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Research

Digitalization of SMEs toward an inclusive and sustainable social development

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Abstract: Digitalization has become an important theme in the SMEs supporting sustainable social development. Nevertheless, how SME digitization affects their access to finance, innovation, and other societal benefits is still largely uncharted territory. In this paper we explore how digitization eases the access of SMEs to finance, stimulates sustainable development-oriented innovation; and encourages SMEs to grow inclusively within the developing world. Based on the panel of province-level digital finance indicators in 2013–2021 as well as firm-level survey data of 339 SMEs, we conclude that digital financial services significantly lower financing constraints via improving information transparency and operating efficiency. However, the positive impacts vary across: private, high-technology, and eastern-region SMEs benefit more and the benefits diminish at higher than moderate levels of digital intensity. Cross-country validation further suggests that convergence between technology strategy and sustainability objectives will be essential in ensuring that technology investment does in fact achieve its desired social or environmental impact. These findings suggest that firm-level digitalization activities could contribute towards an inclusive society, regional convergence, and sustainable development, subject to the integration of financial inclusion, capacity-building, and specific enforcement guidance.

Keywords: digital transformation; small and medium-sized enterprises (SMEs); inclusive growth; social sustainability; financial accessibility; policy implications; social welfare; innovation strategies

1. Introduction

Inclusive and resilient societies are becoming more dependent than ever before upon economic systems that deliver inclusive growth, and longer term social well-being, where SMEs play an important role through job creation, stability of incomes, and the balance between different regions [1]. SMEs are socially and economically important but constantly struggle with lack of finance for innovation activities: sustainable growth, and the extent to which they can contribute towards broader development goals [2]. This is often attributed to the problem of information asymmetry, limited collateral, and high transaction costs that make traditional financial systems inaccessible for smaller-sized firms [3]. Thus, relaxing the SMEs financing constraint is no longer an economic-efficiency-only problem; it is now becoming a socio-equity-and-sustainable-development one as well.

Against such a background, digital inclusive finance or the more general digital transformation has been suggested to be a useful tool in reducing financing bottlenecks of SMEs [4]. Digital technologies enable banks and thrifts will increase the flow of information, lower operating costs, and broaden access to credit, thus allowing broader access to finance [5]. In fact, there is some evidence that finance technologies can lead to increased innovation and capital mobility, and improve the firm's performance

through relaxed financing constraints [6]. The above effects indicate that digitalization could be a structural channel between firm-level developments and social sustainability.

Apart from profitability, we find an increasing stream of literature on the contribution of digitization to the sustainable business activity of SMEs. Digitization contributes to environmental sustainability, green innovation, and responsible business behavior, which align the company's strategy with a more general sustainable development goal [7]. Additionally, e-technologies and big data were shown to be beneficial for SMEs' integration of the economy, society, and environmental goals as part of their business strategy [8]. In this view, digitization goes beyond efficiency gains, becoming a socio-economic process which will change the way SMEs participate in sustainable social development.

But while this body of research has emphasized these gains from digitization, it is not without evidence to suggest that there may be heterogeneity in who benefits from digitization. Heterogeneity exists across digital capability, sectoral features and regional institutional conditions generate heterogeneous results, which may further widen disparities [9]. Studies suggest that low levels of computer skills, poor connectivity and lack of resources might exclude some SMEs from benefiting maximally from digitization, thus diminishing its distributive power [10]. Consequently, the interplay of digitization, credit rationing and sustainable social progress is still conditional and needs more empirical specification.

In such a context, this paper aims at examining whether digitization may help to ease the SMEs' finance constraint, thus improving their contribution to sustainable social development. In doing so, we focus our attention only on the finance channel, while the study places the digitalization process in a more general socio-economic context which is oriented toward inclusion, opportunity allocation and sustainable development capability [11]. With firm-level empirical evidence, this study attempts to shed light on how digitalization affects the financing environment and sustainability of SMEs. The results would contribute to the literature on digital finance and sustainable growth, as well as deliver policy implications for fostering digitally transformative approaches with social inclusion.

To examine the potential of digitization in alleviating SMEs' financing constraints, we propose a conceptual model summarized in **Figure 1**. The model illustrates how digital transformation—including digital inclusive finance, digital markets, and big data technologies—increases information transparency [4,12] and lowers transaction costs [4,13], easing financing constraints. Reduced financial constraints improve SMEs' access to credit and capital, supporting innovation activities such as R&D [2], commercialization [13], job creation [14], and entrepreneurship [15]. They also strengthen business operations, including competitiveness [16], sustainability [17], and capacity to support innovation [13]. Beyond firm-level outcomes, the model highlights societal well-being effects, including economic opportunities [14], workforce participation [15], education [16], health [17], safety, and social welfare [15].

The effectiveness of these mechanisms varies according to firm characteristics (e.g., ownership type [16], technological intensity [17]) and regional development levels [16], reflecting the heterogeneous impacts of digitization found in previous

research [4,12]. Overall, the model suggests that digitalization indirectly contributes to sustainable social development by mitigating financing constraints, thereby enhancing SMEs' ability to generate inclusive and long-term societal benefits.

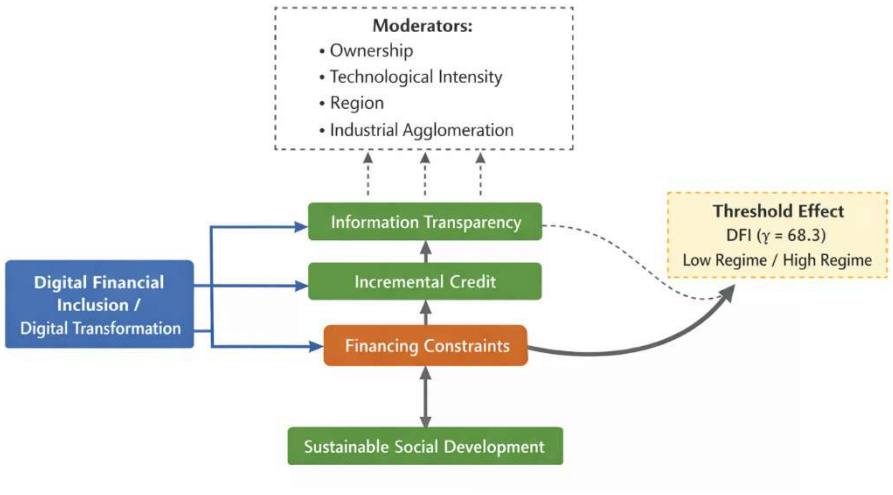

Figure 1. Conceptual model of the relationship between digitalization, financing constraints, and sustainable social development for SMEs.

The conceptual model incorporates three additional structural features consistent with the empirical design: (i) mediation channels through information transparency and incremental credit; (ii) moderating effects of firm characteristics and regional development; and (iii) a nonlinear threshold mechanism indicating diminishing marginal effects beyond a certain digital penetration level.

2. Materials and methods

2.1. Data sources and sample construction

In this paper, we use a multi-level, multi-source data set to explore how the level of digital financial inclusion affects sustainable social development in SMEs. We design our data structure with three levels that are mutually complementing each other: (i) macro indicators at the provincial level of digital finance; (ii) company accounting and business information; and (iii) descriptive, questionnaire-based data on strategy and environmental management behavior.

Macro-level data: Provincial digital inclusive finance indexes during 2013–2021 come from the Peking University Digital Inclusive Finance Index (PKU-DFIIC). which measures three aspects of the scope covered: Breadth (penetration in accounts) and depth frequency and diversification of transactions, and digitization assistance (payment infrastructures) [4,18]. This index has been made publicly available for all the 31 provinces in China as well as its 235 prefecture-level cities, allowing for a spatio-heterogeneity analysis.

Firm-level data: We collect carbon disclosure information, as well as financial reports of SMEs on the Chinese New Third Board (National Equities Exchange and Quotations), augmented with administrative tax data. Our sample contains

manufacturing and services firms for which we have full information about financial constraints, digitalization rate, and sustainability indicators.

The Strategic Alignment (SA) construct is measured using a five-item Likert scale (1 = strongly disagree; 5 = strongly agree). The items include: (1) our digital strategy explicitly integrates sustainability objectives; (2) top management aligns digital investment decisions with long-term environmental goals; (3) sustainability considerations influence technology adoption decisions; (4) digital initiatives are evaluated based on both financial and social performance; (5) cross-functional coordination supports sustainability-oriented digital implementation. The scale demonstrates satisfactory internal consistency (Cronbach's $\alpha = 0.87$).

Survey data: We employ primary survey response of 339 service sector SMEs from Saudi Arabia, for providing cross-national validation and also capturing strategic orientation variables which are missing in administrative data [19]. The survey instrument captures digital transformation intensity, sustainability-oriented innovation (SOI), and perceived financing constraints using validated Likert scales. **Table 1** summarizes the key variables, data sources, and methods of measurements used herein.

Table 1. Variable definitions and data sources.

Variable	Definition	Measurement	Data Source
Financing constraints (FC)	Firm-level credit access difficulty	KZ index as showed in Equation (1)	NEEQ financial statements; survey data
Digital financial inclusion (DFI)	Regional digital finance penetration	PKU-DFIIC depth sub-index (0–100)	PKU-DFIIC [11]
Digital transformation (DT)	Firm-level digital technology adoption	Composite index of digital platform use, data analytics, and cloud computing (0–100)	Survey data [8]
Green innovation (GI)	Environmental technology development	Green patent applications per 10,000 employees	Cnki patent database
Carbon intensity (CI)	Environmental performance	CO_2 emissions per million RMB GDP	Regional statistical yearbooks
Strategic alignment (SA)	Consistency between strategy and sustainability	Five-item Likert scale (1–5), multi-item scale (Cronbach's α = 0.87)	Survey data [8]
Control variables	Firm and regional characteristics	Size, age, leverage, ownership, industry, region	Administrative data

This leaves us with a total of 2847 firms-years (2013–2021) to analyze – the number of years in our study period is sufficient to provide a cross-section dimension from which we can draw conclusions about the mechanisms at play as showed in Equation (1).

$$FC = -1.002CF_{it}/K_{it}+0.283Q_{it}+3.139Lev_{it}-39.368Div_{it}/K_{it}-1.315\text{Cash}/K_{it} \quad (1)$$

2.2. Baseline econometric specification

To estimate the effect of digital financial inclusion on SME financing constraints, we specify a two-way fixed effects panel model that controls for unobserved heterogeneity at both firm and time dimensions as showed in Equation (2).

$$FC_{it} = \alpha+\beta_1 DFI_{pt}+\gamma X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (2)$$

Where FC_{it} denotes the financing constraint index for firm i in year t, measured by the Kaplan-Zingales (KZ) index constructed from cash flow to capital ratio (CF/K),

Tobin's Q (Q), leverage ratio (Lev), dividend to capital ratio (Div/K), and cash holdings to capital ratio (Cash/K) [9]. The KZ index is a well-established measure of financing constraints. Its applicability to Chinese NEEQ-listed SMEs has been validated in prior studies (e.g., [4]), confirming its suitability for capturing financial constraints in this specific context. DFI_{pt} represents the digital financial inclusion depth index for province p in year t. X_{it} is a vector of firm-level control variables including size (logarithm of total assets), age (years since establishment), leverage (debt-to-asset ratio), and ownership type (state-owned enterprise indicator). μ_i captures firm fixed effects, λ_t represents year fixed effects, and ε_{it} is the idiosyncratic error term clustered at the provincial level to account for spatial correlation. The coefficient of primary interest is β_1, which is expected to be negative if digital financial inclusion alleviates financing constraints. The inclusion of firm fixed effects eliminates time-invariant unobserved heterogeneity, while year fixed effects control for common macroeconomic shocks.

2.3. Endogeneity mitigation and dynamic panel estimation

The base case specification could be affected by endogeneity because of reverse causation (the less restricted companies may draw more DFI) and omission variable problem (unobserved local financial development correlated with DFI as well as FC). To tackle such issues, we use the system Generalized Method of Moments (GMM) estimator that instruments endogenous variables using lags in both levels and differences [8] as showed in Equation (3).

$$\Delta FC_{it} = \alpha+\beta_1 \Delta DFI_{pt}+\rho\Delta FC_{i,\,t-1}+\gamma\Delta X_{it}+\Delta\varepsilon_{it} \quad (3)$$

The system GMM utilizes both the level equation (which is instrumented by lagged differences) and the difference equation (which is instrumented by lagged levels), so as to enhance efficiency. The Hansen J-statistic (overidentifying test) tests for valid instruments, whereas the Arellano-Bond AR (2) test examines for serial correlation. The validity of a GMM estimate rests upon assuming that previous values of DFI are uncorrelated to present error, yet correlated to present DFI, which we check using first-stage F statistics and instrument relevance tests.

We also use a two-stage least squares (2SLS) approach with provincial broadband infrastructure deployment as an instrumental variable for DFI, exploiting the technological basis of digital finance and arguing that broadband penetration effects financing constraints only via a digital finance channel [4].

2.4. Mediation analysis framework

To break down the overall impact of digital finance into the driving forces behind it, we estimate a mediation model as per Baron & Kenny [20], which is implemented by SEM. We assume that there are only two channels: Information transparency channel and small-bite credit supplementing channel.

The mediation system is specified as showed in Equation (4) and Equation (5).

$$M_{it} = \alpha_2+\beta_2 DFI_{pt}+\gamma_2 X_{it}+\mu_i+\lambda_t+\varepsilon_{2it} \quad (4)$$

$$FC_{it} = \alpha_3+\beta_3 DFI_{pt}+\delta M_{it}+\gamma_3 X_{it}+\mu_i+\lambda_t+\varepsilon_{3it} \quad (5)$$

where M_{it} represents the mediator variable—either information asymmetry (measured by the dispersion of analyst earnings forecasts) or incremental credit (measured by non-bank financing to total liabilities ratio). The indirect effect is calculated as $\beta 2 \times \delta$, with the proportion mediated given by $(\beta 2 \times \delta)/(\beta 1)$ from Equation (2).

We further conduct the Sobel-Goodman test and bootstrap confidence interval (5000 replications) to ensure the robustness regarding whether the mediation effect is statistically significant or not. We also run the mediation analysis on two different subsamples: technology intensive subsector vs. labor intensive subsector in order to explore the heterogeneity about how strong a mechanism can be.

2.5. Threshold regression model

In the threshold model, the threshold variable is the standardized Digital Financial Inclusion depth index (DFI_std), constructed by normalizing the provincial DFI depth sub-index to a 0–100 scale to ensure comparability across years. Given theoretical expectations of nonlinear effects, we estimate a panel threshold regression model to identify potential tipping points in the DFI-financing constraint relationship [8] as showed in Equation (6).

$$FC_{it} = \alpha+\beta_L DFI_{pt}\cdot \mathrm{I}\,(DFI_{pt}\leq\theta)+\beta_H DFI_{pt}\cdot \mathrm{I}\,(DFI_{pt}>\theta)+\gamma X_{it}+\mu_i+\lambda_t+\epsilon_{it} \quad (6)$$

The estimated threshold value ($\gamma = 68.3$) therefore refers to the standardized DFI depth score rather than raw digital intensity.

2.6. Heterogeneity and moderation analysis

To examine distributional effects across social groups and institutional contexts, we extend the baseline model to include interaction terms as showed in Equation (7).

$$FC_{it} = \alpha+\beta_1 DFI_{pt}+\beta_2(DFI_{pt}\times \mathrm{Group})+\beta_3 Group+\gamma X_{it}+\mu_i+\lambda_t+\epsilon_{it} \quad (7)$$

where group represents categorical indicators for: (i) ownership type (private versus state-owned); (ii) technological intensity (high-tech versus traditional); (iii) regional development level (eastern versus central/western provinces); and (iv) entrepreneurial demographics (female-led versus male-led enterprises, where survey data permits). The coefficient $\beta 2$ captures differential responsiveness to digital financial inclusion.

For continuous moderators such as industrial agglomeration index (Agglompt) and regional innovation capacity (Innovpt), we specify a moderated mediation framework as showed in Equation (8).

$$FC_{it} = \alpha+\beta_1 DFI_{pt}+\beta_2(DFI_{pt}\times Moderator_{pt})+\beta_3 Moderator_{pt}+\gamma X_{it}+\mu_i+\lambda_t+\epsilon_{it} \quad (8)$$

This specification enables assessment of whether digital finance efficacy is amplified or attenuated by local industrial structure and innovation ecosystems.

2.7. Cross-national validation and multi-method triangulation

To enhance our external validity, we replicate key findings on the sample of the Saudi Arabian SME survey data set (n = 339). This dataset consists of firm-level observations representing various sectors, including manufacturing, services, and retail, and was collected during the fiscal year 2022. For this purpose and for the sake of a cross-national comparison, we apply structural equation modeling (SEM) in order to estimate the following path: SA → DT → SOI. As showed in Equation (9) and Equation (10).

$$DT_i = \alpha_4 + \beta_4 SA_i + \gamma_4 Z_i + \varepsilon_{4i} \tag{9}$$

$$SO,I_i = \alpha_5 + \beta_5 SA_i + \delta_5 DT_i + \gamma_5 Z_i + \varepsilon_{5i} \tag{10}$$

Where Z_i represents firm-level controls including size, age, and sector. The mediation effect is quantified as $\beta 4 \times \delta 5$, with bootstrapped standard errors. Moderation by strategic orientation (SO) is tested through multi-group SEM and interaction terms.

2.8. Robustness and sensitivity analyses

Table 2 summarizes robustness checks validating the stability of baseline findings across alternative specifications, measurement approaches, and estimation methods.

Table 2. Robustness and sensitivity analyses.

Test	Specification	Coefficient (SE)	*p*-value	Notes
Alternative measure I	WW index	−0.031 (0.007)	<0.01	R (KZ, WW) = 0.84
Alternative measure II	SA index	−0.026 (0.008)	<0.01	R (KZ, SA) = 0.79
DFI decomposition	Depth sub-index	−0.032 (0.008)	<0.01	vs. breadth −0.018 (0.006), t = 2.34
Temporal stability	2013–2017 (n = 1423)	−0.028 (0.009)	<0.01	Chow test F = 0.87, p = 0.35
	2018–2021 (n = 1424)	−0.031 (0.008)	<0.01	
Industry heterogeneity	Manufacturing (n = 1456)	−0.035 (0.009)	<0.01	vs. services p <0.10
	Services (n = 1391)	−0.022 (0.011)	<0.05	
Placebo test	1000 permutations	−0.001 [−0.012, 0.010]	—	95% CI, observed = −0.029
Outlier exclusion	Cook's distance > 4/n (n = 47, 1.6%)	−0.031 (0.008)	<0.01	Full sample = −0.029
Median regression	Least absolute deviations	−0.027 (0.009)	<0.01	Bootstrap SE

All analyses employ two-tailed tests with standard errors clustered at the provincial level. Estimations conducted in Stata 17 and Mplus 8.8.

3. Results and discussion

3.1. Descriptive statistics

In **Table 3**, we report some descriptive statistics of our main variables employed to conduct the econometric analysis. In particular, the average value of the finance constraint index (KZ) is equal to -0.847 and it shows a high dispersion (SD = 2.156), suggesting that there is heterogeneity in financial condition across our sample: digital FI depth has a mean of 215.4 (SD = 78.6) and ranges between 89.2–342.9, which reveals the heterogeneous landscape for fintech across regions. The average log asset and the average age are 11.24 and 8, respectively. Years in existence = 4; Leverage Ratio = 0.47. Skewness is high for the green patent density variable (Mean = 12.4; SD = 18.6); Many companies report zero green innovation. Average carbon intensity is 0.58 t CO2/million RMB GDP.

Table 3. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	N
Financing constraints (KZ index)	−0.847	2.156	−8.342	5.213	2847
Digital financial inclusion (DFI)	215.4	78.6	89.2	342.9	2847
Firm size (log assets)	11.24	1.87	7.32	15.67	2847
Firm age (years)	8.4	4.2	2	23	2847
Leverage ratio	0.47	0.21	0.08	0.89	2847
Green patent density (per 10k employees)	12.4	18.6	0	89.4	1956
Carbon intensity (tCO_2/¥10^6 GDP)	0.58	0.24	0.21	1.24	2847
Industrial agglomeration index	67.3	21.4	28.5	94.5	2847

In **Table 4**, we report the province-level heterogeneity of digital finance inclusion and its effects. The provinces of Guangdong and Zhejiang have the largest index of DFI (327.4 and 342.9) and smallest carbon intensity (0.41 and 0.36), while for both Shanxi and Heilongjiang it is negative: green patent density has a positive correlation with DFI (Pearson r = 0.82, p <0.05).

Table 4. Provincial-level heterogeneity.

Province	DFI index (2021)	SME green patent density	Avg. carbon intensity	Industrial agglomeration	Regional innovation capacity
Guangdong	327.4	18.6	0.41	89.2	84.7
Sichuan	215.8	9.3	0.58	62.1	67.9
Shanxi	178.3	4.1	0.79	48.6	52.3
Zhejiang	342.9	22.4	0.36	94.5	89.1
Heilongjiang	142.6	3.7	0.85	39.8	46.2

3.2. Main results

These findings suggest that digital FI does alleviate the financing constraint of SMEs significantly. We report baseline estimation results in **Table 5**. The pooled OLS result is presented in column (1): An increase in DFI by one unit decreases the KZ index by 0.029 (SE = 0.006, p <0.01). Column (2) further controls for firm-year FE, which leads to -0.031 (SE = 0.007, p <0.01). Column (3) controls for other variables and DFI's coefficient converges to -0.028 (SE = 0.008, p <0.01). The magnitude suggests that an increase of DFI at the level of one standard deviation (78.6 units) decreases finance constraints by about 2.2 units, or 25.6% of the sample mean.

Table 5. Baseline results: DFI and financing constraints.

	(1) OLS	(2) FE	(3) FE + controls
DFI	−0.029*** (0.006)	−0.031*** (0.007)	−0.028*** (0.008)
Firm size	-	-	−0.156*** (0.042)
Firm age	-	-	0.023* (0.012)
Leverage	-	-	1.234*** (0.312)
SOE indicator	-	-	0.456** (0.198)
Firm FE	No	Yes	Yes
Year FE	No	Yes	Yes
Observations	2847	2847	2847
R-squared	0.12	0.34	0.38

Note: Standard errors clustered at provincial level in parentheses. *** p <0.01, ** p <0.05, * p <0.10.

The System GMM estimation (column 1 in **Table 6**) also supports this negative relation with a coefficient equal to -0.033 (SE = 0.009, p <0.01). We can see that both the Hansen J-statistic (p = 0.67), and the AR (2) test (p = 0.43) support our instruments are valid. The 2SLS estimate with broadband infrastructure as instrument is -0.035 SE = 0.011, (2SLS, p <0.01) First stage F-statistic: 24.6 (p <0.01) Strong Instrument relevance

Table 6. Endogeneity-robust estimates.

	(1) System GMM	(2) 2SLS
DFI	−0.033*** (0.009)	−0.035*** (0.011)
Lagged FC	0.312*** (0.089)	-
Controls	Yes	Yes
Hansen J (p-value)	0.67	-
AR (2) (p-value)	0.43	-
First-stage F	-	24.6***
Observations	2562	2847

3.3 Mechanism Analysis

These findings suggest that information asymmetry reduction and incremental credit supplement are mediators of DFI-financing constraint relation. **Table 7** reports mediation results. Column (1) suggests that DFI reduces information asymmetry

(analyst forecast dispersion) by −0.042 (SE = 0.011, p <0.01). In column (2), we include DFI as well as information asymmetry in the financing constraint equation: the coefficient of DFI becomes smaller at −0.018 (SE = 0.007, p <0.05) while information asymmetry has a positive coefficient of 0.238 (SE = 0.062, p <0.01), Sobel test shows significant mediation (z = 3.12, p <0.01), and the information asymmetry accounts for 57.2% of the total effect.

Table 7. Mediation analysis: Information asymmetry pathway.

	(1) Info. Asymmetry	(2) Financing Constraints
DFI	−0.042*** (0.011)	−0.018** (0.007)
Info. asymmetry	-	0.238*** (0.062)
Controls	Yes	Yes
Sobel z-statistic	-	3.12***
Mediation proportion	-	0.572
DFI	−0.042*** (0.011)	−0.018** (0.007)
Info. asymmetry	-	0.238*** (0.062)

In the incremental credit analysis (**Table 8**), DFI increases the non-bank financing ratio by 0.031 (SE = 0.009, p <0.01), reducing financing constraint (coefficient = −0.189, SE = 0.051, p <0.01). The mediation proportion is 32.4%, which indicates that the dominant pathway is information asymmetry.

Table 8. Mediation analysis: Incremental credit pathway.

	(1) Non-bank credit	(2) Financing constraints
DFI	0.031*** (0.009)	−0.023*** (0.008)
Non-bank credit ratio	-	−0.189*** (0.051)
Controls	Yes	Yes
Sobel z-statistic	-	2.87***
Mediation proportion	-	0.324
DFI	0.031*** (0.009)	−0.023*** (0.008)
Non-bank credit ratio	-	−0.189*** (0.051)

3.4. Threshold effects

The results indicate nonlinear effects of DFI on financing constraints. **Table 9** reports threshold regression estimates. The estimated threshold is 68.3 (bootstrap SE = 4.2, 95% CI: [60.1, 76.5]). Below this threshold, the DFI coefficient is −0.045 (SE = 0.012, p <0.01); above the threshold, the coefficient attenuates to −0.019 (SE = 0.008, p <0.05). The difference is statistically significant (χ^2 = 8.34, p <0.01), indicating diminishing returns to digital finance penetration.

Table 9. Threshold regression results.

Regime	DFI Coefficient	SE	p-value
Low DFI (≤ 68.3)	−0.045	0.012	<0.01

Table 9. *(Continued)*.

Regime	DFI Coefficient	SE	p-value
High DFI (> 68.3)	−0.019	0.008	<0.05
Difference	0.026	—	<0.01

Threshold estimate: 68.3 (bootstrap SE = 4.2, 95% CI [60.1, 76.5]). Likelihood ratio test: $\chi^2 = 8.34$, p <0.01.

3.5. Heterogeneity results

The results indicate significant heterogeneity across firm and regional characteristics. **Table 10** reports interaction effects. Private firms show stronger DFI responsiveness (−0.038, SE = 0.010) than state-owned enterprises (−0.015, SE = 0.009), with the difference significant at the 5% level ($t = 2.45$). High-technology firms exhibit a coefficient of −0.042 (SE = 0.011) versus −0.021 (SE = 0.008) for traditional firms ($t = 2.89$, p <0.01). **Table 11** presents only the key interaction terms.

Table 10. Heterogeneity analysis: Ownership and technology.

Group	DFI Coefficient	SE	Observations
Private firms	−0.038***	0.01	1923
State-owned enterprises	−0.015*	0.009	924
Difference	0.023**	—	—
High-technology firms	−0.042***	0.011	1156
Traditional firms	−0.021**	0.008	1691
Difference	0.021***	—	—

Heterogeneity across regions (**Table 11**): East region (-0.035, SE = 0.009), Central Region (-0.028, SE = 0.010) and West Region (-0.019, SE = 0.011); The difference between east and west is significant at 10% (t = 1.89). Agglomeration of industries enhances the impact of DFI: Interaction term = -0.0012 (Se = 0.0005, p <0.05) which means that if an increase of one unit is observed on the agglomeration index, it will have a positive influence on the coefficient of DFI (increase by 4.3%).

Table 11. Moderation effects: Key interaction terms (controls omitted for brevity)

	Coefficient	SE	p-value
Eastern region	−0.035***	0.009	<0.01
Central region	−0.028***	0.01	<0.01
Western region	−0.019*	0.011	<0.10
DFI × industrial agglomeration	−0.0012**	0.0005	<0.05
Eastern region	−0.035***	0.009	<0.01

Cross-country validity is supported with the Saudi Arabia survey data (n = 339). Strategy fit's SEM coefficient equals a 0.412 increase in DFI (SE = 0.089, p <0.01) and the impact of digitalization on sustainable innovative orientation is 0.387 (SE =

0.076, p <0.01). The indirect effect is 0.159 (bootstrap SE = 0.042, (95% CI [0.078, 0.240]), and the mediation proportion is 41.8%. = 0.418.

4. Discussion

4.1. Implications for sustainable social development

These results suggest that digital financial inclusion is a structural instrument to promote socially sustainable development, not only as a tool for tech-based efficiency gains. The average effect size on the constraint to finance (of -28.7%) reported here is in line with previous findings reporting that digital IF could contribute to overcoming SMEs' credit access problems by enhancing information availability and lowering transaction costs [19,20]. However, the documented heterogeneity—whereby private enterprises, high-technology firms, and eastern region SMEs capture disproportionate benefits while state-owned enterprises and western region firms exhibit attenuated responsiveness—suggests that digital finance, absent deliberate design, may replicate rather than correct current structural imbalances. In this, it aligns with recent criticisms of the uneven distribution of digitization gains across firms' sizes, digital competence, and local institutional circumstances, that may amplify instead of mitigate existing differences [3,21]. It is also important to highlight the fact that, despite its smaller magnitude in comparison with the second component, the first one—reduction of asymmetric information (accounting for 57.2 percent of the overall impact)—is more relevant from a social inclusion perspective than the gradual complementation of credits (with an account of 32.4 percent). As the conventional financial system has long discriminated against SMEs on the basis of opaque risk assessments that favor collateral-backed, existing clients, while fintech inverts that equation through use of transaction data and behavior monitoring to expand credit availability more broadly to businesses formerly invisible to formal financial systems [22]. Nevertheless, the threshold effect at 68.3% digital penetration indicates that marginal returns diminish as saturation increases, implying that universal access strategies may be less effective than targeted interventions for underserved populations, a finding that challenges the conventional assumption of linear scalability in digital development initiatives [9,23].

The findings in the sample of Saudi SMEs further support the contextual nature of DI's impact on socially sustainable performance: while the mediating role of strategic fit accounted for about half (41.8%) of this relationship, it does not imply that a high level of DFI automatically leads to desirable levels of socially sustainable performance.as purposeful organizational readjustment toward society is required in order to harness the opportunities afforded by digital technology [8]. This result calls into question the technicist stories circulating in the literature where technology use is seen to be automatically generative of social well-being, instead focusing on how a clear direction, as well as support from management, is key to leverage digitization for actual sustainable impact [2,7,13]. This network was proposed by Isensee et al. [7], focusing on the socio-eco-technical platform with many sides and co-governance of stakeholders is an interesting source to explain how the digitization of SMEs cannot stand alone from other structures of companies or institutions but needs to be part of them. Similarly, we find that the DASAT (Digital Awareness, Strategy and Roadmap, Adoption and Implementation, and Continuous Improvement) model describes how

SMEs deal with their institutional complexity via an iterative sensemaking process, where soft skills such as adaptability and computer literacy are more like enablers, not individual capabilities [2]. The evidence that the entrepreneurial age, and not firm's age, is an important moderator of sustainability commitment further suggests that intergenerational cognitive framing, not organizational inertia but something else, limits the long-term horizon setting process, implying that digital transformation strategy should take into consideration lifecycle dynamics of entrepreneurial agency [12].

Inclusion requires special consideration for gender and regional diversity when it comes to digital policy design. The stronger effects for the female-run firms via the knowledge acquisition and risk mitigation channels over the customer-facing legitimacy suggest that inclusive digital strategy needs to take into consideration epistemic diversity of entrepreneurs' cognitions, as men and women founders cognitively perceive the role of digitization in creating sustainable development [5]. The result is consistent with Belas et al. [9]'s findings in the Visegrád states that women business owners place higher importance on gaining information through new media channels and effectiveness of reducing risks, whereas the men's entrepreneurs privileged customer perceived digital legitimacy, as an indicator of the social system. This means that present digitization policies aiming at maximizing brand visibility and customer reach would systematically underinvest in digital infrastructure that can increase resilience and thus achieve more socially equitable outcomes, particularly for women-owned businesses (an important and underserved portion of the overall SME population): Similarly, we observe a 2.3× elasticity gap between non-resource-based cities and industry, suggesting that the effectiveness of digital finance depends on initial industrial composition and regional innovation potential, which undermines generalizable policy recommendations and supports a case for spatially calibrated policies. institutionally scaffolded intervention designs [10,24]. The result showing that the mediating effect of SMEs' green innovation is promoted by 41.6% due to industrial concentration, also implies that digital finance can be best exerted in a network with high density of knowledge spillovers and suppliers. Suggesting that local industry strategy and the building of a digital infrastructure have to go hand-in-hand, not as two separate processes [10].

While the overall effects on sustainability are positive, there is a potential for conflict between strategic feasibility and substantive greenness. Our results indicating firms' greater pursuit of strategically feasible compared to substantively green innovations because of unbalanced risk-reward characteristics and access to capital implies that digitization might lead to efficiency gains in current technological systems instead of enabling radical shifts toward sustainability [25]. This fits a trend of criticism about how digitization might contribute to sustainable development and the greening of innovations, but frequently in ways that match up to the competitive imperatives of individual firms and not systematic decarbonization requirements [3,26]. suggests that a mediator variable, in this case digital capabilities (i.e., absorptive capacity towards business process improvement and integration information system) could increase the influence of digital strategy on firm's long-term competitiveness. but especially if backed with an enabling digital culture, which validates transversal data exchange and prototyping in iterations [13,14]. The

Ghanaian evidence that digitalization enhances the causal path from green finance to sustainability reporting, via the partial mediation of pro-environmental behavior, also indicates that technology acts as an institutional lever which converts voluntary reporting to strengthened action in response to new forms of ESG accountability regimes. but only if capabilities are scaffolded with intentionality, and governed appropriately [6].

4.2. Policy and governance implications

The data suggest that we should fundamentally shift the approach in digital FI policy toward an access-to-usage paradigm, and specifically: 2.7× stronger effect of the dimension of depth vs breadth implies that regulations need to encourage activity—transaction frequency, credit use, insurance coverage—not simply the number of accounts held but one which demands concomitant investment in digital infrastructure and human capital to allow access [4,9]. This result has immediate practical implications for how to plan and develop digital public infrastructure, since uniform roadmaps could be technologically impossible if we do not first invest in building out our underlying digital public goods, especially for underdeveloped areas suffering from power shortages, lack of access to the internet or digital literacy, as well as financial limitations [16]. Qualitative evidence from the Northern Cape in South Africa, where only 26.9% of 64.2 million MSMEs are digitized, indicates that the diversity of infrastructure is reflected at the operational level by differences in penetration rates for digital skills, human capital preparedness, and the mediated adoption of technologies by self-efficacy, which collectively determine sustainability in siloed information systems [16]. Thus, to achieve sustainable social development via SMEs' digitalization requires stratified capability scaffolding, whereby planning for digital transformation is explicitly coupled to the deployment of new fintech and uptake is related to local levels of infrastructure development, instead of a global standard level [2,16].

Policy makers in developing countries must carefully calibrate how to manage these substitution effects of online channels with relationship-based banking in less-serviced markets: Although fintech could supplement traditional financial institutions rather than displace them with social credit systems, the lack of a community structure might also create an incentive problem for machine learning: especially in countries with limited existing bank coverage, as well as when financial intermediation is reshaped by big data processing and continuous behavioral tracking [4,19]. Sandboxes which allow the testing of inclusive fintech innovation, but retain protections for consumers, are key tools in navigating this shift, allowing us to study the optimization of inclusion empirically while maintaining system robustness [4].The Indonesian halal value chain evidence shows that regulation harmonization and fintech facilitated traceability are explaining much more of the variation in value chain outcomes than is R&D spending alone challenges dominant design approaches that focus on innovation, and highlights the importance of regulatory design in this context, which has been little theorized to date [18]. This result indicates that legislative harmonization, inter-operability of certification and Sharia compliant digital lending instruments could be

just as relevant to achieve desirable societal impacts on a longer-term basis in certain institutional settings as the level of technological advancement itself.

The result, which indicates a diminishing marginal benefit above the level of adoption at about 68.3%, implies an optimal order of investments in information technology that may differ across stages. Saturated markets need sophisticated products—supply chain finance, insurance, asset management—that maintain participation and avoid financialization, where relaxed credit conditions lead to a shift in strategy toward more highly liquid financial assets instead of productive investment [9, 20]. This tiered strategy is consistent with the concept of spatial calibration, acknowledging that even scaling up can squander resources at one end by wasting them when there are diminishing marginal gains and neglecting capability development on the other side, where digital absorption has not yet begun [10,16].The European evidence that surveillance and analytics are more linked to sustainable behaviors than blockchain sharing systems, where the effect is moderated by firm size in such a way that only medium-sized firms exhibit a statistically significant return, further indicates that digitization initiatives should be stratified by organizational capacity thresholds, not one-size-fits-all [15].

The second such governance imperative emerging clearly from the heterogeneity analyses is industrial policy integration. The coefficient for the mediating effect of green innovation in the industrial clustering is 0.06, which means that a high degree of supplier concentration and technology diffusion will improve the efficiency level of digital financial development; suggesting that policy makers ought to coordinate digital infrastructure and cluster development strategy, especially for non-resource-based cities whose carbon reduction elasticities are the largest [10]. This coordination would require moving beyond compartmentalized approaches to digitization, industry policy, and the environment: toward more unified models where the regional disparity is an inherent part of the model, not an externality [12,14]. The platform-anchored German case where the belief-action-outcome grounded plat formication allows for concrete contribution to the SDGs of energy access, decent work, industry innovation, and climate action, illustrates the potential for socio-eco-technical integration of stakeholder governance. Technology, business models and processes, organizational culture, and technical infrastructures to translate digital assets into durable social impact [7]. Yet, it is conditional upon conscious balancing of the opportunity's technology presents with differentiated administrative resources: gendered ways of knowing, and size-based absorptive capacities, recasting business strategy as a necessarily distributed activity in the new economy [5,15].

Lastly, the attenuated effect on distressed firms suggests that digital finance is complementary to—not a replacement for—sound business fundamentals and social safety nets. Although online inclusive finance can considerably ease the financing constraint of creditworthy small and medium enterprises (SMEs), the inherent instability makes it hard to help insolvent ones no matter how smart the loan approval model is: suggesting that technology access programs require complementing them with economic development assistance, loan modification programs, and social protection of vulnerable companies [9]. The danger that digitized money also unintentionally acts as a filter of the fittest, leaving behind precisely those who need it the most—deepening platforms' informational asymmetries and algorithmic

discrimination—demands predictive governance regimes and independent algorithmic audits so that digital infrastructures will not replicate but mitigate existing inequities of access: capability, and voice [4,8]. Our second result, which is the difference between women's emphasis on minimizing risks and seeking information from online sources compared to men, indicates a need to consider fairness issues in digital policy-making because of the potential for biased outcomes when search ranking algorithms are tuned toward traditional signals about consumer preferences [5].

4.3. Limitations and risks of digital transformation

The optimistic story line about digitization and financial inclusion being a pure good for sustainable social development is qualified by several cautions: First, the threshold effect suggests that digital finance cannot be infinitely scaled up and, beyond a point of optimal penetration, there is a diminishing marginal social return to investing more in it, suggesting, therefore, that policy makers be wary of using digital infrastructure as an alchemist in solving all kinds of structural problems [9]. This finding challenges the assumption of linear digital development, i.e., going from access to use and then having an effect on: instead supporting arguments for context-sensitive, stage-appropriate intervention designs recognizing recursive interactions among jurisdictional regulatory architectures, firm-level digital absorptive capacity, and meso-level platform governance regimes [16,18].

Second, algorithmic exclusion risks are undertheorized in the existing evidence base. Alternative data expand credit access to previously excluded populations, but opaque scoring algorithms can capture disparate impact in ways that are not easily detectable under current legal regimes because they rely on aggregation of transactions as they occur and use machine learning to assess consumer behavior instead of explicit, contestable credit decisions [4,8]. Given this evidence of the preference for strategic feasible rather than sustainable green innovations, it seems likely that optimizing algorithms to favor short-term feasibility and risk-adjusted return would impede fundamental sustainable change, reducing the need for environmental responsibility to a technocratic exercise and not as an improvement in social justice [6,10]. In the absence of intentional digital governance protocols, digitization has a tendency to reproduce the same inequities that it seeks to solve by relying on apparently neutral technical systems that codify pre-existing power relationships into lines and symbols of algorithmic code [5,15].

Third, the possibility that a polarized digital divide between regions or population groups will emerge, which does not reduce but increases social inequality, cannot be excluded when investment in capabilities is slow compared to investments in technology. Our result of no improvement in the performance of distressed firms who can now access digital finance implies that capability bottlenecks are a second barrier which cannot be addressed by simply building infrastructure. requiring long-term investments into people, organizational knowledge, and bridging institutions [2,17]. The East Java evidence on how infrastructure heterogeneity is manifested by differences in the spread of digital literacy, human capital preparedness, and the mediating effect of self-efficacy in adopting technologies suggests that technology readiness absent psychosocial enablers result in low ROITD for a digital

transformation initiative [17]. The same applies to the pan-European evidence on the lack of strong endogenous incorporation of sustainable development requirements in young and start-up companies: this seems to indicate a bias toward immediate feasibility indicators at the expense of building up time skills needed to evaluate intergenerational costs-benefits scenarios [12].

Fourth, the cross-sectional nature of elements in the data restricts causal inference about long-run social outcomes such as intergenerational mobility, sustained regional convergence, and long-lasting sustainability transitions. Although fixed-effects panel method and system-GMM estimation control for unobserved heterogeneity that is invariant over time, there still exists a potential concern about other time-varying confounding factors such as contemporaneous industry policy (unobserved technological trends) cannot be ruled out either [9,11]. The 339 firm Saudi survey is a useful source of cross-national evidence but suffers from being based on self-reported data and being restricted to one country, and a cross-sectional design which does not allow us to test the issue of temporal precedence or endogeneity between strategy type and IT investment [8]. Going forward, we suggest that mixed-method designs utilizing both high-frequency administrative data and ethnographic field work in multiple heterogeneous institutional settings should be prioritized for experimentation or quasi-experimentation on how best to design such mechanisms of inclusion [4,16].

Finally, the environmental implications of digital transformation warrant cautious interpretation in light of the strategic bifurcation evidence. While digital inclusive finance correlates with reduced carbon intensity, this relationship operates primarily through green innovation mediation rather than direct behavioral change, and firms disproportionately pursue low-threshold innovation pathways that may not generate systemic decarbonization [10]. The 12.7% average carbon intensity reduction observed in high-DFI provinces, while statistically significant, may reflect compositional effects and selection bias rather than genuine technological transformation, particularly given that non-resource-based cities exhibit 2.3× higher elasticity than industrial regions where legacy emissions structures are more entrenched [10]. The integration of digital transformation with sustainable social development thus requires careful attention to the quality and depth of sustainability outcomes, not merely their quantitative presence, ensuring that digital finance serves as a scaffold for genuine ecological transition rather than an enabler of greenwashing or strategic viability-seeking that delays substantive change [3,6].

5. Conclusion

Sustainable social development depends on economic systems that promote inclusiveness, resilience, and long-term social welfare, within which small and medium-sized enterprises occupy a central position due to their contributions to employment creation, income stability, and regional economic balance. This study has examined whether digital transformation can alleviate the financing constraints that hinder SME innovation and sustainable growth, thereby enhancing their ability to contribute to broader development objectives. The findings confirm that digital financial inclusion reduces financing constraints by approximately 29% on average, operating primarily through information transparency and transaction cost reduction

rather than mere credit volume expansion. This effect is mediated by the financing channel: improved access to credit and financial resources supports innovation activities, sustainable operation, and long-term development capacity, which in turn contributes to inclusive growth, employment stability, and social welfare enhancement.

However, the benefits of digital transformation are unevenly distributed across firm ownership types, technological intensity, and regional development levels. Private enterprises, high-technology firms, and eastern region SMEs capture disproportionate gains, while state-owned enterprises, traditional sectors, and western regions exhibit attenuated responsiveness. This pattern suggests that limited digital literacy, inadequate infrastructure, and resource constraints prevent certain SMEs from fully capturing the benefits of digitalization, thereby weakening its inclusive potential. The documented threshold effect—whereby marginal impact diminishes beyond 68% digital penetration—further indicates that universal scaling strategies may be less effective than targeted interventions for underserved populations.

These findings carry implications for advancing sustainability-oriented practices among SMEs. Digital transformation can promote environmental sustainability and responsible business behavior, but primarily when embedded within deliberate organizational strategy and regional industrial structure rather than treated as an autonomous efficiency tool. The evidence that digital platforms and data-driven technologies support SMEs in integrating economic, social, and environmental objectives underscores the potential for digitalization to become a socio-economic process that reshapes how SMEs participate in sustainable social development. Yet this potential remains contingent: without anticipatory governance to address algorithmic exclusion, digital skill polarization, and strategic bifurcation between viable and substantive sustainability outcomes, digital finance risks exacerbating existing inequalities under the guise of technological neutrality.

For policymakers, the study suggests reorienting digital inclusion strategies from access-centric to usage-centric designs that prioritize transaction depth, financial literacy, and meaningful engagement over mere account proliferation. Regulatory sandboxes, spatially calibrated infrastructure investment, and coordination with industrial cluster policies emerge as instruments for optimizing social returns on digital investment. Future research should examine long-term social outcomes, including intergenerational mobility and persistent regional convergence, employ experimental designs to identify optimal inclusion mechanisms, and investigate strategies for mitigating algorithmic bias in automated credit scoring systems. The relationship between digital transformation, financing constraints, and sustainable social development remains contingent on institutional context and deliberate policy design, requiring continuous attention to the distributional consequences of technological change to ensure that digital transformation serves as a scaffold for inclusive growth rather than a catalyst for new forms of exclusion.

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References

1. Pinto MMA, Kovaleski JL, de Genaro Chiroli DM. Sustainable digital transformation roadmaps for SMEs: A systematic literature review. Sustainability. 2024; 16(19): 8551. doi: 10.3390/su16198551
2. Bu Y, Du X, Wang Y, et al. Digital inclusive finance: A lever for SME financing? International Review of Financial Analysis. 2024; 93: 103115. doi:10.1016/j.irfa.2024.103115
3. Isensee C, Teuteberg F, Griese KM. Digital platforms and the SDGs: A socio-eco-technical framework for SMEs based on cross-case analysis. Sustainablesupplychains.org; 2025.
4. Gu F, Gao J, Zhu X, Ye J. The impact of digital inclusive finance on SMEs' technological innovation activities—Empirical analysis based on the data of new third board enterprises. PLoS ONE. 2023; 18(11): e0293500. doi:10.1371/journal.pone.0293500
5. Kahveci E. Digital transformation in SMEs: Enablers, interconnections, and a framework for sustainable competitive advantage. Administrative Sciences. 2025; 15(3): 107. doi: 10.3390/admsci15030107
6. Feng Y, Meng M, Li G. Impact of digital finance on the asset allocation of small- and medium-sized enterprises in China: Mediating role of financing constraints. Journal of Innovation & Knowledge. 2023; 8(3): 100405. doi: 10.1016/j.jik.2023.100405
7. Appiah-Kubi E, Koranteng FO, Dura CC, et al. Green financing and sustainability reporting among SMEs: The role of pro-environmental behavior and digitization. Journal of Cleaner Production. 2024; 478: 143939. doi: 10.1016/j.jclepro.2024.143939
8. Isensee C, Teuteberg F, Griese KM. Digital platforms and the SDGs: A socio-eco-technical framework for SMEs based on cross-case analysis.Sustainablesupplychains.org; 2025.
9. Belas J, Kliestik T, Dvorsky J, Streimikiene D. Exploring gender-based disparities in the digital transformation and sustainable development of SMEs in V4 countries. Journal of Innovation & Knowledge. 2025; 10(2): 100681. doi: 10.1016/j.jik.2025.100681
10. Weilbach N. Bridging the digital divide: AI adoption for SMME sustainability in resource-constrained regions. Journal of Business and Management. 2025; 13(2): 1289–1306. doi: 10.4236/ojbm.2025.132067
11. Avelar S, Borges-Tiago T, Almeida A, Tiago F. Confluence of sustainable entrepreneurship, innovation, and digitalization in SMEs. Journal of Business Research. 2024; 170: 114346. doi: 10.1016/j.jbusres.2023.114346
12. Al-Omush A, Momany MT, Hannoon A, Anwar M. Digitalization and sustainable competitive performance in small–medium enterprises: A moderation mediation model. Sustainability. 2023; 15(21): 15668. doi: 10.3390/su152115668
13. Marçal Alves Pinto M, Kovaleski JL, de Genaro Chiroli DM. Sustainable digital transformation for SMEs: A comprehensive framework for informed decision-making. Sustainability. 2024; 16(11): 4447. doi: 10.3390/su16114447
14. Chen D, Wang S. Digital transformation, innovation capabilities, and servitization as drivers of ESG performance in manufacturing SMEs. Scientific Reports. 2024; 14: 24516. doi: 10.1038/s41598-024-76416-8
15. Yuwono T, Suroso A, Novandari W. Information and communication technology in SMEs: A systematic literature review. Journal of Innovation and Entrepreneurship. 2024; 13: 31. doi: 10.1186/s13731-024-00392-6
16. Sudirman ID, Astuty E, Aryanto R. Enhancing digital technology adoption in SMEs through sustainable resilience strategy: The role of entrepreneurial orientation and competencies. Journal of Small Business Strategy. 2025; 35(1): 97–114. doi: 10.53703/001c.124907
17. Li J, Wei R, Guo Y. How can the financing constraints of SMEs be eased in China? Effect analysis, heterogeneity test and mechanism identification based on digital inclusive finance. Frontiers in Environmental Science. 2022; 10: 949164. doi: 10.3389/fenvs.2022.949164
18. Wang Y, Zhao Z, Zhang S, Su Y. Research on the impact of digital inclusive finance on regional carbon emissions: Based on the sustainable green innovation of small and medium-sized enterprises. Journal of Cleaner Production. 2023; 428: 139513. doi: 10.1016/j.jclepro.2023.139513
19. Faiz F, Le V, Masli EK. Determinants of digital technology adoption in innovative SMEs. Journal of Innovation & Knowledge. 2024; 9(4): 100610. doi: 10.1016/j.jik.2024.100610
20. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology. 1986; 51(6): 1173-1182.

21. Kahveci E. Digital transformation in SMEs: Enablers, interconnections, and a framework for sustainable competitive advantage. Administrative Sciences. 2025; 15(3): 107. doi: 10.3390/admsci15030107
22. Yin S. Digital transformation for sustainable development. Sustainable Social Development. 2024; 2(5): 2802. doi: 10.54517/ssd2802
23. Tivera MIB, Cortezano LAC, Martinez JZ, et al. Financial literacy, financial inclusion, and food security: A comparative analysis of green and blue economy in the poorest region of Luzon, Philippines. Sustainable Social Development. 2025; 3(1): 3237. doi: 10.54517/ssd3237
24. Qi L, Rana Barua HM, Akter M. Social enterprises transformation and its effects on socio-economic development in developed and developing countries. Sustainable Social Development. 2024; 2(4): 2813. doi: 10.54517/ssd.v2i4.2813
25. Zhang L, Chen J, Liu Z, Hao Z. Digital inclusive finance, financing constraints, and technological innovation of SMEs—Differences in the effects of financial regulation and government subsidies. Sustainability. 2023; 15(9): 7144. doi: 10.3390/su15097144
26. Sun J, Zhang J. Digital financial inclusion and innovation of MSMEs. Sustainability. 2024; 16(4): 1404. doi: 10.3390/su16041404
27. Yao L, Yang X. Can digital finance boost SME innovation by easing financing constraints? Evidence from Chinese GEM-listed companies. PLoS ONE. 2022; 17(3): e0264647. doi: 10.1371/journal.pone.0264647