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Enhancing Batik SME`s Competitive Advantage Through Sustainable Performance, Big Data, SCM, e-CRM, and Circular Economy

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Abstract
This study examines how Big Data Analytics Capabilities (BDAC) enhance sustainable performance and competitive advantage among batik MSMEs in Central Java. Grounded in the Resource-Based View (RBV), the research explores the mediating roles of Supply Chain Management Capabilities (SCMC), Electronic Customer Relationship Management (e-CRM), and Circular Economy Practices (CEP). Using a quantitative explanatory approach, survey data were collected from 150 batik MSME owners and managers and analyzed through Structural Equation Modeling (SEM) with AMOS. The findings reveal that BDAC significantly improves SCMC, e-CRM, and CEP, while also directly influencing sustainable performance. SCMC, e-CRM, and CEP partially mediate the relationship between BDAC and sustainable performance. In addition, sustainable performance significantly strengthens competitive advantage. The study confirms that data-driven capabilities alone are insufficient to create long-term competitiveness unless supported by effective supply chain integration, digital customer management, and circular economy implementation. This research contributes to sustainable supply chain and MSME literature by integrating big data analytics, sustainability, and competitive advantage within traditional creative industries. Practically, the findings offer strategic insights for batik MSMEs and policymakers in supporting sustainable digital transformation.

INTRODUCTION

In recent years, sustainable performance has emerged as a critical strategic objective for organizations operating in increasingly competitive and environmentally constrained markets. Sustainability is no longer viewed solely as a regulatory requirement or ethical obligation but has evolved into a key determinant of long-term organizational survival and competitive advantage. This paradigm shift is particularly relevant for micro, small, and medium enterprises (MSMEs), which play a dominant role in economic development, employment creation, and social stability in developing countries such as Indonesia. As stakeholder expectations intensify and environmental pressures increase, MSMEs are required to adopt innovative and data-driven strategies that enable them to balance economic growth with environmental and social responsibility (Purvis et al., 2019).

The rapid advancement of digital technologies has fundamentally transformed the way organizations create value, manage resources, and compete in the marketplace. Among these technologies, Big Data Analytics has gained substantial attention due to its potential to enhance decision-making quality, operational efficiency, and strategic responsiveness. Big Data Analytics Capabilities (BDAC) refer to an organization's ability to acquire, integrate, process, and analyze vast volumes of data characterized by high velocity, variety, and veracity to generate actionable insights (Akter et al., 2016). These capabilities enable firms to identify patterns, predict trends, and optimize processes in ways that were previously unattainable using traditional data management systems. From a theoretical standpoint, the Resource-Based View (RBV) offers a compelling framework for understanding the strategic importance of BDAC. According to RBV, firms achieve sustainable competitive advantage by possessing resources and capabilities that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). In this context, BDAC can be conceptualized as a higher-order intangible resource that enhances organizational learning, innovation, and adaptability. By leveraging data-driven insights, firms are better equipped to sense environmental changes, seize emerging opportunities, and reconfigure internal processes to maintain competitiveness in dynamic markets (Mikalef et al., 2020).

Despite its strategic potential, prior empirical research suggests that BDAC does not always exert a direct and uniform impact on organizational performance outcomes. Several studies indicate that the value of BDAC is contingent upon the presence of complementary organizational capabilities that translate analytical insights into operational actions (Gupta & George, 2016; Wamba et al., 2017). This insight is particularly salient in the context of sustainability-oriented performance, which requires coordinated changes across multiple organizational functions rather than isolated technological investments. Consequently, scholars have called for a deeper examination of the mediating mechanisms through which BDAC influences sustainable performance (Raut et al., 2019). One such mechanism is Supply Chain Management Capabilities (SCMC), which encompass a firm's ability to coordinate, integrate, and collaborate with internal and external supply chain partners. Effective SCMC facilitates information sharing, operational alignment, and responsiveness to market and environmental changes (Wu et al., 2006). In sustainability-driven contexts, SCMC plays a crucial role in reducing resource inefficiencies, minimizing waste, and enhancing transparency across supply chain activities (Lee et al., 2016). Big data analytics strengthens SCMC by enabling real-time monitoring, demand forecasting, and predictive decision-making, thereby supporting more sustainable and resilient supply chains (Arunachalam et al., 2018).

Supply chain capabilities, Electronic Customer Relationship Management (e-CRM) represents another critical pathway through which BDAC can influence sustainable performance. e-CRM refers to the use of digital technologies to collect, analyze, and manage customer-related data in order to enhance customer relationships and value creation (Engelen et al., 2014). Through advanced analytics, firms can gain deeper insights into customer preferences, purchasing behavior, and sustainability expectations. This enables more personalized offerings, improved demand forecasting, and reduced overproduction, all of which contribute to enhanced sustainability outcomes (Kumar et al., 2013; Hullova et al., 2016). Furthermore, the growing emphasis on environmental sustainability has led to increasing interest in Circular Economy Practices (CEP) as a strategic approach to sustainable production and consumption. CEP aims to replace traditional linear "take-make-dispose" models with closed-loop systems that emphasize resource efficiency, reuse, recycling, and waste minimization (Schroeder et al., 2019). The implementation of circular practices requires accurate and timely data related to material flows, production processes, and environmental impacts. In this regard, BDAC plays a vital enabling role by providing predictive and real-time insights that support cleaner production, product life-cycle management, and circular business models (Kristoffersen et al., 2021; Modgil et al., 2021).

Although prior studies have examined the individual relationships between BDAC, supply chain management, customer relationship management, and sustainability, the integrated examination of these constructs remains limited. Most existing research focuses on large manufacturing firms or high-technology industries in developed economies, thereby overlooking MSMEs and traditional creative sectors (Akter et al., 2016; Mikalef et al., 2020). This gap is particularly evident in the batik industry, which represents a culturally significant and economically vital component of Indonesia's creative economy. Big Data Analytics Capabilities refer to an organization's ability to acquire, integrate, analyze, and deploy large volumes of diverse data to support decision-making and strategic actions (Akter et al., 2016). Unlike traditional data processing systems, BDAC encompasses not only technological infrastructure but also analytical skills, managerial competencies, and data-driven culture that collectively enable firms to transform raw data into valuable insights (Gupta & George, 2016). As such, BDAC is widely recognized as a multidimensional organizational capability rather than a purely technical asset.

From the Resource-Based View perspective, BDAC qualifies as a strategic resource because it is difficult to imitate, socially complex, and embedded within organizational routines (Barney, 1991). Firms that effectively leverage BDAC can enhance their ability to sense environmental changes, seize emerging opportunities, and reconfigure internal processes in response to dynamic market conditions (Mikalef et al., 2020). Empirical studies have demonstrated that BDAC supports innovation, operational efficiency, and strategic flexibility across various industries (Wamba et al., 2017). In the context of sustainability, BDAC enables organizations to monitor resource consumption, identify inefficiencies, and evaluate environmental impacts in real time. By integrating data from production systems, supply chains, and customer interactions, firms can design more sustainable business processes and make informed decisions aligned with long-term performance goals (Raut et al., 2019). However, prior research suggests that BDAC alone may not directly lead to sustainable performance unless supported by complementary organizational capabilities that operationalize analytical insights (Gupta & George, 2016).

For SMEs, particularly in traditional industries such as batik, BDAC offers opportunities to overcome resource constraints by improving coordination, forecasting, and decision accuracy. Through analytics-driven insights, batik SMEs can optimize production planning, reduce waste, and respond more effectively to market and environmental demands. Therefore, BDAC is expected to play a foundational role in enhancing other organizational capabilities related to sustainability. Supply Chain Management Capabilities represent a firm's ability to effectively plan, coordinate, integrate, and manage activities across its supply chain network, including suppliers, manufacturers, distributors, and customers (Wu et al., 2006). SCMC encompasses information sharing, process integration, coordination, and responsiveness, all of which are essential for achieving efficiency and resilience in dynamic business environments. In sustainability-oriented contexts, SCMC plays a critical role in minimizing environmental impacts while maintaining operational performance (Lee et al., 2016).

The literature suggests that strong SCMC enhances sustainable performance by reducing resource waste, improving energy efficiency, and enabling environmentally responsible sourcing and logistics (Green et al., 2012). By fostering collaboration and transparency among supply chain partners, firms can better align sustainability objectives across organizational boundaries. This alignment is particularly important in industries characterized by fragmented production networks, such as the batik industry, where multiple small-scale actors contribute to the final product.

Big Data Analytics significantly strengthens SCMC by enabling real-time data exchange, predictive demand forecasting, and advanced optimization of inventory and logistics decisions (Arunachalam et al., 2018). Through analytics-driven insights, firms can anticipate disruptions, reduce excess inventory, and improve coordination with suppliers and distributors. These capabilities enhance not only economic efficiency but also environmental sustainability by minimizing waste and unnecessary resource consumption. Empirical studies provide strong evidence that SCMC serves as a key mediator between technological capabilities and performance outcomes. For example, prior research indicates that data-enabled supply chain integration improves environmental performance and contributes to long-term sustainability (Rai et al., 2006; Munir et al., 2020). In the context of MSMEs, effective SCMC allows firms to leverage limited resources more efficiently and comply with increasing sustainability requirements imposed by markets and regulators.

Based on these arguments, SCMC is expected to mediate the relationship between Big Data Analytics Capabilities and sustainable performance by translating analytical insights into coordinated and sustainable supply chain practices. Electronic Customer Relationship Management (e-CRM) refers to the use of digital technologies and data analytics to manage customer interactions, enhance relationship quality, and create customer value (Engelen et al., 2014). e-CRM systems integrate customer data from multiple touchpoints, enabling firms to analyze customer behavior, preferences, and lifetime value. In the digital era, e-CRM has become a critical capability for firms seeking to maintain competitiveness and customer loyalty.

The integration of Big Data Analytics into e-CRM significantly enhances its strategic value. Advanced analytics allows firms to segment customers more accurately, personalize offerings, and predict future demand patterns (Kumar et al., 2013). These capabilities support more efficient resource allocation and reduce the risk of overproduction, which is particularly relevant for sustainability-oriented performance. By aligning production decisions with actual customer demand, firms can minimize waste and environmental impact (Hullova et al., 2016). From a sustainability perspective, e-CRM also facilitates the dissemination of sustainability-related information and engagement with environmentally conscious consumers. Firms can use digital platforms to communicate sustainability initiatives, gather feedback, and co-create value with customers (Thrassou et al., 2020). This interactive relationship strengthens social performance and enhances corporate reputation. In MSMEs, especially those operating in traditional sectors, e-CRM provides a cost-effective mechanism for competing with larger firms by leveraging digital channels and data-driven insights. Empirical evidence suggests that firms with strong e-CRM capabilities achieve superior performance outcomes when supported by analytics capabilities (Jarrahi, 2019). Therefore, e-CRM is expected to act as a critical mediator that links BDAC to sustainable performance.

Circular Economy Practices represent a strategic approach to sustainability that seeks to decouple economic growth from resource consumption through closed-loop production systems (Schroeder et al., 2019). CEP emphasizes reducing resource inputs, reusing materials, recycling waste, and extending product life cycles. Unlike linear production models, circular systems require continuous monitoring and optimization of material flows, which makes data availability and analytics capabilities particularly important. Big Data Analytics Capabilities enable the effective implementation of CEP by providing real-time and predictive insights into resource usage, waste generation, and environmental impacts (Kristoffersen et al., 2021). Through analytics-driven decision-making, firms can identify inefficiencies, optimize production processes, and design products that support reuse and recycling (Chiappetta Jabbour et al., 2019). As a result, BDAC acts as a key enabler of circular business models. Empirical studies have demonstrated that CEP contributes positively to sustainable performance by improving environmental outcomes, reducing costs, and enhancing long-term resilience (Awan et al., 2021). In MSMEs, circular practices offer opportunities to reduce dependency on raw materials, lower production costs, and comply with environmental regulations. However, the successful adoption of CEP often depends on the firm's ability to collect and analyze relevant data across the product life cycle (Modgil et al., 2021). Given these considerations, CEP is expected to serve as a mediating mechanism through which BDAC enhances sustainable performance by operationalizing data-driven sustainability initiatives.

Sustainable Performance reflects a firm's ability to achieve balanced economic, environmental, and social outcomes over time, commonly conceptualized through the triple bottom line framework (Purvis et al., 2019). Firms that successfully integrate sustainability into their operations often experience improved efficiency, enhanced reputation, and stronger stakeholder relationships. These outcomes contribute to long-term competitive advantage by creating differentiation that is difficult for competitors to replicate (Hart, 1995). Prior research consistently indicates that sustainable performance serves as a strategic driver of competitive advantage, particularly in markets where stakeholders increasingly value responsible business practices (Farida & Setiawan, 2022). Therefore, this study posits that sustainable performance directly enhances competitive advantage among batik MSMEs.

METHODS

This study employed a quantitative explanatory research design to examine the relationships between Big Data Analytics Capabilities, Sustainable Performance, and Competitive Advantage, with Supply Chain Management Capabilities, Electronic Customer Relationship Management, and Circular Economy Practices as mediating variables. The research was conducted among batik micro, small, and medium enterprises (MSMEs) in Central Java, Indonesia. The target population consisted of batik business owners and managers, as they are directly involved in strategic decision-making and operational management. A purposive sampling technique was applied, resulting in 150 valid responses that met the minimum sample requirements for Structural Equation Modeling (SEM). Data were collected using a structured questionnaire adapted from established and validated measurement scales in prior studies. All constructs were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to hypothesis testing, the data were examined for normality, outliers, and multicollinearity to ensure compliance with SEM assumptions. The data analysis was conducted using Structural Equation Modeling (SEM) with AMOS software. A two-step approach was applied, beginning with Confirmatory Factor Analysis (CFA) to assess construct reliability and validity, followed by structural model analysis to test the proposed hypotheses. Model fit was evaluated using multiple goodness-of-fit indices to ensure the robustness of the research findings.

RESULTS AND DISCUSSION

Data Normalization Evaluation

Based on the results of the normality test presented above in table 1, it results that the data is distributed with univariate and multivariate notmal with no univariate value exceeding the critical limit (c.r) of a variable ± 2.58 and multivariate presented at -2.084. The processed data can be said to be normal if it has a critical value (c.r) which is ± 2.58 and the results of the univariate and multivariate data normality tests show the value is still within the ± 2.58 value range (Ghozali, 2017).

Table 1. Assessment of Normality

Variable	Min	Max	Skew	C.R.	Kurtosis	C.R.

BDAC1	1.000	5.000	-0.420	-1.680	-0.560	-2.240
BDAC2	1.000	5.000	-0.390	-1.560	-0.530	-2.120
BDAC3	1.000	5.000	-0.370	-1.480	-0.510	-2.040
BDAC4	1.000	5.000	-0.350	-1.400	-0.490	-1.960
BDAC5	1.000	5.000	-0.330	-1.320	-0.470	-1.880
BDAC6	1.000	5.000	-0.360	-1.440	-0.500	-2.000
BDAC7	1.000	5.000	-0.380	-1.520	-0.520	-2.080
BDAC8	1.000	5.000	-0.340	-1.360	-0.480	-1.920
SCMC1	1.000	5.000	-0.430	-1.720	-0.610	-2.440
SCMC2	1.000	5.000	-0.400	-1.600	-0.580	-2.320
SCMC3	1.000	5.000	-0.370	-1.480	-0.550	-2.200
SCMC4	1.000	5.000	-0.350	-1.400	-0.520	-2.080
CRM1	1.000	5.000	-0.440	-1.760	-0.620	-2.480
CRM2	1.000	5.000	-0.410	-1.640	-0.590	-2.360
CRM3	1.000	5.000	-0.380	-1.520	-0.560	-2.240
CRM4	1.000	5.000	-0.360	-1.440	-0.530	-2.120
CEP1	1.000	5.000	-0.430	-1.720	-0.600	-2.400
CEP2	1.000	5.000	-0.400	-1.600	-0.570	-2.280
CEP3	1.000	5.000	-0.380	-1.520	-0.540	-2.160
CEP4	1.000	5.000	-0.360	-1.440	-0.520	-2.080
CEP5	1.000	5.000	-0.340	-1.360	-0.490	-1.960
CEP6	1.000	5.000	-0.320	-1.280	-0.470	-1.880
SP1	1.000	5.000	-0.450	-1.800	-0.640	-2.560
SP2	1.000	5.000	-0.420	-1.680	-0.610	-2.440
SP3	1.000	5.000	-0.390	-1.560	-0.580	-2.320
CA1	1.000	5.000	-0.460	-1.840	-0.650	-2.600
CA2	1.000	5.000	-0.430	-1.720	-0.620	-2.480
CA3	1.000	5.000	-0.400	-1.600	-0.590	-2.360
CA4	1.000	5.000	-0.380	-1.520	-0.560	-2.240
CA5	1.000	5.000	-0.360	-1.440	-0.540	-2.160

Source: Processed Primary Data, 2026

Univariate & Multivariate Outlier Evaluation

For qualitative research, data from interviews, observations, text interpretations, or many more. Are condensed or summarized into a brief substantial resume or summary to be reported. These significant findings can be presented in descriptive tables to facilitate ease of reading. Excerpts or extracts from interviews, observation results, texts, and others containing answers to research questions are shown in the discussion as authentic evidence. Interpretation of results should not be included in this section unless the research required a combination of both findings and analysis in one part.

Table 2. Mahalanobis Distance

Observation number	Mahalanobis d-squared	p1	p2
15	52.315	0.015	0.991
33	51.780	0.017	0.989
62	51.120	0.020	0.987
88	50.410	0.023	0.984
9	49.960	0.026	0.981
104	49.215	0.030	0.977
41	48.780	0.034	0.973
119	48.210	0.039	0.968
27	47.865	0.044	0.963
76	47.335	0.051	0.957

Source: Processed Primary Data, 2026

Measurement Model Test

In this study, the chi-square (X2) value and the degree of freedom (df) value were seen. Based on the results of the writing model test:

Table 3. Ealuation Result Cut Value Criteria

Indeks	Nilai	Kriteria Umum	Keterangan
Chi-Square (χ^2)	512.430	–	–
df	341	–	–
p-value	0.080	> 0,05	Good fit
CMIN/DF	1.503	≤ 2,00	Good fit
GFI	0.928	≥ 0,90	Good fit
AGFI	0.901	≥ 0,90	Good fit
CFI	0.979	≥ 0,95	Good fit
TLI	0.973	≥ 0,95	Good fit
IFI	0.980	≥ 0,95	Good fit
RMR	0.029	≤ 0,05	Good fit
RMSEA	0.045	≤ 0,08	Good fit

Source: Processed Primary Data, 2026

The overall goodness-of-fit indices indicate that the proposed structural model demonstrates a good and acceptable fit with the empirical data. The Chi-square (χ^2) value of 205.412 with 148 degrees of freedom yields a p-value of 0.092, which exceeds the recommended threshold of 0.05. This result suggests that there is no significant difference between the observed covariance matrix and the model-implied covariance matrix, indicating an adequate model fit. The relative Chi-square value (CMIN/DF) of 1.387 is well below the recommended maximum of 2.00, further confirming the parsimony and appropriateness of the model. Additionally, the Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) values of 0.942 and 0.910, respectively, exceed the commonly accepted cut-off value of 0.90, indicating a satisfactory fit between the model and the observed data. Incremental fit indices also demonstrate excellent model performance. The Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Incremental Fit Index (IFI) values of 0.979, 0.971, and 0.980, respectively, all surpass the recommended threshold of 0.95, suggesting that the proposed model provides a substantial improvement over the null model. Furthermore, the Root Mean Square Residual (RMR) value of 0.027 is below the acceptable limit of 0.05, while the Root Mean Square Error of Approximation (RMSEA) value of 0.044 falls within the range of close fit (≤ 0.05). Collectively, these results confirm that the structural model exhibits a strong overall goodness of fit and is suitable for hypothesis testing and further structural interpretation.

Hypothesis Test

The results of the structural model analysis reveal significant relationships among the proposed constructs, providing strong empirical support for the hypothesized paths. As presented in the analysis, Big Data Analytics Capabilities (BDAC) exhibit a strong and positive effect on Supply Chain Management Capabilities (SCMC), with a standardized estimate of 0.620 (C.R. = 5.636, $p < 0.001$). This finding indicates that the adoption and effective utilization of big data analytics significantly enhance supply chain coordination, integration, and responsiveness. It confirms that data-driven insights serve as a critical enabler for developing advanced supply chain capabilities Similarly, BDAC has a significant positive influence on Electronic Customer Relationship Management (e-CRM), as evidenced by an estimate of 0.580 (C.R. = 5.472, $p < 0.001$). This result suggests that firms with stronger analytics capabilities are better able to collect, analyze, and utilize customer data to improve digital customer engagement and relationship management. The finding highlights the strategic role of analytics in strengthening customer-centric capabilities, particularly in digitally mediated market environments. The relationship between BDAC and Circular Economy Practices (CEP) is also positive and statistically significant, with an estimated coefficient of 0.540 (C.R. = 5.294, p < 0.001). This result demonstrates that big data analytics significantly support the implementation of circular economy initiatives by enabling firms to monitor resource usage, optimize production processes, and reduce waste. It underscores the importance of analytics-driven decision-making in facilitating environmentally sustainable business practices Regarding sustainable performance, BDAC shows a positive and significant direct effect, with an estimate of 0.230 (C.R. = 2.706, p = 0.007). Although this effect is weaker than its impact on the mediating variables, it indicates that analytics capabilities directly contribute to improvements in economic, environmental, and social performance. However, the relatively smaller coefficient suggests that the influence of BDAC on sustainable performance is more substantial when mediated through organizational capabilities. Consistent with this interpretation, Supply Chain Management Capabilities exert a significant positive effect on sustainable performance, with a coefficient of 0.280 (C.R. = 3.182, p = 0.001). This finding highlights the central role of supply chain integration and coordination in achieving sustainability outcomes. Firms that effectively manage their supply chains are better positioned to reduce resource inefficiencies and enhance overall sustainability performance. Electronic Customer Relationship Management also significantly influences sustainable performance, with an estimated coefficient of 0.260 (C.R. = 3.023, p = 0.002). This result indicates that strong digital customer management contributes to sustainability by improving demand forecasting, reducing overproduction, and strengthening social performance through better customer engagement. Furthermore, Circular Economy Practices have a significant positive effect on sustainable performance, with a coefficient of 0.240 (C.R. = 2.857, p = 0.004). This finding confirms that the adoption of circular strategies, such as resource efficiency and waste reduction, plays a crucial role in enhancing sustainability outcomes.

Finally, sustainable performance has a strong and significant effect on competitive advantage, with an estimated coefficient of 0.520 (C.R. = 5.417, p < 0.001). This result demonstrates that firms achieving superior sustainability performance are more likely to gain competitive advantages, including improved differentiation, enhanced reputation, and long-term market competitiveness. Overall, the structural model results support all proposed hypotheses and confirm that Big Data Analytics Capabilities indirectly enhance competitive advantage through their positive effects on organizational capabilities and sustainable performance.

Table 4. Hypothesis Test Result (Region weights)

Dependent		Independent	Estimate	S.E.	C.R.	P
SCMC	<---	BDAC	0.620	0.110	5.636	***
eCRM	<---	BDAC	0.580	0.106	5.472	***
CEP	<---	BDAC	0.540	0.102	5.294	***
Sustainable_Performance	<---	BDAC	0.230	0.085	2.706	0.007
Sustainable_Performance	<---	SCMC	0.280	0.088	3.182	0.001
Sustainable_Performance	<---	eCRM	0.260	0.086	3.023	0.002
Sustainable_Performance	<---	CEP	0.240	0.084	2.857	0.004
Competitive_Advantage	<---	Sustainable_Performance	0.520	0.096	5.417	***

Source: Processed Primary Data, 2026

DISCUSSION

This section is also a significant part of the research articles and is also usually the longest part of an article. A discussion of the research presented in this section is the result the process of data analysis, such as statistical calculations or other methods for the achievement of its study. Please present the discussion narratively.

The purpose of this study was to examine how Big Data Analytics Capabilities (BDAC) contribute to sustainable performance and competitive advantage among batik MSMEs in Central Java, with Supply Chain Management Capabilities (SCMC), Electronic Customer Relationship Management (e-CRM), and Circular Economy Practices (CEP) acting as mediating mechanisms. Overall, the findings provide strong empirical support for the proposed conceptual model and extend prior literature on digital capabilities and sustainability in the context of traditional creative industries.

The results indicate that BDAC has a significant positive effect on SCMC, e-CRM, and CEP. This finding aligns with previous studies suggesting that data analytics enhances organizational coordination, information sharing, and responsiveness across business functions (Gupta & George, 2016; Wamba et al., 2017). In the batik MSME context, BDAC enables firms to improve production planning, supplier coordination, and inventory control, thereby strengthening supply chain integration. This result supports the argument that analytics-driven insights serve as an enabling infrastructure for developing higher-order operational capabilities (Mikalef et al., 2020).

Furthermore, the significant effect of BDAC on e-CRM confirms that analytics capabilities enhance firms' ability to manage customer data, understand market demand, and personalize customer interactions. Consistent with Kumar et al. (2013) and Hullova et al. (2016), this study demonstrates that e-CRM supported by analytics not only improves customer relationship quality but also contributes to sustainability by reducing demand uncertainty and overproduction. This is particularly relevant for batik MSMEs, which often face fluctuating demand and limited forecasting accuracy.

The findings also reveal a significant relationship between BDAC and Circular Economy Practices. This result corroborates prior research emphasizing the role of data analytics in enabling circular business models through real-time monitoring of resource use and waste generation (Kristoffersen et al., 2021; Modgil et al., 2021). In traditional industries such as batik, where production processes are resource-intensive, analytics-driven CEP allows firms to reduce material waste, optimize water usage, and improve environmental performance.

Regarding sustainable performance, the results show that BDAC has both a direct and indirect effect. However, the indirect effects through SCMC, e-CRM, and CEP are stronger, indicating partial mediation. This finding reinforces the view that BDAC alone is insufficient to generate sustainability outcomes unless embedded within organizational processes (Raut et al., 2019). Among the mediators, SCMC exhibits the strongest effect on sustainable performance, highlighting the critical role of supply chain integration in achieving sustainability. This is consistent with Lee et al. (2016), who emphasize that sustainability initiatives are most effective when implemented collaboratively across supply chain networks.

Similarly, e-CRM and CEP significantly enhance sustainable performance, supporting the triple bottom line perspective. e-CRM contributes to social and economic dimensions by strengthening customer relationships and market responsiveness, while CEP primarily enhances environmental and long-term economic performance. These results suggest that sustainability in MSMEs is multidimensional and requires the simultaneous development of digital, relational, and environmental capabilities.

Finally, the results confirm that sustainable performance has a strong positive effect on competitive advantage. This finding supports prior studies arguing that sustainability-oriented firms achieve superior differentiation, legitimacy, and long-term competitiveness (Hart, 1995;

Porter & Kramer, 2011). For batik MSMEs, improved sustainability performance enhances brand reputation, compliance with environmental regulations, and access to environmentally conscious markets, thereby strengthening competitive positioning.

Overall, this study extends the Resource-Based View by demonstrating that BDAC functions as a foundational digital resource whose value is realized through complementary sustainability-oriented capabilities. The findings highlight the importance of integrating digital transformation with supply chain management, customer relationship management, and circular economy practices to achieve sustainable competitive advantage in traditional MSME contexts.

CONCLUSION

This study examined the role of Big Data Analytics Capabilities in enhancing sustainable performance and competitive advantage among batik MSMEs in Central Java, with Supply Chain Management Capabilities, Electronic Customer Relationship Management, and Circular Economy Practices as mediating variables. Drawing on the Resource-Based View, the study proposed and empirically tested an integrated model using Structural Equation Modeling.

The findings demonstrate that BDAC significantly strengthens SCMC, e-CRM, and CEP, confirming that analytics capabilities act as an enabling digital infrastructure for developing higher-order organizational capabilities. Moreover, BDAC directly influences sustainable performance, although its impact is substantially enhanced through the mediating roles of SCMC, e-CRM, and CEP. This result highlights that sustainability outcomes are not driven by technology adoption alone but require the integration of data-driven insights into operational, relational, and environmental practices.

Among the mediators, SCMC plays the most prominent role in enhancing sustainable performance, underscoring the importance of supply chain integration and coordination in achieving sustainability goals. e-CRM contributes by improving customer engagement, demand forecasting, and social performance, while CEP enhances environmental efficiency and long-term economic resilience. Together, these capabilities enable batik MSMEs to balance economic growth, environmental responsibility, and social value creation.

Importantly, the study confirms that sustainable performance significantly enhances competitive advantage. This finding reinforces the strategic relevance of sustainability, demonstrating that firms achieving superior sustainability outcomes are better positioned to differentiate themselves, gain stakeholder trust, and sustain competitiveness in dynamic markets. For batik MSMEs, sustainability-driven competitive advantage manifests in improved reputation, regulatory compliance, and access to broader markets.

Theoretically, this study contributes to the literature by extending the Resource-Based View through the integration of digital analytics and sustainability capabilities in a traditional creative industry context. It provides empirical evidence that BDAC is a higher-order capability whose strategic value depends on complementary organizational capabilities. Empirically, the study addresses a gap by focusing on MSMEs in the batik industry, an underexplored sector in digital sustainability research.

From a practical perspective, the findings offer important implications for MSME owners and policymakers. MSMEs should prioritize not only the adoption of data analytics technologies but also the development of supply chain integration, digital customer management, and circular economy practices. Policymakers can support this transformation by providing training, digital infrastructure, and incentives for sustainability-oriented innovation. Overall, the study demonstrates that the integration of big data analytics and sustainability strategies is a viable pathway for enhancing long-term competitiveness in traditional MSMEs.

Limitations And Future Research

Despite its contributions, this study has several limitations that provide avenues for future research. First, the cross-sectional design limits the ability to capture dynamic changes in analytics capabilities and sustainability performance over time. Future studies are encouraged to employ longitudinal designs to examine capability development and causal relationships. Second, the data rely on self-reported measures, which may be subject to common method bias. Incorporating objective performance indicators could enhance result robustness. Third, the sample focuses solely on batik MSMEs in Central Java, which may limit generalizability. Future research could extend the model to other creative industries, regions, or countries and explore moderating variables such as government regulation, digital literacy, or organizational culture.

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