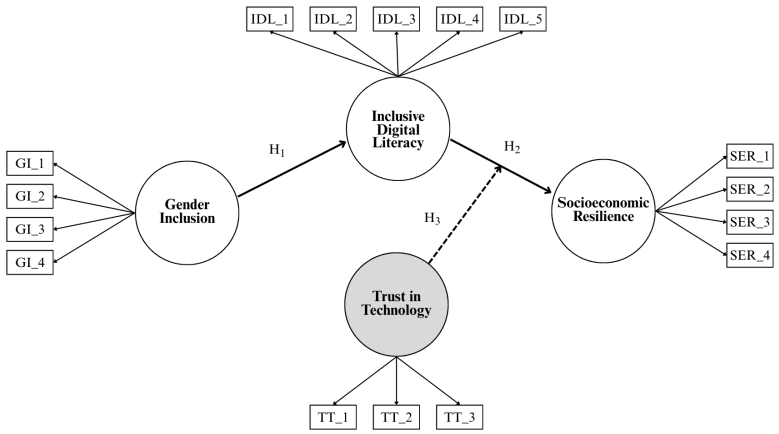
Theoretical perspectives and hypothesis development

The theoretical foundation of this study is grounded in the Technology Acceptance Model (TAM) (Davis, 1989), which posits that the adoption and effective utilization of technology are primarily influenced by users' perceived usefulness and perceived ease of use. Building on this, Trust in Technology is conceptualized as a critical antecedent that shapes individuals' perceptions and confidence in engaging with digital tools, particularly in low-resource settings such as smallholder farming households. Previous studies have demonstrated that trust significantly influences the willingness to adopt digital solutions in agriculture, especially when users face risks related to data security and system reliability (Han et al., 2022; Li et al., 2023).

This study also draws upon Gender and Development Theory (GAD), which emphasizes structural gender inequalities and the need for inclusive frameworks to empower marginalized groups, particularly women (FAO, 2011b). In the agricultural sector, gender norms often restrict women's access to resources, education, and digital infrastructure. Therefore, Gender Inclusion is positioned as an enabling factor that fosters equitable participation in the digital ecosystem. Increased gender inclusion is expected to lead to higher levels of digital literacy among women, which is essential for achieving broader developmental outcomes in food-insecure rural areas (Bryan and Garner, 2022; Huyer and Partey, 2020).

The construct of Inclusive Digital Literacy functions as a central mediating variable in the model, operationalized through access, skills, and participation in digital agriculture platforms. Inclusive digital literacy not only facilitates information flow and productivity gains but also enhances social resilience by enabling individuals (particularly women) to connect with markets, institutions, and support systems (Cheng et al., 2024; C. Li et al., 2025). Within this framework, digital literacy is theorized to influence Socioeconomic Resilience, defined as a household's capacity to maintain stability and adapt to external shocks through diversified income sources, food security, and access to services (Adger, 2000; Keck and Sakdapolrak, 2013).

Furthermore, this study hypothesizes a moderation effect of trust in technology on the relationship between digital literacy and household resilience. In alignment with recent resilience literature, the interaction between digital capabilities and psychological trust factors plays a crucial role in determining adaptive outcomes in rural development (Bathaiy et al., 2021). A higher level of trust is expected to strengthen the positive effects of digital literacy, while low trust may undermine the benefits of digital interventions. This integrative model (Figure 1) thereby provides a robust framework for exploring the intersection of gender, technology, and household resilience in vulnerable agricultural communities.



Source: Authors

Figure 1: Conceptual framework.

Materials and methods

Study area

This study was conducted in East Kotawaringin Regency, Central Kalimantan Province, Indonesia a region characterized by both agricultural potential and high vulnerability to food insecurity. Twelve villages were selected purposively based on their Priority 1 classification in the 2024 Food Security and Vulnerability Atlas (FSVA) issued by the Ministry of Agriculture (Dinas Pertanian Dan Ketahanan Pangan, 2024). The area is home to smallholder farmers whose livelihoods rely heavily on subsistence agriculture, yet face structural constraints related to access, information, and gender disparities.

Sampling procedure

This study employed a stratified random sampling technique to ensure the representation of women farmers across various villages classified as food-insecure zones in East Kotawaringin Regency, Central Kalimantan. Twelve villages were purposively selected based on their Priority 1 status as outlined in the 2024 Food Security and Vulnerability Atlas (FSVA) published by Indonesia's Ministry of Agriculture. These areas were deemed relevant due to the high vulnerability of farming households, especially women, to structural challenges such as limited technology access, low digital literacy, and gender-based constraints.

The study population comprised female members of smallholder farming households who were actively involved in agricultural activities or decision-making. A total of 2,741 eligible respondents were identified across the selected villages. To determine an appropriate sample size, the Yamane formula (Yamane, 1973) was utilized with a 5% margin of error, resulting in a sample size of 350 respondents. Stratification was based on village of residence and age groups to ensure proportional distribution, particularly focusing on women within productive ages (15-64 years).

Prior to data collection, researchers conducted outreach through local agricultural extension officers and women farmer groups to facilitate access and build rapport. Respondents were selected randomly from group rosters, and informed consent was obtained prior to administering the questionnaire. The final sample of 350 respondents was deemed sufficient for robust PLS-SEM analysis, as it exceeded the minimum sample size required for models with moderate complexity and power of 0.80 (Hair et al., 2021).

Data collection instrument

The primary instrument used for data collection in this study was a structured questionnaire designed to measure latent constructs in the proposed structural model. The questionnaire was developed based on established scales and theoretical frameworks relevant to gender inclusion, digital literacy, trust in technology, and household socioeconomic resilience. All items were measured using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), allowing for nuanced capture of respondents' perceptions and experiences.

Each construct consisted of multiple reflective indicators adapted from prior validated instruments.

The Gender Inclusion construct included 4 items capturing dimensions such as decision-making autonomy, income control, group participation, access to training, and leadership in farming decisions (FAO, 2011a; Ishaq and Memon, 2016; Jaim and Hossain, 2011; Quisumbing, 1996). The Inclusive Digital Literacy construct contained 5 indicators, reflecting digital access, basic functional use, participation in digital training, access to agricultural information, and engagement in e-commerce or online platforms (Choruma et al., 2024; Han et al., 2022; Li et al., 2025; Li et al., 2023; Winarti et al., 2025). The Trust in Technology construct included 3 items adapted from technology acceptance and digital trust models, emphasizing perceived benefit, safety, reliability, and ease of use (Cimino et al., 2024; Han et al., 2022; Li et al., 2023). Lastly, Socioeconomic Resilience was measured through 4 indicators capturing household income stability, access to support services, food security perception, expenditure patterns, and community support (Adger, 2000; Islam et al., 2024; Keck and Sakdapolrak, 2013).

To ensure content validity, the initial questionnaire was reviewed by a panel of five academic experts in agricultural sociology, gender studies, and information systems. Subsequently, the instrument underwent pilot testing with 30 respondents from non-sample villages to test its clarity, internal consistency, and response bias. Feedback from the pilot phase was used to revise ambiguous wording, align cultural context, and eliminate redundant items. The final version of the questionnaire was translated into Bahasa Indonesia using a back-translation method to ensure semantic equivalence between the original and translated versions.

Data analysis techniques

This study employed Partial Least Squares–Structural Equation Modeling (PLS-SEM) using SmartPLS 4.0 software to analyze the proposed conceptual model. PLS-SEM was selected due to its ability to handle complex models with latent variables, non-normal data distributions, and relatively small sample sizes (Hair et al., 2019). The technique is particularly suitable for exploratory research aiming at theory development and model prediction, which aligns with the study's objective of validating the GIDL-WE model (Gender-Inclusive Digital Literacy for Women Empowerment).

The analysis was conducted in two main stages: the measurement model (outer model) and the structural model (inner model). The outer model focused on testing the reliability

Construct	Indicator Code	Indicator Description	Source	Scale
Gender Inclusion (GI)	GI_1	Women's involvement in household farming decisions	Quisumbing (1996); FAO (2011)	Likert 1–5
	GI_2	Control over income generated from farming activities	FAO (2011)	Likert 1–5
	GI_3	Participation in community/farmer groups	Ishaq and Memon (2016)	Likert 1–5
	GI_4	Access to agricultural training	Jaim and Hossain (2011)	Likert 1–5
Inclusive Digital Literacy (IDL)	IDL_1	Ownership or access to digital devices (smartphone, internet)	Li et al. (2025)	Likert 1–5
	IDL_2	Ability to use basic digital apps (WhatsApp, browser, e-wallets)	Choruma et al. (2024)	Likert 1–5
	IDL_3	Participation in online/digital farming training	Winarti et al. (2025)	Likert 1–5
	IDL_4	Use of digital tools to search agricultural information	Han et al. (2022)	Likert 1–5
	IDL_5	Engagement in online market platforms/e-commerce	Li et al. (2025)	Likert 1–5
Trust in Technology (TT)	TT_1	Confidence in security of digital tools used	Li et al. (2023)	Likert 1–5
	TT_2	Trust in the accuracy and reliability of online information	Han et al. (2022)	Likert 1–5
	TT_3	Comfort level in using digital platforms	Cimino et al. (2024)	Likert 1–5
Socioeconomic Resilience (SER)	SER_1	Stability of household income	Adger (2000); Keck and Sakdapolrak (2013)	Likert 1–5
	SER_2	Access to basic services (health, education, food)	Islam et al. (2024)	Likert 1–5
	SER_3	Diversity of income sources	Keck and Sakdapolrak (2013)	Likert 1–5
	SER_4	Ability to manage household consumption during crisis	Adger (2000)	Likert 1–5

Source: Author processing, 2025

Table 1: Operationalization of research constructs and indicators.

and validity of the constructs. Indicator reliability was assessed using loading factors (threshold > 0.70), while construct reliability was tested through Cronbach's Alpha and Composite Reliability (CR), both expected to exceed 0.70. Convergent validity was evaluated using the Average Variance Extracted (AVE), which must be ≥ 0.50 (Hair et al., 2019). Discriminant validity was established using the Heterotrait-Monotrait ratio (HTMT), where values below 0.85 indicated acceptable discriminant power (Henseler et al., 2009).

The inner model assessed the causal relationships among constructs, including direct, indirect, and moderating effects. Path coefficients were tested for statistical significance using bootstrapping (5,000 subsamples), and predictive power was evaluated using R^2 and Q^2 values. A key element of the analysis was the moderation test, which examined whether trust in technology moderated the relationship between digital literacy and household socio-economic resilience. This was tested using the two-stage approach, which allows for the inclusion of interaction terms between latent constructs (Sarstedt et al., 2019).

In addition, multicollinearity was checked using the Variance Inflation Factor (VIF), with acceptable values below 5.0. Model fit was assessed using SRMR (Standardized Root Mean Square Residual), where values below 0.08 indicated a good fit. The overall analysis not only validated the psychometric properties of the constructs but also revealed the structural pathways through which gender-inclusive digital literacy and trust in technology influence household resilience among smallholder farming communities in food-insecure areas.

Results and discussion

Demographic characteristics of respondents

A total of 350 respondents participated in this study, comprising a diverse profile of rural agrarian households. In terms of age distribution, the majority of respondents were between 31 and 45 years old (43.4%), followed by those aged 46–60 years (34.3%). Respondents below 30 years constituted 13.1%, while only 9.1% were older than 60 years. This indicates that the productive age group dominates the agricultural workforce in the study area.

Regarding educational attainment, most respondents had completed elementary school (59.1%), with 20.3% having no formal education. Additionally, 15.7% had attended junior high school and only 4.9% had completed senior high school. These findings highlight a relatively low level of formal education among the farming community, which may influence their digital engagement and decision-making capabilities.

A large proportion of respondents (94.6%) reported being part of an active farming household. Farming was the primary occupation for 57.7% of respondents, while 32.9% identified as housewives, 6.6% as private employees, and 2.9% as merchants. Moreover, a majority (69.7%) had dependents (children), with the most common number of children being one or two.

In terms of digital access, 66.0% of respondents owned a mobile phone, and 63.7% had access to internet-connected phones. When asked about sources of agricultural information, the majority cited fellow farmers (62.3%), followed by mobile phones (13.7%), television (11.7%), extension workers (10.9%), and farmer groups (1.4%). Internet usage frequency varied significantly; most respondents (62.9%) reported using the internet 6–7 times per week, while 33.4% never accessed the internet, and only a small proportion used it occasionally (1–5 times per week). This indicates a high reliance on digital platforms among connected users, despite a significant digital divide (see Table 2).

Category	Response	Frequency	Percentage (%)
Age	≤30 years	46	13.1
	31–45 years	152	43.4
	46–60 years	120	34.3
	>60 years	32	9.1
Education	No Schooling	71	20.3
	Elementary School	207	59.1
	Junior High School	55	15.7
	Senior High School	17	4.9
Active Farming Household	Yes	331	94.6
	No	19	5.4
Primary Occupation	Farmer	202	57.7
	Housewife	115	32.9
	Private Employee	23	6.6
	Merchant	10	2.9
Have Dependents (Children)	Yes	244	69.7
	No	106	30.3

Source: Author compilation, 2025

Table 2: Demographic profiles of the respondents

(To be continued).

Category	Response	Frequency	Percentage (%)
Number of Children	0	106	30.3
	1	106	30.3
	2	98	28.0
	3	29	8.3
	4	11	3.1
Own a Mobile Phone	Yes	231	66.0
	No	119	34.0
Internet-Connected Phone	Yes	223	63.7
	No	127	36.3
Sources of Agricultural Information	Fellow Farmers	218	62.3
	Mobile Phone	48	13.7
	Television	41	11.7
	Extension Worker	38	10.9
	Farmer Group	5	1.4
Internet Usage Frequency (per week)	0 times per week	117	33.4
	1–2 times per week	6	1.7
	3–5 times per week	7	2.0
	6–7 times per week	220	62.9

Source: Author compilation, 2025

Table 2: Demographic profiles of the respondents (Continuation).

Measurement model assessment

The assessment of the measurement model focused on establishing both the reliability and validity of the constructs. As shown in Table 3, all outer loadings exceeded the minimum recommended threshold of 0.70, ranging from 0.746 to 0.960, which confirms that each indicator reliably represents its respective construct. Cronbach's alpha values were between 0.820 and 0.975, and the composite reliability (CR) values ranged from 0.888 to 0.980. Both values surpass the minimum threshold of 0.70, indicating satisfactory internal consistency. Furthermore, the average variance extracted (AVE) values were between 0.683 and 0.909, all of which are well above the 0.50 benchmark, confirming adequate convergent validity. Collectively, these results establish that the constructs demonstrate robust reliability and convergence, ensuring the suitability of the measurement model (Hair et al., 2021).

Discriminant validity (DV) was assessed using two criteria: the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). In the Fornell-Larcker analysis, the square root of AVE for each construct was greater than its correlation with any other construct in the model (Table 4), supporting the discriminant validity assumption (Fornell & Larcker, 1981). The HTMT values also remained well below the 0.90 threshold, with the highest HTMT ratio recorded at 0.850 between Inclusive Digital Literacy and Trust in Technology, indicating that the constructs are empirically distinct (see Table 4) (Franke and Sarstedt, 2019; Henseler et al., 2009).

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These findings clearly demonstrate that the measurement model satisfies all of the essential criteria for both convergent and discriminant validity, thereby ensuring the robustness of the constructs used in this study. By meeting these requirements, the measurement model provides strong evidence that the indicators are not only reliable in representing their latent constructs

Construct	Indicator	Outer Loadings	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE
Gender Inclusion	GI_1, GI_2, GI_3, GI_4	0.851, 0.850, 0.774, 0.828	0.849	0.895	0.896	0.683
Inclusive Digital Literacy	IDL_1, IDL_2, IDL_3, IDL_4, IDL_5	0.957, 0.960, 0.959, 0.939, 0.952	0.975	0.981	0.980	0.909
Socioeconomic Resilience	SER_1, SER_2, SER_3, SER_4	0.883, 0.901, 0.746, 0.793	0.851	0.870	0.900	0.694
Trust in Technology	TT_1, TT_2, TT_3	0.752, 0.940, 0.865	0.820	0.972	0.888	0.727

Source: Author's computation from SmartPLS output (2025)

Table 3: Measurement model assessment: Reliability and validity.

Construct Pair	Fornell-Larcker Value	HTMT Ratio	Status
Gender Inclusion vs Inclusive Digital Literacy	0.285	0.293	Valid
Gender Inclusion vs Socioeconomic Resilience	0.605	0.709	Valid
Gender Inclusion vs Trust in Technology	0.37	0.44	Valid
Inclusive Digital Literacy vs Socioeconomic Resilience	0.226	0.249	Valid
Inclusive Digital Literacy vs Trust in Technology	0.733	0.85	Valid
Socioeconomic Resilience vs Trust in Technology	0.464	0.501	Valid

Source: Author's computation from SmartPLS output (2025)

Table 4: Discriminant validity: Fornell-Larcker criterion and HTMT ratio.

but also empirically distinct from one another. This is critical because a measurement model that lacks adequate reliability and validity may lead to biased or misleading interpretations of structural relationships. In contrast, the current results confirm that the constructs capture unique dimensio in technology, and socioeconomic resilience, which are central to the proposed framework. Consequently, the validated measurement model offers a solid and credible foundation for evaluating the hypothesized causal paths in the struct and credibility of the empirical investigation.

Multicollinearity and common method bias

In survey-based studies, Common Method Bias (CMB) is recognized as a potential threat to the validity of findings due to its possible inflation or deflation of relationships among constructs. This study proactively addressed the risk of CMB following the Harman's single-factor test (Kock et al., 2021). We conducted an exploratory factor analysis using SPSS, which revealed that the first factor explained only 46.4% of the total variance below the 50% cutoff indicating that CMB is not a significant concern in this dataset.

To assess multicollinearity, we utilized the Variance Inflation Factor (VIF), as recommended by prior research (Kock et al., 2021; Rasoolimanesh, 2022). According to established guidelines, VIF values should be below 3.3 to rule out potential collinearity issues (Akinwande et al., 2015; Vörösmarty and Dobos, 2020) As shown in Table 5, all VIF values in the inner model fall within acceptable thresholds, ranging from 1.000 to 2.187, thereby confirming the absence of multicollinearity.

Structural Path	VIF
Inclusive Digital Literacy → Gender Inclusion	1.000
Socioeconomic Resilience → Inclusive Digital Literacy	2.187
Socioeconomic Resilience → Trust in Technology	2.165
Trust in Technology × Inclusive Digital Literacy → Socioeconomic Resilience	1.029

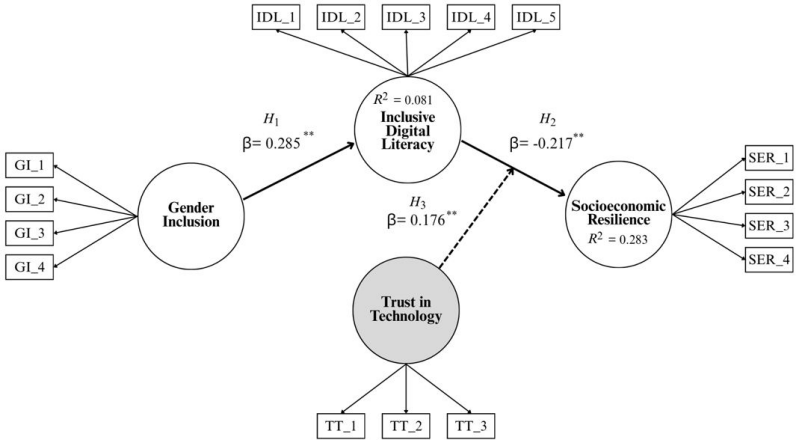
Source: Author's computation from SmartPLS output (2025)

Table 5: Collinearity statistics (VIF) for the structural model.

Structural model valuation

The structural model was examined using path coefficients, explanatory power (R^2), and effect sizes (f^2). Results (Table 6, Figure 2) indicate that gender inclusion positively and significantly influences inclusive digital literacy ($\beta = 0.285$, $t = 7.305$, $p < 0.001$). Interestingly, inclusive digital literacy exerts a negative and significant effect on socioeconomic resilience ($\beta = -0.217$, $t = 4.091$, $p < 0.001$). This finding suggests that digital literacy, when not supported by contextual enablers such as trust in technology or institutional support, may initially challenge household resilience.

Conversely, trust in technology strongly and positively affects socioeconomic resilience ($\beta = 0.651$, $t = 13.656$, $p < 0.001$), highlighting its role as a critical enabler of digital transformation among farming households. The moderation test further reveals that trust in technology significantly moderates the relationship between inclusive digital literacy and socioeconomic resilience ($\beta = 0.176$, $t = 4.041$, $p < 0.001$), indicating that digital literacy enhances resilience only when trust in digital tools is sufficiently high. Collectively, the model explained 8.1% of the variance in inclusive digital literacy and 28.3% of the variance in socioeconomic resilience.



Note: * and, ** denote a 5% and 1%significance level respectively
Source: Authors

Figure 2: Structural model results.

Hypothesized Path	β (Original Sample)	T-Statistics	P-Values	R^2 (Adjusted)	f^2 Effect Size
Gender Inclusion → Inclusive Digital Literacy	0.285	7.305	0.000	0.081	0.089
Inclusive Digital Literacy → Socioeconomic Resilience	-0.217	4.091	0.000	0.283	0.030
Trust × Inclusive Digital Literacy → Socioeconomic Resilience	0.176	4.041	0.000	0.283	0.055

Source: Author's computation from SmartPLS output (2025).

Table 6: Structural model results: Path coefficients, R^2, and f^2.

Model fit assessment and hypotheses testing summary

The overall model fit was evaluated using the Goodness-of-Fit (GoF) index, which integrates information from both the measurement and structural models by combining the average variance extracted (AVE) with the average R^2 values of the endogenous constructs. As reported in Table 7, the GoF value for this study was 0.39, which surpasses the recommended threshold of 0.36 that indicates large effect sizes according to Wetzels et al., (2009), this result suggests that the proposed model not only demonstrates a satisfactory level of explanatory power but also achieves an acceptable global fit, ensuring that the model is well specified and robust. The implication of this finding is that the measurement model and structural relationships together provide a reliable representation of the data, enhancing confidence in the interpretation of the hypothesized causal links. By surpassing the benchmark, the model validates its empirical adequacy and reinf and socioeconomic resilience in the agricultural context.

Measure	Value
Average AVE	0.829
Square root of AVE	0.910
Average of R^2	0.180
Square root of R^2	0.424
Global fit index (GoF)	0.39

Source: Author's computation from SmartPLS output (2025).

Table 7: Overall Model Fit Index (GoF).

Table 8 presents the results of the hypotheses testing, and all four proposed hypotheses were supported. H1 was confirmed, demonstrating that gender inclusion has a significant and positive impact on inclusive digital literacy. This finding emphasizes that when women are given equal opportunities in decision-making, access to resources, and participation in digital initiatives, the overall level of household digital literacy improves. Such results align with prior evidence suggesting that women play a pivotal role in technology adoption and knowledge dissemination in rural settings, thereby validating the critical role of gender equity in driving digital capacity development.

Hypothesis	Path	β	t-value	Supported?
H1	Gender Inclusion → Inclusive Digital Literacy	0.285	7.305	Yes
H2	Inclusive Digital Literacy → Socioeconomic Resilience	-0.217	4.091	Yes (negative effect)
H3	Trust in Technology x Inclusive Digital Literacy → Socioeconomic Resilience	0.176	4.041	Yes (moderation)

Source: Author's computation from SmartPLS output (2025).

Table 8: Summary of hypotheses testing.

H2 revealed a significant negative effect of inclusive digital literacy on socioeconomic resilience, a result that, while counterintuitive, reflects the nuanced challenges of digital transformation in resource-constrained households or trust in digital platforms, households may experience increased vulnerability when adopting digital tools. For example, limited digital skills can expose farmers to risks such as misinformation, cyber scams, or financial mismanagement, which may weaken rather than strengthen househo of contextual enablers to ensure that digital literacy translates into positive and sustainable outcomes.

Meanwhile, H3 revealed that trust moderates the relationship between digital literacy and resilience, such that households with higher levels of trust are better able to leverage their digital literacy to enhance resilience. Together, these findings underline the complex dynamics of digital transformation in rural households. Trust emerges as a crucial mechanism that converts digital inclusion into tangible socioeconomic benefits, reinforcing the argument that digital interventions must integrate trust-building measures to achieve sustainable empowerment outcomes.

The findings confirm that gender inclusion significantly enhances inclusive digital literacy, highlighting that women's participation is a structural driver of household digital capacity. This result is consistent with Suwana and Lily (2017), who noted that Indonesian women still face digital gaps due to limited education, unequal opportunities, and patriarchal norms, requiring targeted digital literacy initiatives. Similar concerns are echoed by Avanesian et al. (2024), who documented significant gender disparities in digital skills among youth in low- and middle-income countries, with wealthier households often showing wider gaps that disadvantage young women. Barra et al. (2024) further demonstrated that gender moderates the relationship between digital skills and entrepreneurial orientation, suggesting that gender inequalities may hinder ICT utilization in entrepreneurship. Long et al., (2023) found that structural inequalities such as access to mobile devices, education, and income explain more than 50% of the digital literacy gap in Indonesia. Together, these studies confirm that gender inclusion is not simply complementary but a prerequisite for strengthening digital literacy. This aligns with Chen et al., (2024), who showed that digital literacy reduces income gaps, particularly between men and women, and Liu & Liao, (2024), who demonstrated that farmers' digital literacy directly increases household income by enhancing access to information and financial services. The present study extends this line of research by emphasizing that gender equity in digital access is indispensable for building household-level resilience.

Contrary to expectations, inclusive digital literacy showed a significant negative effect on socioeconomic resilience. While much of the literature highlights positive effects of digital skills on income, opportunity, and empowerment (Chen et al., 2024; Liu and Liao, 2024). The current finding resonates with arguments that literacy alone is insufficient and may even introduce vulnerabilities. In fragile contexts, households equipped with basic digital skills but lacking trust or institutional support can become more exposed to risks such as misinformation, cyber fraud, or exploitative digital platforms. Similar dynamics were reported by Jia & Li, (2024), who found that digital collaboration weakened resilience unless supported by subsidies and external institutional mechanisms. This paradox is also reflected in Barra et al., (2024), who showed that gender gaps constrain the potential of digital literacy for entrepreneurship, and in Avanesian et al., (2024), who noted that unequal digital capacities exacerbate inequalities. In the agricultural sector, Shatila et al., (2025) further confirmed that digital literacy, accessibility, and human capital can contribute to resilience only when supported by innovation and agility. The present findings thus challenge the linear assumption that digital literacy is always beneficial, instead suggesting that literacy may become a liability in contexts where trust and institutional support are weak.

The validation of H3 that trust in technology moderates the relationship between digital

literacy and socioeconomic resilience underscores the central role of psychological and institutional enablers. Jafri et al. (2024) identified trust and security perceptions as primary determinants of FinTech adoption, confirming that users adopt digital services only when confidence is high. Similarly, Lee-Geiller (2024) showed that digital literacy enhances the link between e-government and public trust, reinforcing the argument that digital competence builds legitimacy when paired with institutional confidence. Zhao et al. (2025) demonstrated that digital leadership fosters resilience through knowledge sharing, but only when trust is strong at the community level. Alfirević et al. (2025) also showed that ICT proficiency moderates the relationship between climate anxiety and preparedness, proving that digital skills transform concern into action only when supported by confidence. Comparable evidence was found by Alsaad et al. (2017), who emphasized the moderating role of trust in e-commerce adoption, and Shatila et al., (2025), who confirmed that agility can amplify the effects of digital resources on resilience. These studies collectively converge with the present findings, positioning trust as both a direct enabler and a moderating force. By showing that digital literacy contributes to resilience only when trust is sufficiently high, this study extends the Technology Acceptance Model (TAM) and resilience theory, while also enriching the GIDL-WE framework by identifying trust as a critical contingency factor.

The broader implications of these findings are twofold. Theoretically, this study advances an interactionist perspective on digital empowerment, moving beyond linear models that treat literacy as sufficient. Instead, it demonstrates that gender inclusion is the structural foundation, digital literacy provides capacity, and trust in technology ensures conversion of capacity into resilience. Practically, the results call for integrated interventions: gender-sensitive digital education, institutional safeguards, and trust-building measures such as digital security programs, awareness campaigns, and transparent governance mechanisms. Evidence from Vargas-Merino et al., (2025) confirms that institutional dimensions like communication and legitimacy shape decision-making outcomes, reinforcing the need to combine structural and psychological supports. Likewise, Du et al., (2023) showed that digital inclusive finance enhances resilience only when the financial environment is enabling. Taken together, the present study demonstrates that trust transforms literacy from a potential vulnerability into a resilience asset, underscoring that digital inclusion strategies in rural households must be comprehensive, gender-sensitive, and context-specific.

Conclusion

This study provides a comprehensive analysis of how gender inclusion, digital literacy, and trust in technology interact to shape socioeconomic resilience among farming households in food-insecure regions of Central Kalimantan, Indonesia. Grounded in the Gender-Inclusive Digital Literacy for Women Empowerment (GIDL-WE) framework and employing PLS-SEM analysis, the study offers a nuanced understanding of how digital and social resources jointly determine household adaptability in contexts marked by structural vulnerability. The findings validate the proposed hypothesis, confirming that trust in technology plays a significant moderating role in strengthening the relationship between digital literacy and resilience, and thereby highlighting the indispensable role of psychological and institutional enablers in digital transformation.

In particular, the results reveal that gender inclusion enhances digital literacy, reinforcing evidence that women's participation in household decision-making and agricultural activities is a critical driver of technology adoption and competence building. Nevertheless, the unexpected negative relationship between digital literacy and resilience suggests that skills acquisition alone, in the absence of institutional support or digital trust, may initially impose risks and burdens on households. This paradox underscores the importance of designing interventions that go beyond training, by embedding safeguards, infrastructure, and trust-building mechanisms to ensure that digital capabilities translate into tangible socioeconomic gains.

Trust in technology emerges as a decisive factor in the model, both as a direct enabler of resilience and as a moderator that conditions the positive impact of digital literacy. Households that exhibit higher levels of trust in digital tools are better positioned to convert literacy into resilience outcomes, while households with low trust may find that literacy remains an underutilized resource. This interaction highlights the layered and contingent nature of digital empowerment, where psychological and institutional confidence are equally as critical as skill acquisition.

From a theoretical perspective, the study contributes to the growing body of literature on digital inclusion and resilience by advancing an interactionist approach. It extends beyond linear models that assume digital skills are sufficient, showing instead that resilience emerges from the interplay between gender inclusion, digital competence, and trust in technology. From a practical perspective, the findings provide valuable insights for policymakers, development practitioners, and community leaders, underscoring the importance of integrated interventions that combine gender-sensitive training, institutional safeguards, and trust-building measures. Such strategies are essential for transforming digital inclusion into sustainable resilience in vulnerable farming households.

This study also sets the stage for future research. Longitudinal studies could investigate how trust and literacy co-evolve over time to strengthen household resilience. Comparative analyses across regions and countries would enhance generalizability and reveal the contextual factors that amplify or constrain the digital–resilience nexus. Finally, mixed-method approaches combining quantitative modeling with qualitative insights could uncover the lived experiences of women farmers, their households, and communities, thereby deepening our understanding of how gender, technology, and trust intersect to shape adaptive capacities in fragile environments.

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