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Sustainable Financial Management of MSMEs in Disadvantaged Regions through Digitalization Post-Pandemic

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A B S T R A C T

Purpose: To explore the effect of digital financial capabilities on sustainable financial performance via digital financial inclusion.
Method: A quantitative survey-based study using structural equation modeling for analyzing MSME digital and financial management practices.
Findings: Results show the importance of digital financial inclusion as a key driver in the relationship between digital financial capabilities and sustainable financial performance. DFL, fintech use and digital record keeping improve the inclusiveness that in turn increasing financial sustainability. Liquidity discipline; its direct impact on overall performance. The former demonstrate the extent to which sustainable cash flow management processes directly contribute to overall performance. Nevertheless, digital readiness fully enhances not all of the digital finance-performance relationships in every context, also demonstrating that technological preparedness is inadequate to improve financial performance but need complementing with effective financial governance.
Novelty: This research presents a comprehensive accounting-based sustainability framework incorporating digital financial inclusion as a mediating mechanism, and digital readiness as a contextual factor. It pushes beyond the efficiency outcomes that have dominated digital finance research to focus on the scope and implications of long-term financial accountability and resilience.
Implications: The results provide insights for MSME managers, policy makers and financial service providers in designing an inclusive digital finance interventions focusing on developing the financial discipline, capability, and sustainable performance instead of immediate digital adoption itself.

1. Introduction

The increasing digitalisation of financial transactions has fundamentally changed the way in which micro, small and medium-sized enterprises (MSMEs) resource their finances. Digital payment ecosystems, including those operated by informal convenience store owners, fintech initiatives and electronic accounting applications, have become increasingly integrated into daily business operations. These innovations have had a positive impact on cash flow, enhanced transactional transparency and expanded access to financial services. Research has shown that digital financial

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tools can improve efficiency, reduce information asymmetry and encourage financial accountability within small firms (Bourke et al., 2025; Gomber et al., 2018; S. Kraus et al., 2022). Despite the high uptake of digital financial technologies, MSMEs continue to demonstrate high exposure to financial risk, as well as liquidity and performance issues (Akinrinde et al., 2025; Verma et al., 2024). This paradox indicates that the link between sustainable financial performance and digitalisation is not automatic or consistent, necessitating further research from an accounting and accountability perspective (Chakhovich & Virtanen, 2025).

This trend is supported by critical challenges faced by MSMEs: their limited ability to adopt digital financial systems for sustainable financial management. Fintech services are known for their focus on speed and convenience, but this can sometimes lead to financial complexity, risk exposure, and increased management pressure, especially in the absence of strong financial knowledge and disciplined accounting practices. Research shows that inadequate financial management, characterized by ineffective cash flow monitoring and poor record-keeping, remains a major cause of SME failure, even in a digitized environment (Beck & Demirguc-Kunt, 2006; Lusardi & Mitchell, 2014; Trinh et al., 2020). Furthermore, access to digital finance alone is not sufficient to achieve financial inclusion. Companies with limited financial capabilities may be prone to credit abuse or fail to utilize financial data strategically. It is clear that digital financial management is not only a technical issue, but also relates to behaviour and governance.

The theoretical basis of this study includes the Technology Acceptance Model (TAM), Resource-Based View (RBV), and Financial Literacy Theory. These theories are used to provide a comprehensive explanation of the sustainable financial performance of MSMEs. According to TAM, the key factors influencing the adoption of digital financial technology are the perceived ease and usefulness of its use. This, in turn, influences TMT behaviour towards the use of fintech (Alkaraan et al., 2022; Ghouri et al., 2021; Verma et al., 2024). RBV contributes to this perspective by classifying DFL and FMC as intangible organizational resources that companies can leverage to achieve sustainable competitive advantage (Barney, 1991; Kraus et al., 2022). Furthermore, research in the field of financial education shows that investors with higher levels of education and sophistication tend to demonstrate a stronger understanding of savings, risk management, and budget discipline over time (Lusardi & Mitchell, 2014; OECD, 2023). When considered together, these perspectives allow us to build a unified argument about how digital finance and managerial capabilities will work together to influence the sustainability of financial performance.

It should be noted that, given the nature of fintech adoption and the still-developing literature on MSME performance, previous findings are fragmented and unclear. Many studies have been conducted on the relationship between digital finance and company performance; some have found a positive relationship, while others have found no significant relationship, or even a negative effect, due to weak financial governance and poor accounting standards (Bocken et al., 2014; Bourke et al., 2025; P. Kraus et al., 2022). Furthermore, many studies are short-term and numerical in nature, with a lack of consideration for sustainability measures such as cash flow resilience, financial sustainability, and long-term viability. Second, there is a lack of empirical evidence to support the application of an accounting-based sustainability approach in the domain of digital finance. This refers in particular to the role of digital financial inclusion as a mediator. This inconsistency highlights a significant research gap regarding why different levels of digital adoption produce different financial effects for MSMEs.

This study aims to explore how digital financial literacy, fintech adoption, digital bookkeeping, and sustainable cash flow management practices affect the sustainable financial performance of MSMEs, with a focus on the role of digital financial inclusion in this process. This study enriches the existing literature by introducing an integrated accounting and sustainability perspective in digital finance research. This approach extends empirical work beyond mere efficiency gains and toward long-term financial accountability and resilience. The results of this study provide practical implications for SME

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owner-managers, financial service providers, and regulators regarding the core competencies required to implement digital finance responsibly. In addition, this analysis provides valuable insights into the development of inclusive digital financial systems and capacity-building efforts. This is essential for promoting the sustainable development of MSMEs in the global digital economy.

The remainder of this paper is divided into five sections. The rest of this study is organized as follows: Section 2 provides the theoretical background and hypothesis development. Section 3 outlines the research methodology. Section 4 reports the empirical findings. Finally, Section 5 concludes the study with implications and future research.

2. Literature Review

2.1 Digital financial literacy and sustainable financial performance

Digital financial literacy is an essential managerial skill that helps MSMEs maximize their financial knowledge in a digital environment. It enables them to better understand, process, and utilize financial information. Financial literacy theory states that greater knowledge will result in better budget planning, risk assessment, and better long-term financial choices (Lusardi and Mitchell, 2014). Digital financial literacy is an intangible resource from a resource-based perspective, which is the basis for organizations to maintain competitive advantage through better financial control (Barney, 1991). Research shows that MSMEs with higher financial literacy have better profitability, better risk management, and better resilience in the face of global crises (Morgan and Trinh, 2020; Demirgüç-Kunt et al., 2022; Bourke et al., 2023). Digital financial literacy has been identified as a key factor in improving sustainable financial performance through effective financial discipline management and strategic resource allocation.

Hypothesis 1: Digital financial literacy has a positive effect on the sustainable financial performance of MSMEs.

2.2 Fintech and digital payment adoption and sustainable financial performance

The implementation of fintech and digital payments has transformed conventional financial operations by accelerating transactions, increasing transparency, and ensuring transaction traceability. This implementation can be explained through the Technology Acceptance Model in terms of perceived usefulness and ease of use. These factors have a significant impact on managerial intent to use financial technology (Venkatesh et al., 2012). Research in the field of digital finance shows that fintech adoption can reduce transaction costs and improve cash flow, which ultimately contributes to improved company performance (Gomber et al., 2018). However, according to accounting literature, the benefits of adoption can only be fully realized in an efficient financial control and performance system (Kraus et al., 2020; Bourke et al., 2023). Extensive research has shown that MSMEs that adopt digital payments experience increased income stability and better financial reporting, which ultimately leads to sustainability-focused outcomes (Ryu, 2018; Kraus et al., 2022).

Hypothesis 2: Fintech and digital payment adoption has a positive effect on the sustainable financial performance of MSMEs.

2.3 Digital financial record-keeping and sustainable financial performance

Digital accounting records play an important role in improving management transparency and accountability in MSMEs, and are a fundamental component of effective business practices. According to Romney and Steinbart (2018), the quality and timeliness of financial information can have a positive impact on decision-making and internal control. The application of the RBV approach allows companies to utilize financial records as strategic assets for planning and performance analysis (Barney, 1991). As shown in research, MSMEs that use digital recording systems have been proven to have better capabilities in cash flow forecasting and cost control, as well as the ability to maintain their financial sustainability (Kraus et al., 2022; Abdullah et al., 2022; Bourke et al., 2023). Digital data facilitates the implementation of compliance measures, thereby ensuring a fair balance of information. Such balance supports the maintenance of sustainable financial performance over a period of time.

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Hypothesis 3: Digital financial record-keeping has a positive effect on the sustainable financial performance of MSMEs.

2.4 Sustainable cash flow management practices and sustainable financial performance

Research shows that companies that have the ability to maintain liquidity, reduce cash outflows, and plan financial reserves can survive in the long term. Financial management theory states that there is a direct correlation between strict budgeting and bankruptcy risk mitigation, a principle that is emphasized in business continuity planning (Ross et al., 1996). Research on sustainability accounting highlights that stable cash generation is a key factor in long-term performance, rather than short-term profits (Bocken et al., 2019). Research shows that companies that implement structured cash flow monitoring processes and are cautious in managing debt tend to demonstrate greater resilience and consistent performance (Brinckmann et al., 2010; Kraus et al., 2020; Bourke et al., 2023). As a result, sustainable cash flow indicators are believed to correlate with sustainable financial performance.

Hypothesis 4: Sustainable cash flow management practices have a positive effect on the sustainable financial performance of MSMEs.

2.5 Digital financial capabilities and digital financial inclusion

Digital inclusion in the financial sector refers to effective access to and use of digital financial services by companies. According to financial inclusion theory, access alone is not enough without adequate financial capabilities as (Demirgüç-Kunt et al., 2018). Digital financial literacy, fintech adoption, and digital bookkeeping improve the ability of MSMEs to interact responsibly with financial institutions and platforms (Morgan and Trinh, 2020). Empirical evidence shows that MSMEs with advanced digital financial capabilities benefit from better access to credit, lower transaction costs, and higher levels of trust from financial service providers (Allen et al., 2016; Demirgüç-Kunt et al., 2022; Bourke et al., 2023). Sustainable cash flow management is also important for inclusion, as it signifies financial discipline and creditworthiness.

Hypothesis 5–8: Digital financial literacy, fintech adoption, digital financial record-keeping, and sustainable cash flow management practices positively affect digital financial inclusion.

2.6 *Digital financial inclusion and sustainable financial performance*

Digital financial inclusion has been shown to increase MSME access to credit, facilitate faster transaction processing, and facilitate integration into the formal financial system. In addition, in terms of financial accountability, exposure has a mitigating effect on information gaps by reducing uncertainty in financial reports (Demirgüç-Kunt et al., 2018). Research shows that companies with strong financial health tend to have greater investment capacity, stable liquidity, and good long-term performance (Allen et al., 2016; Morgan & Trinh, 2020). Recent evidence also shows that digital inclusion improves the resilience of MSMEs by facilitating easier cash flow and adaptive financial strategies (Demirgüç-Kunt et al., 2022; Bourke et al., 2023). Digital financial inclusion is expected to have a direct and positive impact on sustainable financial performance.

H9: Digital financial inclusion has a positive effect on the sustainable financial performance of MSMEs.

2.7 *Mediating role of digital financial inclusion*

The mediating role played by digital financial inclusion explains how digital financial capabilities can lead to sustainable financial effectiveness. According to RBV Volberda (1996), internal capabilities can only create value that improves performance when achieved through external systems and networks, and the implementation of these systems is also very important. Digital literacy and the use of fintech by MSMEs have been shown to have a positive impact on access to and use of inclusive financial services (Morgan & Trinh, 2020), thereby supporting economic sustainability. Empirical research has shown that financial inclusion plays a mediating role in the relationship between applicants' financial capabilities and company performance, especially in digitally facilitated environments (Demirgüç-Kunt et al., 2022; Bourke et al., 2023; Kraus et al., 2022). Inclusion is a key transmission system.

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Hypothesis 10–H13: Digital financial inclusion mediates the relationships between digital financial capabilities and sustainable financial performance.

2.8 Moderating role of digital readiness

Digital readiness is the ability of MSMEs to have the adequate infrastructure, skills, and organizational capabilities necessary to adopt digital technology. According to contingency theory, organizational effects are not linear, but rather the results vary depending on the level of optimal capabilities and contextual readiness (Zhu and Kraemer, 2005). Previous research shows that digital readiness increases the influence of digital and fintech adoption (Scuotto et al., 2021; Kraus et al., 2022). This focus is reinforced by the observation that digitally ready MSMEs are able to translate financial literacy and fintech usage into sustainable performance improvements (Bourke et al., 2023). Therefore, digital readiness is hypothesized to have a moderating effect on the relationship between digital financial skills and sustainable financial performance.

Hypothesis 14–H17: The moderating effect of digital readiness on the relationship between digital financial skills and sustainable financial performance.

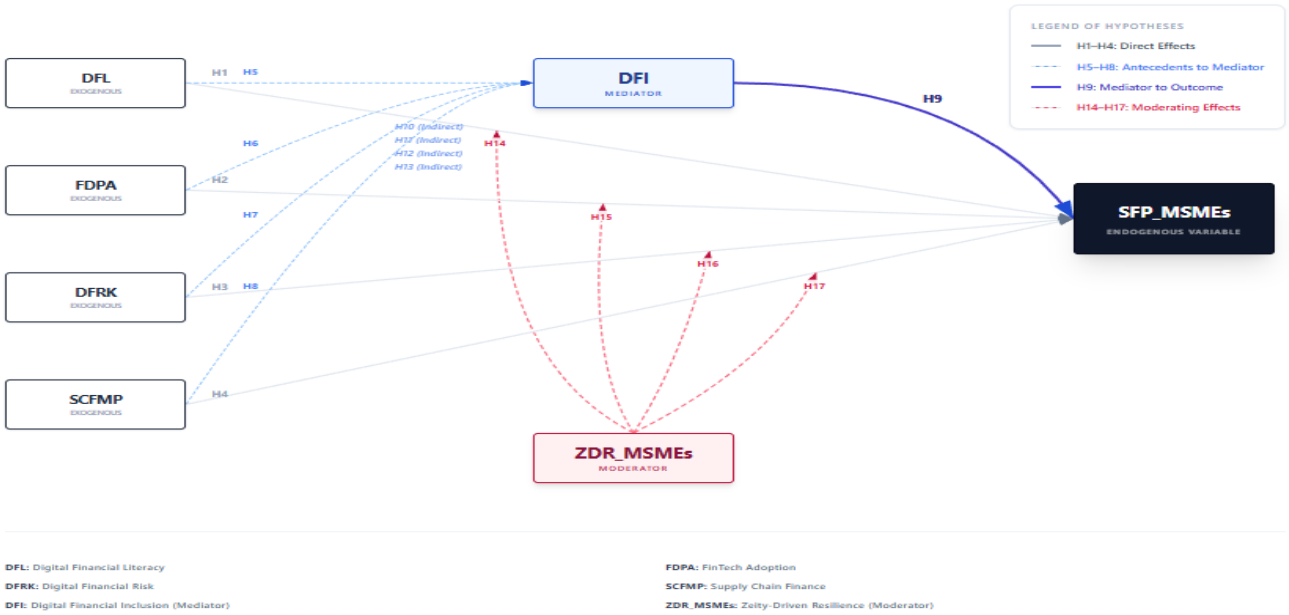

Figure 1. Sustainable Digital Financial Management Model of MSMEs

3. Methods Innovation

3.1 Design research

This study uses a quantitative approach with an explanatory research design to measure the impact of digital financial capabilities on digital financial inclusion and the sustainable financial performance of MSMEs. A cross-sectional survey research design was used to provide a comprehensive picture of respondents' perceptions and management practices at a specific point in time. This research design is well-suited for testing theory-based hypotheses in the fields of accounting and management research (Creswell, 2014). This model includes direct, mediating, and moderating effects, so the main analysis method chosen is partial least squares structural equation modeling (PLS-SEM). This approach is suitable for multi-effect models, research objectives that focus on prediction, and non-normal data distribution (Hair et al., 2022). Data were collected using a structured questionnaire on Google Forms. This is a standard measurement method and a quick way to collect data from a

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dispersed MSME population. This approach is recommended by the latest empirical research methodology (Hair et al., 2022; Kock, 2020).

3.2 Research data population

Samples were taken from MSMEs operating in remote, border, and outermost (3T) areas, with a focus on the food processing and handicraft industries, as described in Appendix A. The unit of analysis was the owner/manager of the MSME. This ensured that respondents had direct experience in financial decision-making and the use of digital finance. Purposive sampling was also used in conjunction with the snowball referrer method to ensure that as many relevant and informative respondents as possible were included in the sample. The minimum sample requirement was in accordance with the 10-times rule, which is based on the maximum number of structural paths leading to endogenous constructs. This is a common approach in PLS-SEM studies (Hair et al., 2022). To improve the statistical power and robustness of the model, it is recommended to obtain at least 200 valid responses. This is in line with the recommendations listed in the PLS-SEM guidelines published by Springer Nature for complex models.

3.3 Variable data instrument

All constructs of the research study are operationalized with reflective items and measured using a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). Please refer to Appendix B for further details. Source factors items are adapted for content validity and theoretical relevance from well-developed, top-tier sources. Digital financial literacy and financial behaviour can be measured using frameworks from the OECD/INFE and important papers within economics and accounting (see Lusardi and Mitchell 2014; OECD 2013 for details). The adoption of fintech, digital readiness, and digital record-keeping are guided by the Technology Acceptance Model and digital transformation literature. This literature is frequently cited in leading publications such as the American Economic Association and several top journals (Venkatesh et al., 2012; Kraus et al., 2022). The measurement, construction and validation processes have been designed in accordance with the guidelines set out by SmartPLS and PLS-SEM. This approach ensures the establishment of reliability and construct validity (Hair et al., 2022).

3.4 Data analysis

We analyse the data using SmartPLS 4, based on an extended Kashmiri and Ahmed (2019) model, which is built upon a strict PLS-SEM method. Data screening is the first stage of data analysis, which includes dealing with missing values, outliers and common method bias. Thanks to the reinforcement learning approach, these issues are unnecessary. However, we still carry out full collinearity VIF (Variance Inflation Factor) testing before hypothesis testing. The measurement model is then put to the test using a reflective specification, with investigations focusing on outer loadings, internal consistency and reliability (via composite reliability or CR), convergence validity (measured using the average variance extracted or AVE) and discriminant validity (assessed through the heterotrait–monotrait ratio or HTMT). Subsequently, the structural model was subjected to a series of rigorous evaluations. These included testing for multicollinearity (VIF), assessment of path coefficients for direct hypotheses (H1–H9), adjustment, and coefficient of determinacy (R^2), effect size (f^2), and predictive relevance (Q^2). These evaluations were conducted using blind folding techniques, a method that ensures the independence and integrity of the data. The mediation process is assessed using the bootstrap indirect effects, while the moderation stage is evaluated by constructing interaction terms and analysing the pathway to sustainable financial performance in accordance with the guidelines stipulated for SmartPLS.

4. Results of Innovation and Discussion

4.1 Respondent profile and descriptive statistics

Table 1 Demography of the respondents The table 1 shows MSME ownership and management, males dominate (68.4%), and females are (31.6%). Age-wise, most respondents belong to the economically active age groups of 35–44 years

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(44.4%) and 45–54 years (32.0%), an indication that the conduct of business in most MSMEs is managed by persons who have considerable working and entrepreneurial experience. Newer owners aged 25–34 years comprise 17.2% whereas older respondents over 55–65 years are a comparably small segment (6.4%). In terms of education, large proportion of respondents reported finishing senior secondary (36.4%) followed by junior secondary (22.8%) and primary school (16.4%). Levels of higher education are low and only 24.4% have diploma or university degree indicating moderate level of formal education among MSME decision makers.

The business profile of the selected MSMEs is presented in Table 2, which indicates a balanced sector composition, with food processing and handicraft firms accounting for half (%) of each sample. Geographically, respondents are widely spread in most of 3T areas including the dominantly East Nusa Tenggara (40%), Maluku (34%) and Papua (26%). Most businesses are quite matured – more than four years old as 52.4% of the business, which shows that there is continuity despite structural limitation in the 3T Areas. Small MSMEs dominate (60%), with non-overlapping 40% from the small and medium categories. More than half (59.2%) of monthly income is less than IDR 10 million, which shows constraints on financial scale. Importantly, the possession of smartphone is relatively high (83.2%), meaning there exists adequate basic digital infrastructure to facilitate digital financial adoption.

Table 3 Descriptive statistics for the main constructs Table 3 shows the descriptive statistics of the primary research variables and reveals relatively high average values for all variables; all means hover around 4.448. This implies that MSME owners in the 3T areas, on average, rate moderate-high levels of DFL, FDPA,Digital records keeping (DFRK), SCFMP, Digital Financial Incllusion (DFI), Sustainable financial Performance(SFP_MSMEs) and digital readiness for business automation(ZDR_MSMEs). The standard deviations spread between 1.459 and 1.566 indicate a good extent of variability in respondents' opinions for multivariate statistical analysis. All variables have slightly negative skewness values, meaning that responses tend to be located towards the highest end of the scale and are not highly skewed. Altogether, these figures indicate the data spread and distributional properties to be acceptable for further PLS-SEM analysis according to Elsevier reporting standards.

Table 1. Respondent demographic characteristics

Variable	Category	n	%
Gender	Female	79	31.6
Gender	Male	171	68.4
Age (years)	25–34	43	17.2
Age (years)	35–44	111	44.4
Age (years)	45–54	80	32
Age (years)	55–65	16	6.4
Education	Primary (SD)	41	16.4
Education	Junior secondary (SMP)	57	22.8
Education	Senior secondary (SMA)	91	36.4
Education	Diploma (D1–D3)	36	14.4
Education	Bachelor (S1)	19	7.6
Education	Postgraduate (S2/S3)	6	2.4

Table 2. Business profile of MSMEs

Variable	Category	n	%
Sector	Food processing	125	50
Sector	Handicraft	125	50
3T region	East Nusa Tenggara (NTT)	100	40
3T region	Maluku	85	34
3T region	Papua	65	26
Business age (years)	1–3	74	29.6

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Variable	Category	n	%
Business age (years)	4–6	63	25.2
Business age (years)	7–10	45	18
Business age (years)	>10	68	27.2
Employees	Micro (1–5)	150	60
Employees	Small (6–20)	75	30
Employees	Medium (21–50)	25	10
Monthly revenue (IDR million)	<5	94	37.6
Monthly revenue (IDR million)	5–10	54	21.6
Monthly revenue (IDR million)	10–25	51	20.4
Monthly revenue (IDR million)	25–50	24	9.6
Monthly revenue (IDR million)	50–100	17	6.8
Monthly revenue (IDR million)	>100	10	4
Smartphone ownership	Yes	208	83.2
Smartphone ownership	No	42	16.8

Table 3. Descriptive statistics of research variables

Construct	Mean	SD	Min	Max	Skewness
DFL	4.448	1.536	1.000	7.000	-0.132
FDPA	4.448	1.544	1.000	7.000	-0.176
DFRK	4.448	1.566	1.000	7.000	-0.151
SCFMP	4.448	1.459	1.4	7.000	-0.126
DFI	4.448	1.51	1.000	7.000	-0.203
SFP_MSMEs	4.448	1.557	1.000	7.000	-0.219
ZDR_MSMEs	4.448	1.516	1.000	7.000	-0.177

4.2 Measurement model assessment

Table 4 shows that all measurement items are strong in indicator reliability, with outer loadings between 0.815 to 0.919, which exceeds the standard precut-off values of 0.70 for reflective constructs based on PLS-SEM. This means that each indicator also explains a large proportion of the variance in their latent variable. In particular, the loadings for DFI, DFL, FDPA and DFRK are relatively high which is consistent with strong measurement of digital financial capability. Moreover, sustainable CFMP (SCFMP), sustainable FPMSMEs (SFP_MSMEs) and ZDR_MSMEs are combined well by their indicators. On the whole, the findings provide evidence that no further indicator deletion is necessary and that the reflective measurement model meets SmartPLS measurement standards for reliability and validity.

Table 5 shows that strong internal consistency and convergent validity are produced for all constructs. 5 Cronbach's alpha values are comprised between 0.899 and 0.945 [38] whereas construct reliability measures (rA and rC) are over the reference cutoff of 0.70 for all constructs, testifying a high level of reliability [39]. Moreover, all the AVE values vary between 0.713 and 0.821 exceeding the threshold value of 0.50, which suggests that each construct account for more than half of the variance in its indicators. These findings validate that digital financial inclusion, digital financial literacy, fintech and digital payment adoption, digital financial record-keeping, sustainable cash flow management practices, sustainable financial performance of MSMEs and digital readiness are all constructs measured with acceptable reliability and convergent validity which demonstrate the sufficiency of reflective measurement model.

Discriminant validity Discriminant validity is assessed by employing heterotrait–monotrait ratio, that is HTMT which in summary are reporting the results in the Table 6. All HTMT values are lower than the conservative cutoff of 0.85, providing evidence that each construct is empirically distinct from the others. The strongest HTMT value is that for digital financial inclusion and sustainable financial performance of MSMEs (0.615) which still fall well below the threshold, indicating satisfactory discriminant validity but related association in theory, though conceptually distinct. Likewise, the values of HTMT estimates amongst digital financial

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literacy, digital financial record-keeping (or management), fintech and digital payment adoption, sustainable cash flow management practices and digital readiness are moderate suggesting that multicollinearity is not an issue. As a whole, the HTMT findings indicate the sufficient discriminant validity of all constructs and thereby support the measurement model's quality.

Table 4. Indicator loadings and measurement items

Construct	Indicator	Measurement item (short label)	Outer loading
DFI	DFI1	Active digital financial account ownership	0.882
	DFI2	Ease of accessing digital financial services	0.887
	DFI3	Access to formal financing (banks/fintech)	0.873
	DFI4	Reduced transaction/financing costs	0.874
	DFI5	Reliability of digital financial services	0.853
DFL	DFL1	Understanding cash inflow/outflow	0.896
	DFL2	Ability to prepare business budgets	0.902
	DFL3	Knowledge of digital fees/interest rates	0.898
	DFL4	Awareness of financial risks/cybersecurity	0.891
	DFL5	Separation of personal vs business finance	0.855
DFRK	DFRK1	Consistent daily transaction recording	0.908
	DFRK2	Use of apps/POS for bookkeeping	0.916
	DFRK3	Accuracy of simple financial reports	0.906
	DFRK4	Using financial data for decisions	0.903
	DFRK5	Storage of digital transaction evidence	0.897
FDPA	FDPA1	Frequency of using digital payments	0.907
	FDPA2	Perceived ease of use	0.893
	FDPA3	Perceived usefulness/efficiency gain	0.918
	FDPA4	Trust in fintech providers	0.878
	FDPA5	Perceived transaction security	0.869
SCFMP	SCFMP1	Emergency cash reserves availability	0.822
	SCFMP2	Regular operational cost monitoring	0.875
	SCFMP3	Controlled debt management	0.815
	SCFMP4	Periodic financial performance review	0.861
	SCFMP5	Long-term financial planning	0.848
SFP_MSMEs	SFP1	Stable revenue growth	0.896
	SFP2	Sustained/improved profit margins	0.893
	SFP3	Sustainable operating cost coverage	0.919
	SFP4	Improved access to external financing	0.903
	SFP5	Business survival and growth intention	0.894
ZDR_MSMEs	ZDR1	Internet/device availability	0.888
	ZDR2	Digital skills of owner/workers	0.872
	ZDR3	Organizational support for digitalization	0.855
	ZDR4	Integration of digital tools across functions	0.881
	ZDR5	Operational readiness for digital processes	0.887

Table 5. Construct reliability and convergent validity (CR and AVE)

Construct	Cronbach's alpha	(rho_a)	(rho_c)	AVE
DFI	0.923	0.923	0.942	0.764
DFL	0.933	0.936	0.949	0.79
DFRK	0.945	0.946	0.958	0.821
FDPA	0.937	0.943	0.952	0.797
SCFMP	0.899	0.904	0.925	0.713
SFP_MSMEs	0.942	0.944	0.956	0.812
ZDR_MSMEs	0.925	0.929	0.943	0.769

Table 6. Discriminant validity assessment using HTMT criterion

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	DFI	DFL	DFRK	FDPA	SCFMP	SFP_MSMEs	ZDR_MSMEs
DFI	–						
DFL	0.567	–					
DFRK	0.533	0.539	–				
FDPA	0.569	0.474	0.418	–			
SCFMP	0.423	0.415	0.513	0.356	–		
SFP_MSMEs	0.615	0.288	0.476	0.312	0.557	–	
ZDR_MSMEs	0.593	0.515	0.564	0.508	0.358	0.469	–

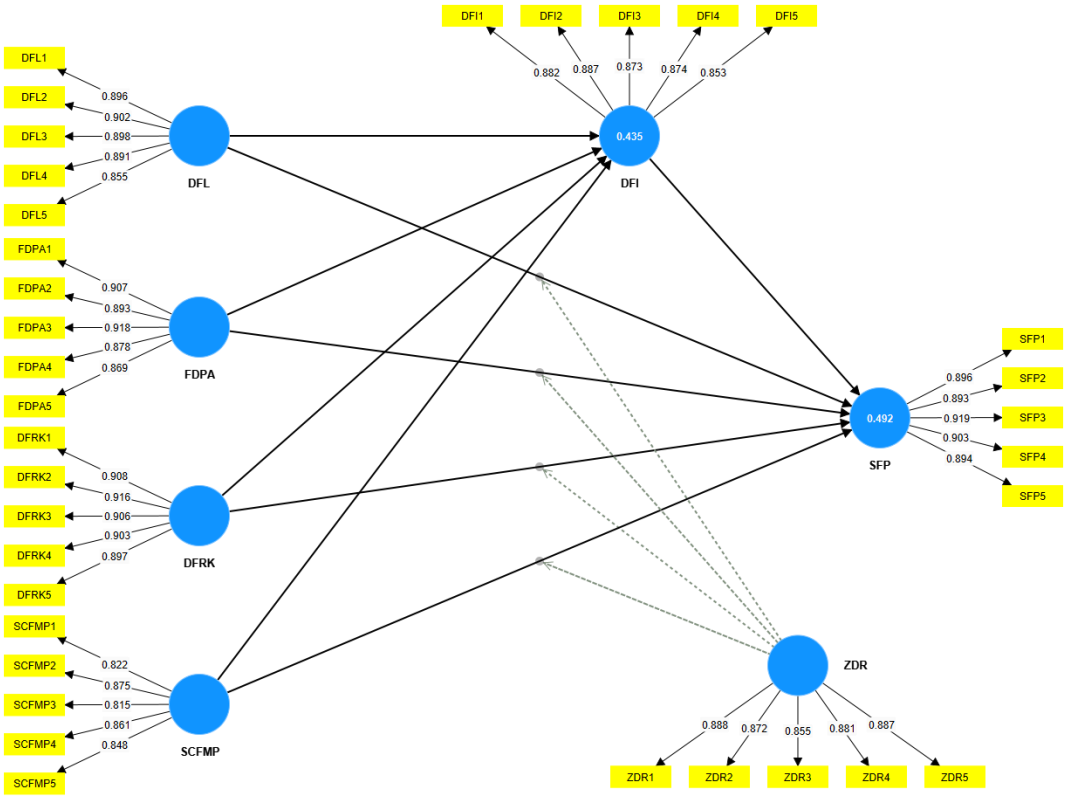

Figure 2. Measurement model results: outer loadings and construct relationships

The Outer loadings of indicators and the relationships between constructs are presented in Figure 2. All items load high (standardized loadings of all indicators are consistently higher than the critical value 0.70) on their corresponding construct, which indicate acceptable indicator reliability. Thus the reflective constructs digital financial literacy, fintech and digital payment adoption, digital financial record-keeping sustainable cash flow management practices, digital financial inclusion, digital readiness and sustainable financial performance are well specified. The values presented within the endogenous constructs suggest large amounts of explained variance (the R^2 values for ProHFSS and DFIN ranges from moderate to strong). In general, the figure supports that the measurement model is valid and this fitting can be used for further analysis on structural modeling.

4.3 Structural model assessment (inner model)

The results on collinearity through VIF (Variance Inflation Factor) for the all predictors and interaction terms in the structural model are presented in Table 7. The VIFs of the indicators of the main construct are between 2.068 and 4.060, which is a far cry from an overly conservative cut-off point of 5.0, thus we can conclude that multicollinearity poses no threat to our model. digital financial record-keeping and sustainable financial performance

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indicators are the highest, but these VIF coefficients still fall within a tolerable range not to unduly affect the stability of the estimates. Moreover, no interaction term with digital readiness has a VIF above 1.000 indicating that there are no collinearity problems in the moderation analysis. In general, the findings confirmed that the structural model conforms to the collinearity and hypothesis testing requirements.

Table 8 for the estimated structural paths and test results. The results show that digital financial inclusion has a significant and positive impact on sustainable financial performance (β = 0.450, p-value < 0.001), confirming its central role in linking digital financial capabilities with organizational performance. It is clear that sustainable cash flow management has a significant positive influence on performance (β = 0.344, p < 0.001). In contrast to its impact on mediated financial literacy, digital financial literacy has a significant direct negative impact on performance. Furthermore, the findings regarding the direct impact of fintech adoption and digital financial recording are also insignificant. Except for sustainable cash flow management practices, all digital financial capability variables have a significant positive effect on digital financial inclusion. Regarding the issue of moderation, my research shows that digital readiness has a negative effect on the relationship between digital financial recording and sustainable financial performance. No other interaction effects are supported. In general, performance improvement is more influenced by inclusion and effective cash flow management than by digital adoption alone.

The explanatory power, effect sizes and predictive relevance of the structural model are shown in Table 9. The R2 value shows moderate explanation, digital financial inclusion explained 43.5% of its variance and sustainable financial performance MSMEs are explained by the model =49.2%. The adjusted R^2 values (table 2, 4) are also similar, which in turn indicates good robustness of the models. Effect size The effect of digital financial inclusion on sustainable financial performance and sustainable cash flow management practices are moderate and significant as well in the context. Other direct and interaction effects were small or of little effect size. The Q^2 outcomes also enhance the predictive worth of the model, which can be checked by positive redundancy and communality values for both endogenous constructs. In general, these results suggest that the model has good explanatory and forecasting power.

Table 7. Collinearity assessment using variance inflation factor (VIF)

Indicator	VIF	Indicator	VIF
DFI1	2.925	FDPA1	3.643
DFI2	3.097	FDPA2	3.127
DFI3	2.849	FDPA3	3.977
DFI4	2.782	FDPA4	3.048
DFI5	2.493	FDPA5	2.887
DFL1	3.385	SCFMP1	2.155
DFL2	3.533	SCFMP2	2.593
DFL3	3.248	SCFMP3	2.068
DFL4	3.132	SCFMP4	2.56
DFL5	2.607	SCFMP5	2.429
DFRK1	3.749	SFP1	3.255
DFRK2	3.982	SFP2	3.303
DFRK3	3.545	SFP3	4.06
DFRK4	3.511	SFP4	3.662
DFRK5	3.402	SFP5	3.376

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Indicator	VIF	Indicator	VIF
ZDR1	2.93	ZDR×DFL	1
ZDR2	2.921	ZDR×FDPA	1
ZDR3	2.511	ZDR×DFRK	1
ZDR4	3.04	ZDR×SCFMP	1
ZDR5	3.029		

Table 8. Path coefficients and hypothesis testing results (H_1–H_9)

Hypothesis	Structural path	β (O)	STDEV	t-value	p-value	Decision
H1	DFL > SFP_MSMEs	-0.196	0.056	3.497	0.000	Supported (negative)
H2	FDPA > SFP_MSMEs	-0.087	0.058	1.517	0.129	Not supported
H3	DFRK > SFP_MSMEs	0.104	0.066	1.585	0.113	Not supported
H4	SCFMP > SFP_MSMEs	0.344	0.056	6.092	0.000	Supported
H5	DFL > DFI	0.251	0.059	4.247	0.000	Supported
H6	FDPA > DFI	0.309	0.052	5.909	0.000	Supported
H7	DFRK > DFI	0.206	0.058	3.585	0.000	Supported
H8	SCFMP > DFI	0.091	0.054	1.709	0.088	Not supported (marginal)
H9	DFI > SFP_MSMEs	0.450	0.061	7.355	0.000	Supported
H14	ZDR×DFL > SFP_MSMEs	0.012	0.056	0.219	0.826	Not supported
H15	ZDR×FDPA > SFP_MSMEs	0.027	0.057	0.470	0.638	Not supported
H16	ZDR×DFRK > SFP_MSMEs	-0.149	0.055	2.703	0.007	Supported (negative)
H17	ZDR×SCFMP > SFP_MSMEs	-0.015	0.055	0.265	0.791	Not supported

Table 9. Coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2)

Category	Construct / Relationship	Statistic	Value
Explanatory power	DFI	R^2	0.435
		R^2 adjusted	0.426
	SFP_MSMEs	R^2	0.492
		R^2 adjusted	0.47
Effect size (f^2)	DFI > SFP_MSMEs	f^2	0.207
	DFL > DFI	f^2	0.073
	DFL > SFP_MSMEs	f^2	0.045
	DFRK > DFI	f^2	0.048
	DFRK > SFP_MSMEs	f^2	0.012
	FDPA > DFI	f^2	0.127
	FDPA > SFP_MSMEs	f^2	0.010
	SCFMP > DFI	f^2	0.011
	SCFMP > SFP_MSMEs	f^2	0.166
	ZDR > SFP_MSMEs	f^2	0.024
	ZDR×DFL > SFP_MSMEs	f^2	0.000
	ZDR×FDPA > SFP_MSMEs	f^2	0.001
	ZDR×DFRK > SFP_MSMEs	f^2	0.024
	ZDR×SCFMP > SFP_MSMEs	f^2	0.000
Predictive relevance (Q^2)	DFI	Q^2 (redundancy)	0.324
		Q^2 (communality)	0.634
	SFP_MSMEs	Q^2 (redundancy)	0.385
		Q^2 (communality)	0.706
	DFL	Q^2 (redundancy)	0.000
		Q^2 (communality)	0.674
	DFRK	Q^2 (redundancy)	0.000
		Q^2 (communality)	0.718
	FDPA	Q^2 (redundancy)	0.000
		Q^2 (communality)	0.685
	SCFMP	Q^2 (redundancy)	0.000
		Q^2 (communality)	0.563
	ZDR	Q^2 (redundancy)	0.000
		Q^2 (communality)	0.642

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4.4 Mediation and moderation analysis

Table 10. Mediation analysis: indirect effects of digital financial inclusion

Indirect Path	Indirect Effect (β)	STDEV	T-value	p-value	95% CI (BCa)	Mediation Type
DFL > DFI > SFP_MSMEs	0.113	0.032	3.551	0.000	[0.055; 0.179]	Partial mediation
DFRK > DFI > SFP_MSMEs	0.093	0.03	3.079	0.002	[0.039; 0.157]	Partial mediation
FDPA > DFI > SFP_MSMEs	0.139	0.031	4.537	0.000	[0.086; 0.205]	Full mediation
SCFMP > DFI > SFP_MSMEs	0.041	0.024	1.708	0.088	[-0.008; 0.089]	Not supported

Table 11. Moderation analysis: interaction effects of digital readiness

Interaction Path	(β)	STDEV	T-value	p-value	95% CI (BCa)	Moderation Result
ZDR × DFL > SFP_MSMEs	0.012	0.056	0.219	0.826	[-0.102; 0.121]	Not supported
ZDR × FDPA > SFP_MSMEs	0.027	0.057	0.47	0.638	[-0.082; 0.141]	Not supported
ZDR × DFRK > SFP_MSMEs	-0.149	0.055	2.703	0.007	[-0.257; -0.040]	Supported (negative)
ZDR × SCFMP > SFP_MSMEs	-0.015	0.055	0.265	0.791	[-0.119; 0.092]	Not supported

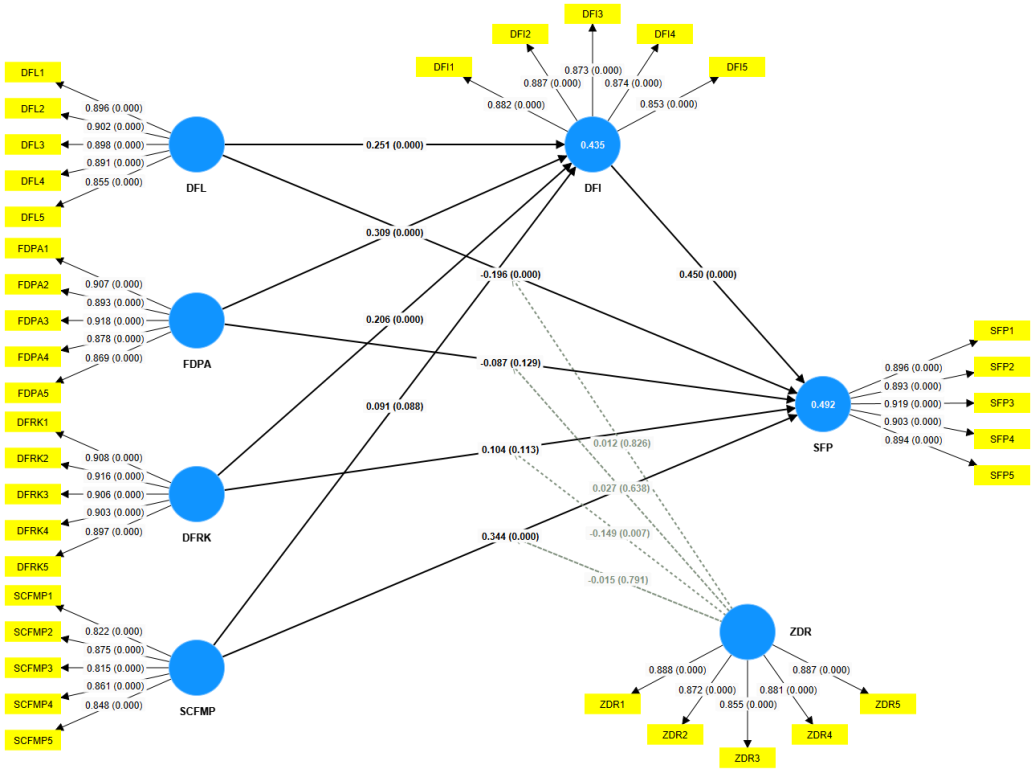

Figure 3. Structural model results (inner model)

4.5 Discussion of innovation results

Table 12 summarize the findings from hypothesis testing and presents a number of key insights. Sustainable cash flow management practices and digital financial inclusions, on the other hand, are observed as appearing to be the most significant consistent drivers of sustainable financial performance which are suggests that disciplined liquidity management and ensuring effective accessibility towards digital financial services is vital for SMEs. DFL has negative but moderate direct impact on performance, and thus higher level of awareness may not necessarily lead to the highest financial gains immediately without other supporting skills (ie BF or CF). Mediation results

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show digital financial inclusions serves as a core transmitting mechanism, partially mediating the effects of digital financial literacy and digital record-keeping and fully mediating that of fintech/digital payments adoption. This suggests that performance is more accomplished through synergistic rather than direct use of digital technology. Moderation analysis reveals there is a debilitation of the relation between digital financial record keeping and performance, indicating potential adjustment costs or complexity associated with greater levels of digitalization. In sum, the results highlight the originality of bridging digital capability, inclusion and readiness views in MSME financial sustainability studies.

Table 12. Summary of hypothesis testing results

Hypothesis	Structural Path	β (Original Sample)	T-value	p-value	Decision
H1	DFL > SFP_MSMEs	-0.196	3.497	0.000	Supported (negative)
H2	FDPA > SFP_MSMEs	-0.087	1.517	0.129	Not supported
H3	DFRK > SFP_MSMEs	0.104	1.585	0.113	Not supported
H4	SCFMP > SFP_MSMEs	0.344	6.092	0.000	Supported
H5	DFL > DFI	0.251	4.247	0.000	Supported
H6	FDPA > DFI	0.309	5.909	0.000	Supported
H7	DFRK > DFI	0.206	3.585	0.000	Supported
H8	SCFMP > DFI	0.091	1.709	0.088	Not supported
H9	DFI > SFP_MSMEs	0.45	7.355	0.000	Supported
H10	DFL > DFI > SFP_MSMEs	0.113	3.551	0.000	Supported (partial mediation)
H11	DFRK > DFI > SFP_MSMEs	0.093	3.079	0.002	Supported (partial mediation)
H12	FDPA > DFI > SFP_MSMEs	0.139	4.537	0.000	Supported (full mediation)
H13	SCFMP > DFI > SFP_MSMEs	0.041	1.708	0.088	Not supported
H14	ZDR × DFL > SFP_MSMEs	0.012	0.219	0.826	Not supported
H15	ZDR × FDPA > SFP_MSMEs	0.027	0.47	0.638	Not supported
H16	ZDR × DFRK > SFP_MSMEs	-0.149	2.703	0.007	Supported (negative moderation)
H17	ZDR × SCFMP > SFP_MSMEs	-0.015	0.265	0.791	Not supported

4.6 Discussion

The results of this study support the central role of digital financial inclusion (DFI) in achieving sustainable financial performance for MSMEs. Our findings show a significant and positive relationship between DFI performance and the 'financial inclusion theory'. According to this theory, companies can improve liquidity management, access to credit, and long-term operational efficiency when they have significant access to formal financial services. This view is supported by research conducted by Allen et al. (2016), Demirgüç-Kunt et al. (2018), and Demirküç-Kunt et al. (2022). From an accounting and accountability perspective, inclusion is key to overcoming information asymmetry and improving monitoring mechanisms. This, in turn, enables MSMEs to transform digital tools into long-term financial benefits through the use of digital technology (Bourke et al., 2023).

As described above, it is interesting to note the implications of the relationship between DFL and sustainable financial performance. There is a strong but negative direct effect, and a positive indirect effect that balances it through digital financial inclusion. These findings are consistent with the principles outlined in the behavioral finance and financial literacy literature (Lusardi & Mitchell, 2014; Morgan & Trinh, 2020), which states that increased knowledge, without institutional support or practical experience, can initially lead to higher perceptions of risk, complexity, and conservatism. However, increased financial literacy leads to greater availability of inclusive digital financial services, which have a significant positive indirect effect. This is

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consistent with the resource-based view, which states that the generation of value from intangible capabilities depends on their effective utilization with complementary external resources (Barney, 1991; Kraus et al., 2022).

Moreover, the findings also show that fintech and digital payment adoption (FDPA) and digital financial record-keeping (DFRK) does not directly contributed to sustainable financial performance but both significantly enhance digital financial inclusion. These results are in line with past research suggesting that digital technologies by themselves do not ensure better performance unless they are grounded on solid financial governance and accounting mechanisms (Gomber et al., 2018, Kraus et al, 2020; Bourke et al., 2023). The complete mediation effect documented for FDPA suggests that fintech adoption helps to promote sustainability solely when it fosters formal access, trust, and integration while supporting the idea that DF is an enabling infrastructure rather than a performance enhancer in itself (Ryu, 2018; Demirgüç-Kunt et al., 2022).

On the other hand, SCFMP exerts a strong and direct positive influence on sustainable financial performance, thus underlining that liquidity discipline is of utmost importance for MSMEs' sustainability. This result is further inline with the theories underpinning financial management and sustainability accounting which underline that long term survival relies primarily on stable cash generation and efficient expense management than actual short run profitability (Ross et al., 1996; Brinckmann et al., 2010; Bocken et al., 2019). DCDFMI had a non-significant effect on digital financial inclusion, thereby supporting the notion that internal financial discipline affects performance without solely depending on external access to digital finance system.

Finally, the moderation result indicates that ZDR negatively moderates the relationship between digital financial record-keeping and sustainable financial performance. The counterintuitive finding could be accounted for by contingency theory that suggests that the increased digital sophistication potentially comes with coordination costs, complexity of system and learning load which may temporarily outweigh performance benefits (Zhu & Kraemer, 2005; Scuotto et al., 2021). Advanced systems of documentation in highly digital ready MSMEs can require more managerial attention and resources, so that their short-term contribution to financial sustainability is limited. This implies a contribution to the recent DT literature, which have argued that "more digital" necessarily is not always spat out as "better" when there is no or less alignment across technology, skills and organizational capacity (Kraus et al., 2022; Bourke et al., 2023).

Taken together, the discussion highlights that sustainable MSME financial performance in the digital age is not the result of technology adoption by itself but rather from interplays between digital capabilities, financial inclusion and disciplined cash flow management within an accountable framework.

5. Conclusion

This research contributes empirically to the understanding that sustainable financial performance of MSMEs in the digital age is contingent not only on adopting digital technologies but how these technologies are embedded into inclusive financial systems and disciplined financial management. The results stress digital financial inclusion as a crucial process in linking digital financial literacy, fintech usage, and cash record-keeping to performance attributes of interest. Although direct effects of digital financial literacy and use of fintech on performance are not evident, indirect effects through financial inclusion highlight

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the significance of factors such as access, trust and proper use of formal digital finance services. On the other hand, cash flow management best practices for sustainability appear as a strong and direct force of financial sustainability, reiterating the importance of liquidity regime and long-time horizon outlook on financing. The moderating role of digital readiness also suggests that higher level's of digital sophistication might actually introduce complexity that could undermine certain performance effects if not aligned with the organizations capabilities. In sum, this paper contributes an integrated accounting and sustainability framework for digital finance with important implications for MSME managers, policy makers, and financial services providers to develop inclusive capability-oriented digital financial ecosystems that foster long-term resilience and sustainable growth.

CRediT Author Statement

Nayla Annida Salsabila: Conceptualization; Methodology; Formal analysis; Data curation; Writing – original draft; Visualization. **Diana Puspitasari**: Supervision; Validation; Writing – review & editing; Theoretical guidance; Research administration.

Declaration of Competing Interest

Conflict of Interest The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Data Availability Statement

The data supporting the conclusions of this article will be made available by the correspondence author upon reasonable request. The data (and some of the questions asked to respondents) are not available on the open web; this is because of certain ethical considerations and confidentiality agreements with the respondents.

Appendix/Appendices

Appendix A. Population, sampling criteria, and data collection design of MSMEs in disadvantaged regions

Component	Specification
Target population	MSMEs in 3T areas (food processing and handicraft)
Respondent criteria	Owner/manager; business active ≥ 12 months; involved in financial decisions
Digital relevance criteria	Uses or is exposed to digital payments/fintech and/or digital bookkeeping
Sampling technique	Purposive sampling + snowball referrals (community/association networks)
Data collection mode	Online Google Form + assisted administration (enumerator support where needed)
Minimum sample size rule	10-times rule based on maximum incoming arrows to an endogenous construct (Springer Nature Link)
Target sample	≥ 200 usable responses (recommended for stable PLS-SEM estimates in complex models) (Eli Johogo)

Appendix B. Measurement instruments and indicator items for digital financial management constructs

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Variable (abbr.)	Code	Dimension	Indicator	Key source (top-tier / reputable)
DFL	DFL1	Cashflow understanding	I understand how to track cash inflows and cash outflows using digital records.	(Afonso et al., 2024; Lusardi & Mitchell, 2013, 2023)
	DFL2	Budgeting ability	I can prepare a business budget and monitor it using digital tools.	(Lusardi & Mitchell, 2013, 2023) (OECD, 2023)
	DFL3	Cost/fee knowledge	I understand digital transaction fees/charges and their impact on business costs.	(OECD, 2023)
	DFL4	Risk & cybersecurity	I understand the financial risks and cybersecurity issues in digital transactions.	(OECD, 2023)
	DFL5	Financial separation	I separate personal and business finances consistently.	(Clark et al., 2025; Lusardi & Mitchell, 2014; Mitchell & Lusardi, 2011)
FDPA	FDPA1	Usage intensity	I frequently use digital payments/fintech for business transactions.	(Andhini, 2017; S. Kraus et al., 2022)
	FDPA2	Ease of use	Digital payment/fintech services are easy for me to use.	
	FDPA3	Usefulness	Digital payments/fintech improve my business efficiency (time/cost).	
	FDPA4	Trust	I trust fintech/digital payment providers for business transactions.	(Appiah & Agblewornu, 2025)
	FDPA5	Security perception	I believe my digital transactions are secure and traceable.	(Appiah & Agblewornu, 2025)
DFRK	DFRK1	Recording consistency	I record sales and expenses consistently using digital tools.	(Jassem & Abdelfattah, 2025)
	DFRK2	System use	I use POS/bookkeeping apps/spreadsheets to manage business records.	(S. Kraus et al., 2022)
	DFRK3	Reporting accuracy	I can generate simple reports (cash flow/profit–loss) from digital records.	(Jassem & Abdelfattah, 2025)
	DFRK4	Decision support	I use digital financial data to make pricing, inventory, or cost decisions.	(Jassem & Abdelfattah, 2025)
	DFRK5	Evidence retention	I store digital transaction evidence (e-receipts, bank statements) systematically.	(Jassem & Abdelfattah, 2025)
SCFMP	SCFMP1	Cash buffer	I maintain cash reserves to handle unexpected business needs.	(Brinckmann et al., 2010)
	SCFMP2	Cost monitoring	I regularly monitor and control operational costs.	(Brinckmann et al., 2010)
	SCFMP3	Debt control	I manage debt prudently to avoid repayment burden harming cash flow.	(Brinckmann et al., 2010)
	SCFMP4	Performance review	I review financial performance periodically and adjust targets.	(Brinckmann et al., 2010)
	SCFMP5	Long-term planning	I plan cash needs for future periods (e.g., next months/season).	(Brinckmann et al., 2010)
DFI	DFI1	Account ownership	My business has active formal/digital financial accounts.	(Allen et al., 2016)
	DFI2	Access convenience	It is easy for my business to access digital financial services.	(Allen et al., 2016)
	DFI3	Financing access	My business can access formal financing (banks/regulated fintech).	(Allen et al., 2016)
	DFI4	Cost reduction	Digital finance reduces transaction/financing costs for my business.	(Murinde et al., 2022)
	DFI5	Reliability	Digital financial services are reliable for my business operations.	(Murinde et al., 2022)
SFP_MSMEs	SFP1	Revenue stability	My business achieves stable revenue growth over time.	(Allen et al., 2016; Jassem & Abdelfattah, 2025)
	SFP2	Margin sustainability	My profit margins are stable or improving.	
	SFP3	Cost coverage	My business can sustainably cover operational costs.	(Sagala & Őri, 2025)
	SFP4	Funding improvement	My access to external financing has improved.	(Allen et al., 2016)
	SFP5	Continuity intention	I intend to sustain and grow the business in the future.	(Sagala & Őri, 2025)
ZDR_MSMEs	ZDR1	Infrastructure	My business has sufficient internet/device access for digital operations.	(Scuotto et al., 2021)
	ZDR2	Digital skills	I (and/or staff) have adequate digital skills to use business technologies.	(Scuotto et al., 2021)
	ZDR3	Organizational support	My business has support (time/training) for adopting digital tools.	(Sagala & Őri, 2025)
	ZDR4	Integration	Digital tools are integrated across transactions, records, and reporting.	(S. Kraus et al., 2022)

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