

The impact of green knowledge and green performance management on the sustainability of green businesses in batik SMEs in Pekalongan

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Abstract

This study examines the influence of green knowledge and green performance management on the sustainability of batik enterprises within the MSME sector in Pekalongan, a region widely recognized as one of Indonesia's largest batik production center. As global and local pressures for environmentally responsible production increase, the adoption of green economic principles has become essential for the long-term viability of the batik industry in this area. Previous studies indicate that several batik artisans have begun adopting natural dyes and implementing waste-management practices; however, they continue to face significant challenges, including high operational costs, limited access to technology, and low environmental awareness. Using a quantitative research approach, this study collected data through surveys distributed to owners and managers of batik MSMEs in Pekalongan. The data were analyzed using Structural Equation Modeling (SEM) with PLS 3.0 to assess the proposed relationships between green knowledge, green performance management, and their impact on sustainability performance encompassing economic, social, and environmental dimensions. The findings reveal a positive influence of green knowledge and green performance management on the sustainability of batik enterprises in the MSME sector in Pekalongan.

Keywords

Green knowledge, Green performance management, Sustainability of green businesses, Batik SMEs, Pekalongan

Introduction

Small and medium-sized enterprises (SMEs) play a pivotal role in economic development, employment, and cultural preservation worldwide. However, the sustainability of small and medium-sized enterprises continues to be a growing area of focus in sustainability research, owing to their limited resources and the challenges they face in operations. As the global economy shifts towards low-carbon and environmentally responsible practices, MSMEs are increasingly facing external

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pressures from regulatory bodies, markets, and civil society to adopt green business models and sustainable production processes. Despite increasing sustainability motivations, many MSMEs struggle to integrate environmental principles into managerial routines and strategic decision-making, resulting in ongoing gaps between green intentions and sustainable outcomes.

A key determinant of effective sustainable transformation is green knowledge the environmental awareness, skills, and information that enable firms to recognize, evaluate, and respond to ecological challenges. Empirical evidence shows that having knowledge about the environment can greatly improve environmental performance and innovation results for small and medium-sized enterprises. For example, in Indonesian MSMEs, environmental knowledge was a key factor in driving green innovation and sustainable performance. Existing research often views green knowledge as a static resource rather than as a dynamic managerial asset that needs to be integrated into systemic organizational processes.

Complementary to green knowledge, green performance management involves the systems, processes, and measurements that connect daily operations with environmental goals, such as environmental key performance indicators, monitoring tools, and feedback mechanisms. Performance management frameworks have been shown to translate strategic goals into measurable actions and outcomes in large organizations, enhancing accountability for sustainability performance. However, unlike studies in large firms and manufacturing sectors, research examining how green performance management influences sustainability outcomes in the MSME context remains limited and fragmented, especially among traditional industries with complex cultural and production heritage.

The batik industry represents a highly relevant empirical setting for examining sustainability challenges in MSMEs. As a traditional textile sector, batik production is linked to major environmental pressures, such as high water consumption, the use of chemical dyes, and water pollution from wastewater [1]. In Indonesia, Pekalongan is well known as a key center for batik production, where small and medium-sized enterprises form industrial clusters that significantly contribute to local employment and the preservation of cultural heritage. Despite growing regulatory pressure and public awareness about environmental protection, many batik MSMEs continue to struggle with implementing systematic green business practices due to limited managerial systems and performance monitoring capabilities.

Although previous studies have examined sustainability practices and environmental performance in MSMEs, several important research gaps still exist. Existing research mainly looks at green knowledge as a direct factor affecting sustainability performance, but it often ignores how managers turn this knowledge into consistent actions within the organization [2], [3]. Second, empirical studies that explicitly integrate green performance management as a key explanatory variable in MSME sustainability models remain scarce, particularly within traditional and creative industries. Third, evidence

from developing-country contexts and culturally embedded sectors such as batik MSMEs is still limited, reducing the contextual robustness and generalizability of sustainability frameworks developed largely in advanced economies [1].

The strategic role of green knowledge in green management and sustainable development [4], [5], point out its importance in creating eco-friendly supply chain performance [4]. Emphasize the importance of broad public education to inform people about the environmental effects of products and the advantages of using goods with green labels [6].

Systematic literature reviews also show that most studies on sustainability in small and medium-sized enterprises focus on factors like innovation and technology adoption, while there is still a lack of comprehensive models that combine managerial control mechanisms with environmental capabilities. This gap is especially noticeable in sectors rooted in culture, where traditional practices, informal knowledge sharing, and management approaches may affect sustainability in a different way compared to more formal industrial environments.

Addressing these gaps, the present study investigates the impact of green knowledge and green performance management on the sustainability of green businesses among batik MSMEs in Pekalongan. By combining ideas from resource-based perspectives and sustainability performance frameworks, this research seeks to explain how green knowledge and organized performance management systems together influence sustainable business results at the level of small and medium-sized enterprises. Empirically, this study offers context-specific insights into the interaction between intangible resources and managerial systems within traditional creative industries, contributing to both theoretical progress and policy guidance for the sustainable development of MSMEs.

this study aims to examine the impact of green knowledge and green performance management on the sustainability of green businesses among batik MSMEs in Pekalongan. This research aims to achieve three main objectives. The main goal is to examine how green knowledge supports the sustainability of green business practices in batik small and medium enterprises. It examines the role of green performance management in enhancing sustainability outcomes by transforming environmental awareness into measurable and controllable business practices. Third, this study examines the combined impact of green knowledge and green performance management in enhancing the long-term sustainability of MSMEs operating in environmentally sensitive and culturally embedded industries.

To achieve the research objectives, this study uses a quantitative research approach based on a survey and employs Partial Least Squares Structural Equation Modeling (PLS-SEM) for data analysis, using SmartPLS 3 software. PLS-SEM is particularly appropriate for this study because it is well suited for exploratory and prediction-oriented research,

complex models with multiple latent constructs, and contexts characterized by relatively small sample sizes conditions commonly encountered in MSME research.

The empirical data were gathered from small and medium-sized enterprise owners and managers in the batik industry in Pekalongan, who are key in shaping environmental practices, performance management systems, and decisions related to sustainability within their businesses. A structured questionnaire was employed to assess green knowledge, green performance management, and the sustainability of green businesses, with the measurement items adapted from previous validated studies and adjusted to reflect the specific features of batik production and MSME operations.

Method

This study uses a quantitative research method with a cross-sectional survey to investigate the connections between green knowledge, green performance management, and the sustainability of green businesses. The research setting focuses on batik micro, small, and medium-sized enterprises (MSMEs) located in Pekalongan, a major center for batik production that is facing growing environmental sustainability challenges. The unit of analysis comprises batik MSME owners and managers, as they are directly responsible for strategic decision-making, environmental practices, and performance evaluation within their businesses. Data were gathered through a structured questionnaire that was directly given to the respondents. The sample size meets the minimum requirements for PLS-SEM analysis, adhering to the ten-times rule and recommendations for predictive-oriented structural modeling.

Data analysis was carried out using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3 software. This method is appropriate for this study because it can manage complex models, data that does not follow normal distributions, and smaller sample sizes, which are common in MSME research. The analysis followed a two-stage process: evaluation of the outer model (measurement model) and the inner model (structural model).

Results

Measurement model results (outer model)

The measurement model was assessed to guarantee the reliability and validity of the constructs before testing the structural relationships. The results show that all indicators had satisfactory outer loadings, which were above the recommended threshold of 0.70, confirming the reliability of the indicators. Several indicators with loadings between 0.60 and 0.70 were kept because they contributed meaningfully to construct validity and did not affect reliability. The convergent validity value shown in [Table 1](#).

The measurement model was assessed using outer loading values to evaluate indicator reliability. The results present in [Table 1](#) indicate that all indicators related to Green

Knowledge, Green Management Performance, and Sustainability Business have factor loadings that are above the recommended threshold of 0.70, showing that these indicators are reliable.

Table 1. Convergent validity value

Constructs	Code	Loading Factor	Finding
Green Knowledge	GK.1	0.915	Valid
	GK.2	0.925	Valid
	GK.3	0.913	Valid
	GK.4	0.872	Valid
	GK.5	0.868	Valid
	GK.6	0.925	Valid
	GK.7	0.908	Valid
	GK.8	0.926	Valid
	GK.9	0.929	Valid
Green Management Performance	GM.1	0.943	Valid
	GM.2	0.950	Valid
	GM.3	0.944	Valid
	GM.4	0.913	Valid
	GM.5	0.909	Valid
	GM.6	0.936	Valid
	GM.7	0.938	Valid
	GM.8	0.931	Valid
Sustainability Business	SB.1	0.939	Valid
	SB.2	0.936	Valid
	SB.3	0.934	Valid
	SB.4	0.938	Valid
	SB.5	0.919	Valid
	SB.6	0.933	Valid
	SB.7	0.927	Valid
	SB.8	0.940	Valid
	SB.9	0.940	Valid
	SB.10	0.936	Valid
	SB.11	0.942	Valid
	SB.12	0.928	Valid

Source: Processed primary data, 2025

For Green Knowledge, the loading values range from 0.868 to 0.929, which confirms that all indicators consistently measure environmental awareness and understanding among batik micro and small enterprises. The Green Management Performance construct shows very high loading values ranging from 0.909 to 0.950, indicating that environmental performance planning, monitoring, and evaluation are measured in a consistent manner. Similarly, indicators of Sustainability Business demonstrate strong loadings ranging from 0.919 to 0.942, indicating a robust measurement of sustainability outcomes.

The overall results that all indicators are valid, and no items were excluded from the model. These results confirm that the measurement instruments are reliable and suitable for subsequent structural model analysis.

Table 2 indicates that all indicators have the highest correlation with their respective constructs compared to other constructs. Indicators of Green Knowledge, Green

Management Performance, and Sustainability Business each load more strongly on their intended variables, confirming that the constructs are empirically distinct. These results show that discriminant validity is properly confirmed, which supports the effectiveness of the measurement model for further structural analysis.

Table 2. Discriminant Validity Value (Cross Loading)

Indicator	Green Knowledge (GK)	Green Management Performance (GM)	Sustainability Business (SB)
GB.1	0.921	0.943	0.931
GB.2	0.932	0.950	0.943
GB.3	0.921	0.944	0.934
GB.4	0.889	0.913	0.894
GB.5	0.898	0.909	0.896
GB.6	0.905	0.936	0.926
GB.7	0.911	0.938	0.924
GB.8	0.916	0.931	0.921
GK.1	0.915	0.904	0.907
GK.2	0.925	0.904	0.918
GK.3	0.913	0.887	0.893
GK.4	0.872	0.843	0.835
GK.5	0.868	0.839	0.831
GK.6	0.925	0.914	0.918
GK.7	0.908	0.893	0.899
GK.8	0.926	0.901	0.901
GK.9	0.929	0.905	0.909
SF.1	0.914	0.926	0.939
SF.2	0.914	0.928	0.936
SF.3	0.914	0.916	0.934
SF.4	0.926	0.930	0.938
SF.5	0.898	0.911	0.919
SF.6	0.921	0.922	0.933
SF.7	0.913	0.912	0.927
SF.8	0.926	0.929	0.940
SF.9	0.929	0.936	0.940
SF.10	0.906	0.921	0.936
SF.11	0.915	0.929	0.942
SF.12	0.907	0.908	0.928

Source: Processed Primary Data, 2025

Table 3. Cronbach Alpha dan Composite Reliability

	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Green Knowledge	0.974	0.974	0.977	0.827
Green Management Performance	0.979	0.979	0.982	0.871
Sustainability Business	0.987	0.987	0.988	0.873

Source: Processed Primary Data, 2025

Table 3 shows that all constructs demonstrate excellent reliability and convergent validity. The Cronbach's Alpha and Composite Reliability values for Green Knowledge, Green Management Performance, and Sustainability Business are all above the recommended threshold of 0.70, which shows a very high level of internal consistency.

In addition, the average variance extracted (AVE) values for all constructs are above 0.50, confirming satisfactory convergent validity. These results indicate that each construct explains a substantial proportion of variance in its indicators. The results show

that the measurement model is reliable and valid, which supports the further analysis of the structural model.

Evaluation of the structural model (inner model)

Based on substantive theory, the purpose of evaluating the structural model is to predict the relationships between latent variables. The main model is evaluated based on the R-square (R^2) value. This evaluation includes analyzing the model's ability to explain phenomena and verifying the hypotheses that were proposed.

Tabel 4. R-Square

	R Square	R Square Adjusted
Sustainability Business	0.980	0.980

Source: Processed Primary Data, 2025

Table 4 indicates that the R-square value for Sustainability Business is 0.980, with an adjusted R-square of 0.980, showing an extremely high explanatory power. This result indicates that 98.0% of the variance in sustainability business performance among batik MSMEs is explained by the exogenous variables in the model, namely Green Knowledge and Green Management Performance. According to PLS-SEM guidelines, this R-square value reflects a substantial model fit, demonstrating that the proposed structural model is highly effective in explaining sustainability outcomes. The small difference between R-square and adjusted R-square further suggests that the model is stable and reliable.

Table 5. Direct Effect Bootstrapping Results

	Original Sample	Sample Mean	Standard Deviation	T Statistics (O/STDEV)	P Values
Green Knowledge -> Sustainability Business	0.333	0.339	0.077	4.318	0.000
Green Management Performance -> Sustainability Business	0.662	0.656	0.076	8.692	0.000

Source: Processed Primary Data, 2025

Table 5 indicates that both Green Knowledge and Green Management Performance have positive and statistically significant impacts on Sustainability Business. Green Knowledge significantly influences sustainability ($\beta = 0.333$; $t = 4.318$; $p < 0.001$), suggesting that increased environmental knowledge leads to improved sustainability outcomes. Meanwhile, Green Management Performance shows a stronger impact ($\beta = 0.662$; $t = 8.692$; $p < 0.001$), indicating that structured environmental performance management plays a leading role in enhancing the sustainability of batik small and medium enterprises. The results confirm the effectiveness of the proposed model and highlight the importance of combining green knowledge with efficient management systems to attain sustainable business performance.

Discussion

The findings of this study provide empirical evidence that both green knowledge and green management performance play significant roles in enhancing the sustainability of green businesses among batik MSMEs. The positive and significant impact of green

knowledge on sustainability shows that having awareness about the environment, understanding of eco-friendly materials, and knowledge about sustainable production methods play an important role in ensuring long-term business sustainability. This outcome is consistent with recent studies highlighting green knowledge as a crucial intangible asset that allows MSMEs to identify environmental issues and implement more sustainable business practices [7], [8].

However, the scale of the effect indicates that green knowledge alone is not enough to guarantee sustainable results. This finding supports recent arguments in the sustainability literature that knowledge must be operationalized through organizational systems and routines to generate consistent performance improvements [9]. In the context of batik MSMEs, where managerial practices are often informal and based on experience, green knowledge may enhance awareness but does not necessarily lead to systematic sustainability actions without suitable managerial mechanisms.

The findings also show that green management performance has a more significant and stronger impact on sustainability business performance than green knowledge. This finding reinforces recent empirical evidence showing that performance management systems such as environmental planning, monitoring, and evaluation serve as a crucial bridge between sustainability intentions and realized outcomes [9].

These findings are particularly relevant for batik small and medium-sized enterprises in Pekalongan, as their production processes are resource-intensive and have significant environmental impacts. The prominence of green management performance indicates that sustainability in traditional creative industries goes beyond cultural values or environmental awareness; it necessitates structured yet adaptable management systems that align with MSME characteristics. This supports recent sustainability research in developing economies, which emphasizes the importance of using management tools that are suitable for local contexts rather than applying the same sustainability frameworks universally [3].

This study contributes to the expanding literature on sustainability and MSMEs by empirically confirming the complementary roles of green knowledge and green management performance. While green knowledge lays the cognitive basis for sustainability, green management performance guarantees its consistent implementation and monitoring. This integrated approach helps to clarify the differences in previous studies about sustainability in small and medium enterprises and provides a more complete way to understand how environmentally friendly businesses can achieve sustainable performance in traditional and resource-limited environments.

Conclusion

This study examines the impact of green knowledge and green management performance on the sustainability of green businesses among batik MSMEs in Pekalongan using PLS-SEM. The results show that both variables have a positive and

significant effect on sustainability, with green management performance having a stronger impact than green knowledge. These results suggest that although environmental knowledge is important, the sustainability success in small and medium-sized enterprises is more likely when this knowledge is combined with organized performance management practices. The study contributes to the literature by integrating knowledge-based resources and managerial control mechanisms in explaining MSME sustainability. In practice, the findings indicate that sustainability initiatives for small and medium-sized enterprises should focus on creating straightforward and practical green performance management systems. Future research may extend this study by incorporating additional variables and broader contexts.

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