

THE EFFECT OF GREEN INNOVATION AND DIGITAL TRANSFORMATION ON THE SUSTAINABILITY OF SMES, WITH FINANCIAL LITERACY AS A MODERATING VARIABLE

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Abstrak

Penelitian ini bertujuan untuk menguji pengaruh green innovation dan transformasi digital terhadap keberlanjutan UMKM, serta menganalisis peran literasi keuangan sebagai variabel moderasi. Pendekatan kuantitatif diterapkan dengan melibatkan 74 pelaku UMKM di wilayah Madiun dan Magetan sebagai sampel penelitian. Pengumpulan data dilakukan menggunakan kuesioner berskala Likert, kemudian diolah dan dianalisis menggunakan SPSS dan SmartPLS 4 yang mencakup pengujian statistik deskriptif, uji kualitas data, uji asumsi klasik, serta uji hipotesis.

Hasil pengujian menunjukkan bahwa green innovation, transformasi digital, dan literasi keuangan masing-masing berpengaruh positif dan signifikan terhadap keberlanjutan UMKM. Namun demikian, hasil analisis moderasi menunjukkan bahwa literasi keuangan belum terbukti memperkuat pengaruh green innovation maupun transformasi digital terhadap keberlanjutan UMKM. Penelitian ini menegaskan pentingnya sinergi antara praktik ramah lingkungan, digitalisasi, dan kecakapan finansial dalam menjaga kelangsungan bisnis UMKM.

Kata Kunci: Green Innovation, Transformasi Digital, Literasi Keuangan, Keberlanjutan UMKM.

Abstract

This study aims to examine the influence of green innovation and digital transformation on MSME sustainability and to analyze the role of financial literacy as a moderating variable. A quantitative approach was applied, involving 74 MSMEs in the Madiun and Magetan areas as the research sample. Data were collected using a Likert-scale questionnaire and analyzed using SPSS and SmartPLS 4, including descriptive statistics, data quality testing, classical assumption testing, and hypothesis testing.

The results indicate that green innovation, digital transformation, and financial literacy each have a positive and significant effect on MSME sustainability. However, the moderation analysis shows that financial literacy has not been proven to strengthen the effect of green innovation or digital transformation on MSME sustainability. This study emphasizes the importance of synergy among environmentally friendly practices, digitalization, and financial competence in maintaining MSME business continuity.

Keywords: *Green Innovation, Digital Transformation, Financial Literacy, MSME Sustainability.*

A. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are a fundamental pillar supporting Indonesia's national economic structure and are also the largest absorber of domestic labor (UKM, 2023). Nevertheless, business sustainability is no longer sufficiently measured by profitability alone, but requires the integrated alignment of economic, social, and environmental aspects (Savitz, 2022). In reality, MSMEs in the Madiun and Magetan areas are still predominantly oriented toward survival targets, so operational practices that overlook environmental sustainability remain common, while the government is targeting an increase

in environmentally friendly MSMEs to support the achievement of the Sustainable Development Goals (SDGs) 2030 (PPN/Bappenas, 2023).

Green innovation, namely the development of products, processes, and systems designed to minimize environmental impacts (Wiratri et al., 2023), and digital transformation, which refers to fundamental changes in how organizations operate and deliver value to customers through the integration of technology (Vial, 2022), are regarded as two strategic instruments for improving resource efficiency while expanding the MSME consumer base. Previous studies have consistently demonstrated the contribution of green innovation to MSME sustainability and performance (Nurhalimah et al., 2023; Wiratri et al., 2023; Heliani, 2024). Likewise, digital transformation has been shown to be a key driver of MSME resilience in the post-pandemic period (Solechan et al., 2023; Berliandaldo, 2022; Godwin, 2024).

Nevertheless, the transition toward these two practices requires considerable financial capital and technical readiness, so its success depends heavily on business actors' ability to manage financial resources. Financial literacy, defined as a combination of knowledge, skills, and discipline in making financial decisions (Sugita & Ekayani, 2022), is assumed to play a moderating role in the effectiveness of green innovation and digital transformation on business sustainability. Previous studies have tended to examine digital technology and environmental innovation variables separately without measuring the role of business actors' financial competence. Some studies have even found an anomaly in which the amount of digital investment is not necessarily strengthened by internal governance readiness (Wijaya & Siregar, 2022). This gap underlies the novelty of this study, namely integrating financial literacy as a moderating variable within the Resource-Based View (RBV) framework to examine whether business actors' financial intelligence can strengthen the effects of green innovation and digital transformation on MSME sustainability.

Based on the above description, this study aims to: (1) examine the effect of green innovation on MSME sustainability; (2) examine the effect of digital transformation on MSME sustainability; (3) examine the role of financial literacy in moderating the effect of green innovation on MSME sustainability; and (4) examine the role of financial literacy in moderating the effect of digital transformation on MSME sustainability, with a case study of MSME actors in Madiun City/Regency and Magetan Regency.

B. METHOD

This study employed a survey method with a verificative approach to test hypotheses and generalize relationships among variables from the sampled population (Sugiyono, 2020). The study population consisted of all MSME actors in Madiun City/Regency and Magetan Regency, categorized as an unknown population because official data on the number of MSMEs have not been fully classified based on criteria for digital technology adoption and environmentally friendly practices. The sample size was determined using the approach of Hair et al. (2014), namely 12 indicators multiplied by 5 to 10, resulting in a range of 60–120 respondents; the study ultimately involved 74 MSME actors as the final sample meeting the requirements for PLS-SEM testing. Sampling was conducted using purposive sampling with the following criteria: (1) the MSME had been operating for at least one year, (2) it had adopted digital technology in its operations, and (3) it had implemented or was in the process of implementing environmentally friendly practices.

This study involved four variables: Green Innovation (X1) and Digital Transformation (X2) as independent variables, Financial Literacy (Z) as the moderating variable, and MSME Sustainability (Y) as the dependent variable. Each variable was measured using five indicators with a 1–5 Likert-scale questionnaire instrument (1 = strongly disagree, 5 = strongly agree). Data were collected through questionnaires distributed both online (Google Forms) and offline to MSME owners/managers.

Data analysis was conducted in two stages. Descriptive statistics were processed using SPSS to map respondent characteristics and the distribution of responses for each variable. Subsequently, model testing was performed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) through SmartPLS 4 software (Ghozali, 2021), including evaluation of the measurement model (outer model) through convergent validity testing (outer loading > 0.70 and $AVE \geq 0.50$), discriminant validity (Fornell-Larcker and HTMT < 0.90), and construct reliability (Cronbach's Alpha and Composite Reliability ≥ 0.70); as well as evaluation of the structural model (inner model) through R^2 , f^2 , and Goodness of Fit tests. Hypothesis testing and moderation effects were assessed using path coefficients with a bootstrapping procedure involving 5,000 subsamples, with significance criteria of t-statistics > 1.96 and p-value < 0.05 (Hair et al., 2014).

C. RESULTS AND DISCUSSIONS

The study respondents consisted of 74 MSME actors distributed across Madiun and Magetan, predominantly female business owners of productive age, with secondary to higher educational backgrounds, and who had, on average, operated their businesses for more than one year across various culinary, craft, and service sectors. The descriptive statistical recap (Table 1) shows that all research variables were in the good category, with mean scores ranging from 3.42 to 3.61.

Table 1. Descriptive Statistics Recap of Research Variables

Variable	Mean Range	Mean	Category
Green Innovation (GI)	3.35 - 3.51	3.42	Good
Digital Transformation (DT)	3.47 - 3.58	3.52	Good

Variable	Mean Range	Mean	Category
MSME Sustainability (MS)	3.42 - 3.55	3.49	Good
Financial Literacy (FL)	3.55 - 3.66	3.61	Good

Source: Primary data processed (2026)

Financial Literacy recorded the highest mean score (3.61), while Green Innovation had the lowest score (3.42), indicating that MSME actors' readiness to manage finances was relatively stronger than their implementation of green innovation practices.

Evaluation of the measurement model (outer model) shows that, after re-estimation, all indicators had outer loading values above 0.70, with AVE for all constructs ≥ 0.50 (0.699–0.764), thereby satisfying convergent validity. Discriminant validity was also confirmed through the Fornell-Larcker criterion and HTMT values below the 0.90 threshold. Construct reliability was also very good, as indicated by Composite Reliability values above 0.90 for all variables (GI = 0.942; TD = 0.903; FL = 0.938; MS = 0.956). In the structural model (inner model) evaluation, the R^2 value was 0.633, meaning that 63.3% of the variation in MSME Sustainability could be explained by Green Innovation, Digital Transformation, and Financial Literacy, while the remaining 36.7% was explained by factors outside the model. The f^2 test showed that Digital Transformation had the largest effect (0.625), followed by Green Innovation (0.536), while Financial Literacy had a small effect (0.110); meanwhile, both moderation interactions showed very weak effects (0.013 and 0.014). The Goodness of Fit value of 0.6859 (> 0.50) confirms that the research model fits the empirical data.

The results of hypothesis testing using the bootstrapping procedure with 5,000 subsamples are presented in Table 2 and Figure 1.

Table 2. Hypothesis Testing Results (Path Coefficients)

Hypothesis	Relationship Between Variables	Original Sample	T-Statistics	P-Values	Description
H1	Green Innovation -> MSME Sustainability	0.472	6.295	0.000	Significant (Accepted)
H2	Digital Transformation -> MSME Sustainability	0.488	6.895	0.000	Significant (Accepted)
H3	Financial Literacy -> MSME Sustainability	0.207	2.440	0.015	Significant (Accepted)
H4	Financial Literacy moderates Green Innovation -> MSME Sustainability	0.080	0.839	0.402	Not Significant (Rejected)
H5	Financial Literacy moderates Digital Transformation -> MSME Sustainability	0.071	1.025	0.305	Not Significant (Rejected)

Source: SmartPLS 4 output, bootstrapping with 5,000 subsamples (2026)

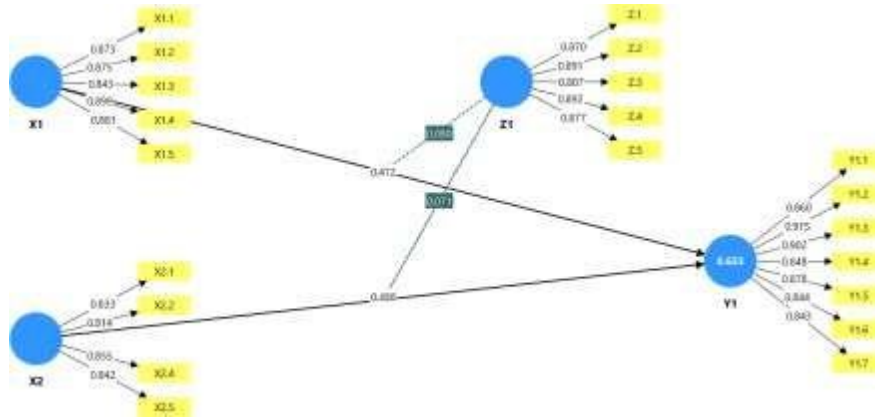


Figure 1. Structural Model of Hypothesis Testing Results

The hypothesis testing results demonstrate that Green Innovation has a positive and significant effect on MSME Sustainability (H1 accepted). This finding is consistent with the Resource-Based View perspective, which positions green innovation as a valuable and difficult-to-imitate internal strategic resource, and supports the studies of Nurhalimah et al. (2023), Wiratri et al. (2023), and Heliani (2024). MSMEs in Madiun and Magetan that have begun adopting environmentally friendly practices tend to obtain a better business image while reducing waste of raw materials and energy, thereby strengthening long-term business resilience.

Digital Transformation was also proven to have a positive and highly significant effect on MSME Sustainability (H2 accepted), with its contribution ($f^2 = 0.625$) being slightly more dominant than that of Green Innovation. This result is consistent with Solechan et al. (2023), Berliandaldo (2022), and Godwin (2024), who emphasize the role of digital technology as a driver of MSME competitiveness in the post-pandemic period. The use of e-commerce, social media, and cashless payment systems reduces intermediary costs and expands market reach, enabling MSMEs to better maintain cash-flow stability and sales volume.

Financial Literacy also has a positive and significant effect on MSME Sustainability (H3 accepted), although its contribution ($f^2 = 0.110$) is relatively smaller. This finding supports Sugita & Ekayani (2022) and Sari et al. (2022), and reinforces the agency theory perspective, which views financial literacy as an internal control mechanism that ensures capital expenditures, including spending on green innovation and digital investment, remain controlled without disrupting core cash flows.

Contrary to the initial expectation, Financial Literacy was not proven to moderate the effect of Green Innovation on MSME Sustainability (H4 rejected), consistent with the anomaly identified by Wijaya & Siregar (2022). This condition indicates that decisions to adopt environmentally friendly practices among MSMEs in Madiun and Magetan are driven more by external market and regulatory pressures than by financial literacy readiness alone, or may be attributable to the limited variation in financial literacy levels within the research sample.

Financial Literacy was also not proven to moderate the effect of Digital Transformation on MSME Sustainability (H5 rejected). This result indicates that the success of digital transformation among MSMEs in the research area is determined more by infrastructure readiness and the technological literacy of business actors themselves than by their financial competence, while also enriching the discussion of the research gap regarding the effectiveness of MSME digitalization, which has remained inconsistent.

D. CONCLUSIONS

This study concludes that Green Innovation, Digital Transformation, and Financial Literacy each have a positive and significant effect on MSME Sustainability in Madiun City/Regency and Magetan Regency, with Digital Transformation making the most dominant contribution, followed by Green Innovation and Financial Literacy. However, Financial Literacy was not proven to moderate the effects of Green Innovation or Digital Transformation on MSME Sustainability, indicating that the success of these two strategies is determined

more by the availability of physical capital, infrastructure readiness, and external market/regulatory pressures than by the financial competence of business owners alone. The research model explains 63.3% of the variation in MSME Sustainability and is considered fit ($GoF = 0.6859$); however, the study is limited by the scope of variables, the sample area (74 respondents in Madiun and Magetan), and the questionnaire-based self-assessment method, which may introduce subjective bias, particularly regarding environmental awareness.

E. SUGGESTIONS

Future research is recommended to expand the model by adding relevant external variables, such as access to capital, tax policy, or market competition intensity, in order to obtain a more comprehensive picture of the determinants of MSME sustainability. Expanding the geographical coverage and sample size beyond Madiun and Magetan is also necessary to improve external validity and generalizability of the findings. In addition, a mixed-methods approach combining questionnaires with in-depth interviews, field observations, or empirical document reviews is recommended to mitigate subjective bias (common method bias) while validating the actual implementation of Green Innovation and the operational conditions of MSMEs in the field.

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