Towards an Advanced Economy Through Batik SMEs: The Strategic Role of Green Innovation and Knowledge Management in Local Competitiveness

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ABSTRACT

This study explores the potential of the East Java Bakorwil II batik industry, a creative cultural sector hindered by weak branding, low design innovation, and minimal adoption of environmentally friendly practices. The research aims to design a model highlighting the role of green innovation as a mediating factor in strengthening the competitive advantage of local batik products. Using quantitative Partial Least Squares Structural Equation Modeling (PLS-SEM), 154 batik industry players participated in the study, with ethical clearance obtained. The results indicate that green innovation significantly mediates the relationship between knowledge management and competitive advantage ($O = 0.282$; $T = 4.482$; $p = 0.000$), and brand image and competitive advantage ($O = 0.239$; $T = 4.648$; $p = 0.000$). The study also finds significant direct effects of knowledge management on green innovation ($O = 0.507$; $T = 8.338$; $p = 0.000$), brand image on green innovation ($O = 0.431$; $T = 7.078$; $p = 0.000$), and green innovation on competitive advantage ($O = 0.555$; $T = 5.723$; $p = 0.000$). However, the direct effect of brand image on competitive advantage was not significant ($p = 0.088$). This study contributes to the understanding of how integrating green innovation and knowledge management can enhance the competitiveness of batik MSMEs, offering practical implications for strengthening their market position through sustainable strategies.

1. INTRODUCTION

The MSME industry accounts for 90% of global businesses and has created 7 out of 10 job ideas in developing countries, but 65 million businesses face a financing gap of $5.2 trillion, which is 1.4 times the global MSME loan [1] (Figure 1). On the other hand, market demands for sustainability, MSMEs are now not only required to innovate, but also to integrate environmentally friendly practices into the entire business value chain [2-7]. Practices such as green manufacturing, green Human Resource Management (HRM), and green marketing are key to creating sustainable competitive advantage [8-12].
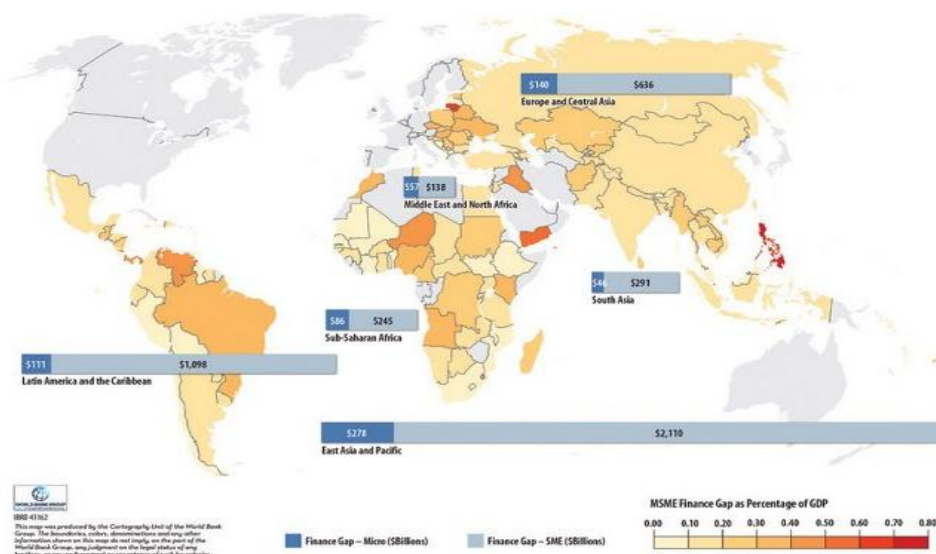

Figure 1. Formal MSME finance gap in developing countries [1]

Green innovation in MSMEs can be measured through several key parameters. These include the adoption of environmentally friendly technologies, such as renewable energy usage, energy efficiency, and waste management practices. It can be assessed by the number of green technologies implemented, energy savings achieved, and carbon emissions reduced. Product design focusing on sustainability, such as using recyclable materials, is another important parameter, measured by the percentage of products designed with eco-friendly materials. Compliance with environmental standards and certifications like ISO 14001 also plays a role, measured by the number of certifications or products meeting specific environmental criteria. Efficiency in production processes, including resource and energy consumption reduction, is another crucial factor, assessed by the reduction in energy use per unit of production or water consumption. Innovation in business processes, such as the integration of sustainable resource management systems, is measured by the number of initiatives aimed at sustainability and their impact on cost reduction and environmental impact. Lastly, the influence of green innovation on customer satisfaction and loyalty can be measured through customer surveys, focusing on their perceptions of the company's sustainability efforts and its impact on their purchasing decisions. These parameters help MSMEs evaluate the effectiveness of their green innovation strategies in both environmental conservation and enhancing competitiveness [8, 10, 13-15]. By combining green innovation and adaptive business strategies, MSMEs are able to respond to environmental challenges while driving inclusive and sustainable growth.

The batik industry in the East Java BAKORWIL II region, which includes Bojonegoro, Lamongan, Tuban, Jombang, Mojokerto, and Kediri, faces a number of strategic challenges that affect long-term competitiveness in local and global markets. Although the cultural potential and skills of artisans have been passed down from generation to generation, a number of major obstacles still limit their achievements [16, 17]. Batik UMKM players who do not yet have a strong brand imaging strategy cause their products to be less well known as exclusive, superior products [18-20]. Although some actors claim that their batik products are used in formal events and recommended by customers, consistency in maintaining the quality and aesthetics of the design is still a challenge [21, 22]. Limitations in expanding market reach and low exposure on digital platforms also weaken market perception of the quality and exclusivity of local batik products [23, 24], and the local batik industry, which does not yet have a structured system for creating, storing, and utilizing knowledge for product innovation and business strategy [9]. External collaboration with universities, research centers, or professional associations is also still limited, hampering the development of new knowledge and solutions to technical and market problems [25-28]. Lack of research for business development also slows down the pace of adaptation to the dynamics of consumer preferences and global competition. Although some craftsmen have started to save water and energy or try to recycle production waste, the implementation of environmentally based innovations is still sporadic and has not become an operational culture [29]. The minimal use of environmentally friendly raw materials, sustainable packaging, and green initiative monitoring systems are obstacles to meeting the expectations of modern consumers who care about environmental issues [30, 31]. Although there is a perception

that local batik products have unique value, the lack of design innovation and weak reputation for quality make consumers prefer products from other regions or brands that are considered superior. Through this identification, it becomes clear that to encourage the competitiveness of the batik industry in BAKORWIL II East Java, a holistic approach is needed [32, 33]: strengthening the knowledge management system, encouraging green innovation as a sustainability strategy, and building the brand image of batik as a national superior product. This study is important to provide empirical evidence that it is necessary to classify it into Knowledge Management, Green Innovation, and Brand Image, acting as a strategic foundation in forming a sustainable Competitive Advantage [34-37].

This study aims to explore the role of green innovation as a mediator in the relationship between knowledge management, brand image, and competitive advantage within the batik industry of Bakorwil II, East Java. Specifically, it seeks to analyze the direct impact of knowledge management on competitive advantage, focusing on organizational learning, information management, and strategic value creation within local batik MSMEs. The study also investigates how brand image drives the adoption of green innovation, shaping consumer perception of batik products in the region. Additionally, it examines how green innovation contributes to competitive advantage through cost efficiency, product differentiation, and market penetration. Moreover, this research assesses the mediating role of green innovation in the relationship between brand image and competitive advantage, as well as between knowledge management and competitive advantage, aiming to develop a strategic framework that integrates knowledge management, sustainability, and brand strengthening. The study further deepens the understanding of how local cultural values and collective knowledge enhance regional competitiveness, transforming the batik industry towards a sustainable creative economy.

2. LITERATURE REVIEW

Resource-Based View (RBV) is a strategic management theory that suggests that a firm's competitive advantage is derived from its internal resources and capabilities, rather than from external market forces. These resources can be tangible or intangible assets such as physical capital, human capital, intellectual property, and organizational culture. The theory emphasizes that resources must be valuable, rare, inimitable, and non-substitutable (VRIN criteria) for them to provide a sustained competitive advantage. In relation to Green Innovation, the RBV framework can be applied to understand how firms utilize their resources, such as knowledge management, technological capabilities, and brand image, to develop sustainable innovations. For example, a firm with a strong knowledge management system can effectively harness its resources to create eco-friendly products and processes, enhancing its competitive edge in an environmentally conscious market. Green innovation, driven by internal resources, not only helps the firm comply with environmental standards but also creates new business opportunities and strengthens brand reputation.

When linked to competitive advantage, the RBV highlights that firms with unique, sustainable, and innovative practices can differentiate themselves in the market. In the context of the batik industry in East Java, for example, the strategic

management of green innovation and knowledge can lead to long-term success. This approach integrates resource-based capabilities (such as knowledge of traditional batik techniques and eco-friendly processes) to achieve both environmental and competitive advantages. By leveraging these internal resources effectively, batik MSMEs can align themselves with market demands for sustainability, ultimately improving their market position and profitability. Existing studies, such as Shahzad et al. [38] showed that precision knowledge management process (KMP) enhances green innovation (GI): components of knowledge acquisition ($\beta = 0.127$; t = 2.827; p < 0.05), knowledge dissemination ($\beta = 0.134$; t = 2.856; p < 0.05), and knowledge application ($\beta = 0.487$; t = 8.885; p < 0.01). Green innovation (GI) has a positive effect on corporate sustainable performance ($\beta = 0.215$; t = 4.517; p < 0.01), covering economic, social, and environmental aspects. GI mediates the knowledge management process (KMP) and corporate sustainable performance ($\beta = 0.121$; t = 3.683; p < 0.01), indicating that knowledge management process (KMP) drives green innovation (GI) and has an impact on corporate sustainable performance in manufacturing in Pakistan. In a different study, Tu and Wu [39] found that green innovation (GI) contributes to competitive advantage ($\beta = 0.280$; p < 0.001) in manufacturing in China. The findings [40] added that green creativity, as a result of the knowledge and innovation process, is dominant to green innovation (GI) ($\beta = 0.367$; p < 0.001) and has an impact on green competitive advantage ($\beta = 0.125$; p < 0.001) and green brand image ($\beta = 0.508$; p < 0.001) in the equipment industry in China. This is an innovation effort driven by knowledge and creativity to strengthen brand image and differentiate companies in the increasingly green and environmentally conscious market competition. Empirical [41] proves that knowledge management plays an important role in driving green product competitive advantage through the mediation of green process innovation. The knowledge acquisition component is significant in green process innovation ($\beta = 0.157$; t = 2.227; p < 0.05), as well as knowledge storage & retrieval ($\beta = 0.396$; t = 5.239; p < 0.001) and knowledge utilization ($\beta = 0.281$; t = 4.171; p < 0.001). Furthermore, green process innovation increases green product competitive advantage ($\beta = 0.544$; t = 9.135; p < 0.001), indicating that environmentally oriented innovative processes have strategic value in creating competitive advantage with knowledge management, especially in terms of knowledge acquisition, storage, and utilization. Findings [9] strengthen the contribution of knowledge management to encourage green innovation (path coefficient = 0.401; t = 4.464; p = 0.000), in improving organizational performance and competitive advantage. Competitive advantage is not only determined by organizational performance, but also by green innovation practices developed through systematic knowledge management in Batik SMEs in Rembang, Indonesia. Thus, knowledge management plays a role as a catalyst in building sustainable innovation that is oriented towards long-term excellence. Findings [15] show the importance of green innovation as a mediating mechanism between various dimensions of green practices and economic performance in the textile, leather, and garment industry in Ethiopia. Precision green innovation, GMO ($\beta = 0.497$; t = 8.056; p = 0.000), Green Investment (GIV) ($\beta = 0.158$; t = 2.456; p = 0.014), and Green Manufacturing Practices (GMP) ($\beta = 0.120$; t = 1.984; p = 0.047). Mediation test shows that green innovation significantly mediates the relationship between GIV and economic performance ($\beta = 0.069$; t = 2.306; p = 0.021), and

between GMO and economic performance ($\beta = 0.215$; t = 4.990; p = 0.000). Green strategies that focus on markets and sustainable resource allocation can be the main drivers of superior economic performance.

Existing studies, Competitive Advantage and Green Innovation, still dominate in large manufacturing industries and are not specific to the developing industry in the field of batik textiles in Bakorwil II, East Java, Indonesia. Green Innovation has not dominated in studies related to Knowledge Management, Brand Image, and Competitive Advantage. In practice, this batik industry needs to be studied in depth because Knowledge Management is not properly structured. The need for a robust 1-way methodology to ensure the right mediator.

3. METHODOLOGY

3.1 Research design

This study uses quantitative survey-based and PLS-SEM analysis with reflective factor weighting scheme 1000 iterations and subsamples, percentile confidence interval (one tailed < 0.01; omission distance 10) for testing the validity, reliability and predictability of the causal framework [8, 42, 43].

3.2 Population and research sample

The targeted population consists of 161 batik industry entrepreneurs in the Bakorwil II East Java region, covering Bojonegoro, Lamongan, Tuban, Jombang, Mojokerto, and Kediri. A purposive sampling method was used, focusing on the relationship between Green Innovation and Competitive Advantage, which are central to the industry. The sampling process employed a proportional stratified random sampling technique across the six districts, followed by simple random sampling. After considering field conditions and ensuring complete data validation, the final sample size was adjusted to 154, with a margin of error of 7.9%. This approach ensures an accurate and reliable representation of the population, aligned with the study's objectives [44-47].

$$e^* = \sqrt{\frac{Z^2 * P * Q}{n}} = \sqrt{\frac{(1.96)^2 * 0.5 * 0.5}{154}} = 0.07895 \sim 7.9\%$$
$$n_0 = \frac{Z^2 PQ}{e^2} = \frac{1.96^2 * 0.5 * 0.5}{(0.07895)^2} = 154$$

3.3 Instruments

The data were collected through in-depth semi-structured interviews and traditional questionnaires on a scale of 1-5 to measure participants' perceptions quantitatively. This scale is flexible because it facilitates the measurement of the intensity of attitudes and preferences for descriptive tests and systematic statistical instrument tests. Quantitative measurements use question items in the main dimension questionnaire for each construct. Data processing uses SmartPLS 3 version software [48-51].

The constructs in this study include Competitive Advantage (CA-Y), consisting of 5 question items, Green Innovation (GI-Z) has 7 items, Knowledge Management (KM-X1) consists of 10 items, and Brand Image (BI-X2) includes 7 question items [52-54]. The total number of items in this research instrument

is 29. Competitive Advantage (CA-Y) is measured through customer perceptions related to brand recognition, organizational reputation in providing quality products, product uniqueness and differentiation, consumer preference for products compared to competitors, and operational excellence that strengthens competitive position and long-term relationships with customers [15, 55-57]. Green Innovation (GI-Z) as a mediating variable assesses the extent to which an organization implements environmentally friendly innovations, including sustainable packaging improvements, integration of environmental aspects into product design, implementation of a preventive approach during technology development, utilization of recycled materials in operational processes, and monitoring and improvement of green initiatives such as energy efficiency and waste management [41, 52, 54, 56]. In addition, aspects of innovation in the use of energy and water and the implementation of waste recycling systems are also important indicators [13, 58-60]. Knowledge Management (KM-X1) is measured by focusing on the organization's ability to create, value, and utilize new knowledge through external collaboration, adaptation to market needs, and effective information storage and retrieval systems, including consulting behavior with experts when facing problems, and research activities for business development [9, 16, 53, 61]. Meanwhile, Brand Image (BI-X2) measures the perception of the quality of batik products, which includes customer recognition of high quality, product recommendations, design exclusivity, aesthetic value, consistency of exclusive brand image, customer pride, and product use in formal events, which overall describes the brand's position in the market [19, 61-63].

3.4 Ethical clearance

All research activities have been carried out by considering the principles of research ethics, such as informed consent from respondents, anonymity, and confidentiality of personal data. Respondents were given an explanation of the purpose and benefits of the research, as well as the freedom to participate or not.

3.5 Data analysis technique

The instrument testing was started with the setting of the stability level weighting scheme of 1000 iterations and sub samples (p < 0.01) and predictability of 10 omission distance. This assessment was with loading factor ≥ 0.70; AVE ≥ 0.50; crossloading ≥ 0.70; and Cronbach's alpha > 0.70 [48, 51, 64]. R-Square structure model (0.75 strong; 0.50 moderate; and

0.25 weak), with parallel processing on bootstrapping T-statistic parameter 1000 samples and stable iteration (p < 0.01). Blindfolding using omission distance 10 for Q-Square predictability [65, 66].

4. RESULT AND DISCUSSION

4.1 Result

4.1.1 Evaluation of basic statistics

The basic statistical test results for the Batik industry in Bakorwil II, East Java, show that all constructs—Brand Image (BI-X2), Competitive Advantage (CA-Y), Green Innovation (GI-Z), and Knowledge Management (KM-X1)—have outer loading values ≥ 0.7, indicating good convergent validity. Most constructs also have Cronbach's Alpha values above 0.88, confirming good reliability, and the Average Variance Extracted (AVE) values exceed 0.58, demonstrating accurate representation of the variables. Brand Image indicators, with mean values between 3.6 and 3.8, suggest a positive perception of local batik, especially regarding design and aesthetic value. Competitive Advantage, with mean values between 3.65 and 3.87, indicates that batik companies in this region are gaining competitive advantages, particularly in product reputation and customer preference. Green Innovation, with mean values from 3.48 to 3.80, shows that companies are adopting eco-friendly practices, such as natural dyes and sustainable materials. Knowledge Management, with mean values ranging from 3.46 to 3.76, suggests effective management practices that support innovation and enhance competitiveness.

4.1.2 Structural model assessment

Out of seven proposed hypotheses, six are accepted, and one is rejected in the study of the Batik industry in Bakorwil II, East Java. The hypothesis that Brand Image directly influences Competitive Advantage is rejected (T = 1.353, P = 0.088), indicating that the brand image alone does not significantly enhance competitiveness. However, Brand Image positively influences Green Innovation (T = 7.078, P = 0.000), encouraging eco-friendly practices. Green Innovation is shown to significantly impact Competitive Advantage (T = 5.723, P = 0.000), highlighting its role in boosting competitiveness through sustainable practices like natural dyes. Knowledge Management also directly influences Competitive Advantage (T = 2.399, P = 0.008) and significantly drives Green Innovation (T = 8.338, P = 0.000), demonstrating its key role in fostering sustainability and innovation (Table 1).

Table 1. Direct effect

Direct Hypothesis	Original Sample (O)	Sample Mean (M)	T Statistics (|O/STDEV|)	P Values	Decision
Brand Image (BI-X2) -> Competitive Advantage (CA-Y)	0.118	0.118	1,353	0.088	rejected
Brand Image (BI-X2) -> Green Innovation (GI-Z)	0.431	0.432	7,078	0.000	accepted
Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.555	0.551	5,723	0.000	accepted
Knowledge Management (KM-X1) -> Competitive Advantage (CA-Y)	0.239	0.242	2,399	0.008	accepted
Knowledge Management (KM-X1) -> Green Innovation (GI-Z)	0.507	0.506	8,338	0.000	accepted
Brand Image (BI-X2) -> Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.239	0.237	4,648	0.000	accepted
Knowledge Management (KM-X1) -> Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.282	0.280	4,482	0.000	accepted

Source: Data processing, 2025

Bootstrapping on the Partial Least Squares (PLS) model reveals significant insights into the relationships between variables in the Bakorwil II East Java batik industry. Knowledge Management has a highly significant effect on Green Innovation (T = 8.338), indicating that effective management of traditional and modern knowledge fosters eco-friendly innovations. Green Innovation, in turn, significantly impacts Competitive Advantage (T = 5.723), highlighting its role in enhancing competitiveness through sustainable practices. Additionally, Knowledge Management also directly influences Competitive Advantage (T = 2.399), improving efficiency, quality, and value in batik products (Figure 2).

However, Brand Image's effect on Competitive Advantage is not significant (T = 1.353), suggesting that the local batik brand image is not strong enough to directly impact competitiveness. Nevertheless, Brand Image does positively influence Green Innovation (T = 7.078), showing that a strong brand linked to local cultural and environmental values encourages sustainable innovation.

All indicators show high T-statistic values (average above 15), confirming the reliability of the research instrument. Competitive Advantage (Q² = 0.519) and Green Innovation (Q² = 0.546) demonstrate significant predictive contributions to the industry's performance. In contrast, Brand Image and Knowledge Management do not significantly predict performance, suggesting a focus on enhancing competitive advantage and green innovation for sustainable growth in the region.

4.1.3 Mediation effect

Two indirect effects (mediation) were tested and found significant (Table 2). First, the relationship between Brand Image and Competitive Advantage through Green Innovation was significant (T = 4.648; P = 0.000), meaning a strong brand image boosts competitiveness when paired with green innovation. Second, Knowledge Management's impact on Competitive Advantage through Green Innovation was also significant (T = 4.482; P = 0.000), indicating that effective knowledge management enhances competitiveness when focused on green innovation. In the Bakorwil II East Java batik industry, Green Innovation is crucial for competitive advantage. Therefore, businesses should focus on product innovation, knowledge management, and strengthening a sustainability-oriented brand image to stay competitive.

To effectively leverage green innovation as a mediator between brand image, knowledge management, and competitive advantage, batik MSMEs in the Bakorwil East Java region must adopt a strategic, multifaceted approach. The key lies in creating a robust mechanism where green innovation isn't merely an add-on but is fully integrated into the organization's strategic framework, values, and daily operations. By doing so, businesses can create a sustainable competitive advantage that resonates with modern market demands while preserving local heritage. This mechanism involves several interconnected strategies that empower businesses to turn sustainability into a core driver of growth and competitiveness.
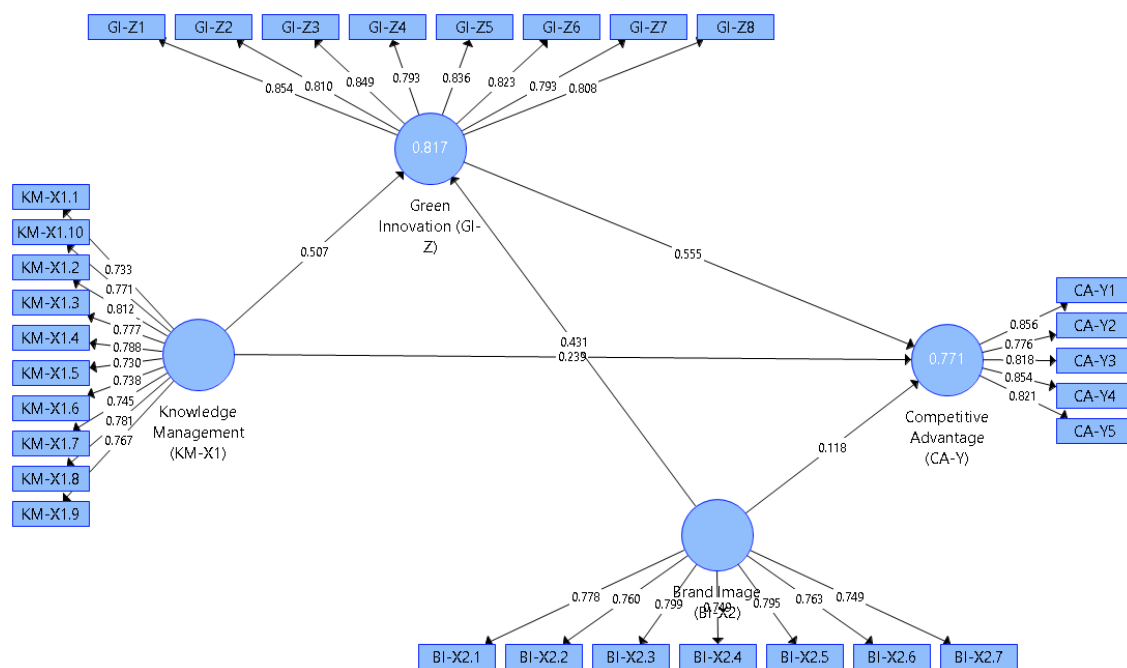

Figure 2. Structural model (Iteration 1000)
Source: Data processing, 2025

Table 2. Indirect effect

Indirect Hypothesis	Original Sample (O)	Sample Mean (M)	T Statistics	P Values	Decision
Brand Image (BI-X2) -> Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.239	0.237	4.648	0.000	accepted
Knowledge Management (KM-X1) -> Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.282	0.280	4.482	0.000	accepted

First, a strong mechanism begins with embedding sustainability into the company's core identity, particularly its brand image. The narrative around the brand must reflect an authentic commitment to environmental sustainability. This begins with incorporating green practices like using natural dyes, renewable energy sources, and waste reduction initiatives. The brand image then evolves to stand as a symbol of eco-consciousness, which appeals to a growing consumer base that values sustainability. When consumers recognize a company's commitment to sustainable practices, it builds trust and loyalty—key elements in maintaining a competitive edge in a market that increasingly prioritizes green initiatives.

Next, the role of knowledge management is central in the innovation process. For green innovation to thrive, it must be supported by an organizational culture that fosters knowledge sharing and continuous learning. Batik MSMEs need to create platforms where both traditional knowledge (e.g., batik-making techniques) and new sustainable practices (e.g., eco-friendly production methods) are shared and disseminated. This can be achieved through internal workshops, cross-functional teams, and external collaborations with universities, research institutes, and other stakeholders focused on green technologies. The more knowledge is transferred, integrated, and applied throughout the organization, the more innovative solutions emerge, especially in the context of sustainable production processes.

Furthermore, establishing a green supply chain is crucial for ensuring that sustainability practices are not limited to individual companies but extend throughout the value chain. This means working closely with suppliers to ensure that raw materials are sustainably sourced, that production processes are efficient, and that waste is minimized. Batik MSMEs can also use technologies like IoT to monitor energy consumption or waste generation, ensuring compliance with sustainability targets. Blockchain can be utilized to track the sustainability of materials used in production, ensuring transparency and reinforcing trust with consumers who are increasingly concerned with the authenticity of green claims.

Finally, the mechanism must include continuous feedback loops that allow businesses to track the effectiveness of their green innovation efforts and make necessary adjustments. This involves setting clear sustainability goals, such as reducing carbon emissions or using a certain percentage of renewable energy, and measuring progress against these benchmarks. By regularly assessing the performance of green initiatives, businesses can refine their strategies to meet both environmental and market demands.

4.1.4 Fit model

R-Square (R^2) results show that Green Innovation (GI-Z) is explained 81.7% by Knowledge Management and Brand Image, while Competitive Advantage (CA-Y) is explained 77.1% by these variables. This highlights that knowledge management, brand image, and green innovation significantly boost the competitiveness of batik MSMEs in Bakorwil II, East Java. The high R^2 values indicate the model effectively explains the relationships between variables to support the industry's sustainability and competitive advantage (Table 3).

The f-square (f^2) analysis shows that Brand Image has a significant influence on Green Innovation ($f^2 = 0.276$) but not on Competitive Advantage ($f^2 = 0.013$). Green Innovation significantly impacts Competitive Advantage ($f^2 = 0.246$), and Knowledge Management strongly influences Green Innovation ($f^2 = 0.382$), though its impact on Competitive Advantage is minimal ($f^2 = 0.049$). These findings confirm that Green Innovation is key in linking knowledge management and brand image to competitiveness, making it the focal point for future batik MSME development strategies (Table 4).

Table 3. R-square

Competitive Advantage (CA-Y)	0.771
Green Innovation (GI-Z)	0.817

Table 4. F-square

	Original Sample (O)	Sample Mean (M)	F Statistics	P Values	Decision
Brand Image (BI-X2) -> Competitive Advantage (CA-Y)	0.013	0.022	0.534	0.297	Rejected
Brand Image (BI-X2) -> Green Innovation (GI-Z)	0.276	0.291	2,665	0.004	Accepted
Green Innovation (GI-Z) -> Competitive Advantage (CA-Y)	0.246	0.256	2,751	0.003	Accepted
Knowledge Management (KM-X1) -> Competitive Advantage (CA-Y)	0.049	0.061	1,064	0.144	Rejected
Knowledge Management (KM-X1) -> Green Innovation (GI-Z)	0.382	0.396	3,163	0.001	Accepted

4.2 Discussion

4.2.1 Literature reflections

Bootstrapping shows that the influence of Brand Image (BI-X2) on Competitive Advantage (CA-Y) is not statistically significant. The coefficient value of 0.118 with T-Statistics 1.353 and P-Value 0.088 (> 0.05) indicates that although the direction of the influence is positive, its strength is not yet convincing enough at the 95% significance level. Brand image has not been proven to directly increase competitive advantage. This finding is different from the results of previous studies, which stated that Brand Image plays an important role in driving competitiveness. Study [40] finds that Green Brand Image positively influences Green Competitive Advantage ($\beta = 0.545$, CR = 14.513, $p < 0.001$). However, in the Bakorwil East Java batik industry, brand image alone does not significantly increase competitive advantage, likely due to more dominant factors such as green innovation, knowledge management, and product quality. To enhance competitiveness, strategies involving unique design, quality, loyalty, differentiation, and communication are needed. Brand image shapes consumer perceptions of reputation, value, and identity, strengthening trust and loyalty through consistency and sustainability [19].

The results of the bootstrapping analysis show that the influence of Brand Image (BI-X2) on Green Innovation (GI-Z) has an Original Sample (O) value of 0.431 with a Sample Mean (M) of 0.432. The Standard Deviation (STDEV) value

was recorded at 0.061, resulting in a T-Statistics value of 7.078 and a P-Value of 0.000. Because the P-Value <0.05, statistically the influence of Brand Image on Green Innovation is significant at a 95% confidence level, so the hypothesis is accepted. These results are in line with research conducted by Zameer et al. [40]. Green Creativity significantly affects Green Brand Image (β = 0.377, CR = 7.973, p < 0.001). This shows that creativity in developing eco-friendly products, processes, or strategies enhances the green brand image. A strong brand image impacts green innovation, requiring sustainable design, a green narrative, loyalty, education, and differentiation. Unilever's hybrid model for sustainable competitive advantage integrates green marketing, social responsibility, brand equity, and green brand image [62].

The results of the bootstrapping analysis show that the influence of Green Innovation (GI-Z) on Competitive Advantage (CA-Y) has an Original Sample (O) value of 0.555 with a Sample Mean (M) of 0.551. The Standard Deviation (STDEV) value was recorded at 0.097, resulting in a T-Statistics value of 5.723 and a P-Value of 0.000. Because the P-Value <0.05, statistically the influence of Green Innovation on Competitive Advantage is significant at a 95% confidence level, so the hypothesis is accepted. These results are in line with the results of research conducted by Tu and Wu [39]. Green Innovation has a positive and significant effect on Enterprises' Competitive Advantage. This is indicated by the influence coefficient value of β = 0.280 and a significance level of p <0.001. The results of the study indicate that Green Innovation (GI-Z) has a positive and significant effect on Competitive Advantage (CA-Y) in the batik industry in Bakorwil, East Java. This means that the higher the application of environmentally friendly innovation in the production and operational processes, the greater its contribution to increasing the company's competitive advantage. Management needs to integrate environmentally friendly design, production efficiency, green brand narratives, external collaboration, and green innovation as sustainable main differentiation strategies to strengthen competitive advantage and customer trust [41, 67].

Bootstrapping analysis shows that Knowledge Management (KM-X1) significantly influences Competitive Advantage (CA-Y) with an Original Sample value of 0.239, T-Statistics of 2.399, and a P-Value of 0.008, confirming the hypothesis at a 95% confidence level. This supports previous research that highlights KM's positive impact on competitive advantage. In the Bakorwil East Java batik industry, effective knowledge management can enhance competitiveness by fostering innovation, employee engagement, collaboration, and strategic integration.

For Knowledge Management (KM-X1) and Green Innovation (GI-Z), the Original Sample value is 0.507, with a T-Statistics of 8.338 and a P-Value of 0.000, indicating a significant effect at a 95% confidence level. These findings align with previous studies, confirming the importance of knowledge management in driving green innovation [9]. Knowledge Management (KM) significantly affects Green Innovation (GI) with a path coefficient of 0.401, t-value of 4.464, and p = 0.000. Effective knowledge management fosters environmentally friendly innovations. In Bakorwil East Java, batik MSMEs should strengthen knowledge management through green innovation, external collaboration, eco-friendly systems, and employee idea appreciation for sustainable production.

Bootstrapping results show that Brand Image (BI-X2) indirectly influences Competitive Advantage (CA-Y) through Green Innovation (GI-Z), with an Original Sample value of 0.239, t-value of 4.648, and p = 0.000. This significant mediation effect supports the hypothesis [40], Green Brand Image significantly mediates the relationship between Green Creativity and Green Competitive Advantage. This is indicated by the indirect effect of 0.221, with a Critical Ratio (CR) value of 3.877 and a significance level of p = 0.001. Creativity in developing environmentally friendly products or processes can increase a company's competitive advantage by strengthening the green brand image. In other words, Green Creativity contributes to the formation of Green Brand Image, which then becomes an important path in creating sustainability-based competitive advantage. Green Innovation mediates the influence of Brand Image on competitive advantage. Therefore, batik SMEs need to integrate brand image with environmentally friendly practices so that green innovation becomes a strategic bridge to market differentiation and sustainable competitive advantage.

In the mediation study, the indirect effect of Knowledge Management (KM-X1) on Competitive Advantage (CA-Y) through Green Innovation (GI-Z) has an Original Sample (O) value of 0.282 with a Sample Mean (M) of 0.280. The Standard Deviation (STDEV) value was recorded at 0.063, resulting in a T-Statistics value of 4.482 and a P-Value of 0.000. Because the P-Value <0.05, statistically, this mediation effect is significant at a 95% confidence level, so the hypothesis is accepted. These results are in line with the results of research conducted by Rehman et al. [41], Green Process Innovation (Z) significantly mediates the relationship between Knowledge Management (X) and Green Product Competitive Advantage (Y), with an indirect effect of 0.247, confidence interval between 0.123 and 0.391, and p = 0.000, confirming the mediation is significant. Effective knowledge management fosters green process innovation, which boosts competitive advantage. In the Bakorwil East Java batik industry, knowledge management practices encourage sustainable innovation, increasing competitiveness. Strengthening collaborative knowledge management will help MSMEs build unique, adaptive, and sustainable competitive advantages through green innovation.

4.2.2 Implication theory

Literature development on the relationship between brand image, green innovation, knowledge management, and competitive advantage. Although several previous studies found a direct effect of brand image on competitive advantage, the results of this study indicate that in the context of the East Java Bakorwil batik industry, the effect is not statistically significant (β = 0.118; T = 1.353; P = 0.088). On the contrary, the significant effect of brand image on green innovation (β = 0.431; T = 7.078; P = 0.000), as well as the effect of green innovation on competitive advantage (β = 0.555; T = 5.723; P = 0.000), confirm the importance of mediation pathways that have previously been less explored in depth in the local literature. In other words, this model proposes an extension of the theoretical framework of sustainable competitive advantage by integrating the role of green innovation as an intervening variable. In addition, the direct influence of knowledge management (β = 0.239) and indirect influence through green innovation (β = 0.282) also enriches the dynamic capability and resource-based view (RBV) theories in the context of small and medium enterprises based on local wisdom.

4.2.3 Practical implications

Batik MSMEs cannot only rely on the strength of brand image to create a competitive advantage, but also need to integrate it with a concrete and systematic green innovation strategy. Green innovation is a significant mediator between brand image and competitive advantage ($\beta = 0.239$; T = 4.648; P = 0.000) and between knowledge management and competitive advantage ($\beta = 0.282$; T = 4.482; P = 0.000), emphasizing that companies must build an organizational environment that supports idea creation, knowledge sharing, and implementing environmentally friendly processes. Practices such as sustainable product design, use of clean technology, green brand narratives, and external training and collaboration are crucial in improving market position and consumer loyalty. By implementing a good knowledge management system and strengthening sustainability-based brand image, batik MSMEs can achieve sustainable competitive differentiation in both domestic and global markets.

4.2.4 Limitations and future research

This study has several limitations. First, it focuses solely on the batik industry in Bakorwil, East Java, limiting the generalizability of findings to other sectors or regions. Second, the quantitative approach, while analyzing variable relationships, does not fully capture qualitative aspects like consumer perceptions or local cultural values that may influence brand image and competitive advantage. Third, variables such as digital technology adoption, market orientation, or dynamic capabilities were not included. The insignificant effect of Brand Image on Competitive Advantage suggests the need for additional moderator or mediator variables.

Future research should expand to other creative industries or regions to enhance generalizability. A mixed-methods approach, combining qualitative insights, would deepen understanding of brand image in local contexts. Researchers could also explore moderators like customer loyalty or corporate environmental orientation and use a longitudinal approach to observe variable dynamics over time. Investigating digital knowledge management and green innovations using technologies like IoT or blockchain could further support sustainable competitiveness.

5. CONCLUSION

This study contributes to the literature by extending the theoretical framework of sustainable competitive advantage, particularly by integrating the role of green innovation as a mediator between brand image, knowledge management, and competitive advantage. Previous studies have highlighted a direct effect of brand image on competitive advantage, but this study shows that, in the context of the Bakorwil East Java batik industry, brand image alone does not significantly influence competitive advantage ($\beta = 0.118$; T = 1.353; P = 0.088). Instead, the significant effect of brand image on green innovation ($\beta = 0.431$; T = 7.078; P = 0.000) and green innovation on competitive advantage ($\beta = 0.555$; T = 5.723; P = 0.000) demonstrates the critical role of green innovation as an intervening variable. This shift in focus supports the integration of dynamic capability theory and the resource-based view (RBV), particularly in the context of small and medium enterprises (SMEs) that rely on local wisdom.

Knowledge management further enriches this framework, with both its direct ($\beta = 0.239$) and indirect ($\beta = 0.282$) effects on competitive advantage through green innovation. These findings indicate that sustainable competitive advantage in SMEs depends not only on resources and capabilities but also on the ability to innovate sustainably.

Practically, batik MSMEs in Bakorwil, East Java, cannot solely rely on brand image to drive competitiveness. Instead, they must integrate a systematic green innovation strategy that strengthens their brand image and facilitates knowledge sharing, idea generation, and environmentally friendly practices. The findings underscore the importance of green innovation as a mediator between brand image, knowledge management, and competitive advantage, suggesting that sustainable product design, clean technologies, and external collaboration are vital for enhancing market position and consumer loyalty. Strengthening knowledge management systems and sustainability-based brand image are critical for achieving sustainable competitive differentiation in both local and global markets.

However, this study has limitations, including its focus on a specific sector and region, which restricts the generalizability of the findings. Future research should broaden the scope to include other creative industries and regions, use a mixed-methods approach to capture qualitative insights, and explore additional moderator or mediator variables, such as customer loyalty and corporate environmental orientation. A longitudinal approach and the application of emerging technologies, like IoT or blockchain in green innovation, could further deepen understanding and support sustainable competitiveness.

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