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Evaluating the Role of Open Innovation and Circular Economy in Enhancing Organizational Performance: Insights from Batik Small and Medium Enterprises in Banyuwangi, Indonesia

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Abstract: Batik SMEs are key contributors to Indonesia's heritage and economy. Their inability to fully harness innovative and sustainable practices threatens not only their survival but also their contribution to economic development. However, their path to sustainability is hindered by many limitations in adopting circular economy (CE) principles; a framework widely acknowledged to enhance organizational performance. This study examines and evaluates the application of innovation within Indonesia's batik SME sector, focusing on the simultaneous impact of open innovation and circular economy principles—an area that has been largely unexplored within this specific sector. Our study analyzes the influence of open innovation and circular economy on organizational performance, measured via simulations among 70 Batik SMEs in Banyuwangi, Indonesia, using Structural Equation Modeling–Partial Least Square (SEM-PLS). The results reveal that while both open innovation and CE enhance performance, some dimensions of CE—such as waste reduction—prove less relevance to the business models of Batik SMEs based on model iteration. Moreover, this includes a discussion about several elimination items within the iteration. These findings suggest that Batik SMEs benefit more from resource optimization and innovation networks than from rigid waste management practices. In conclusion, integrating open innovation with tailored circular economy strategies can improve the operational efficiency and sustainability of Batik SMEs, enabling them to better compete and grow. This research highlights the need for context-specific adaptations of CE principles to ensure their practical impact on different sectors, emphasizing the role of innovation in overcoming resource limitations.

Keywords: open innovation; circular economy; organizational performance; batik SMEs

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1. Introduction

Batik is a traditional dyeing technique involving the application of wax to fabric to create intricate patterns, preventing dye from penetrating the wax-covered areas. Originating in Indonesia, batik is also practiced in countries such as Malaysia, China, Sri Lanka, India, and several African nations, with each region adding its unique style and cultural significance. It serves as both an artistic expression and a cultural symbol, with diverse methods that reflect the rich heritage of the regions where it is practiced [1]. Batik small and medium enterprises (SMEs) face urgent and multifaceted challenges in achieving global competitiveness [2]. This issue is further exacerbated by a lack of alignment with evolving consumer demands, leading to missed opportunities for growth [3]. Compounded by insufficient resources for innovation, many SMEs are unable to adapt to rapid changes in market trends [4]. Moreover, while environmental sustainability is increasingly essential, many SMEs lack the necessary resources to implement green practices, further weakening their market positioning [5].

To address these challenges, adopting a sustainable framework such as the circular economy (CE) is crucial. While the potential benefits of a CE are well-established, the role of institutional pressures in shaping organizational behavior is less well-known. Institutional theory shows how external pressures—such as market demands, cultural expectations, and regulatory requirements—shape the adoption of open innovation and circular economy practices. This perspective is particularly relevant for Batik SMEs, which operate within a complex network of cultural and economic influences.

Innovation can indeed help batik businesses adopt circular economy (CE) practices by promoting more sustainable products and improving production efficiency [6]. However, this transition is not easy, especially for many SMEs, including the batik industry, due to their limitations. For instance, the adoption of eco-friendly materials can be costly, posing a significant financial challenge for these businesses. The cost barrier becomes a critical concern, as many SMEs lack the capital or resources to invest in new technologies or innovative methods. The traditional methods they rely on often use cheaper but environmentally harmful materials and processes. Shifting to more sustainable alternatives, such as natural dyes, not only requires a different skill set but also incurs higher costs in sourcing raw materials, labor, and machinery upgrades. This can lead to reluctance to adopt CE practices, as the short-term financial burden may overshadow the long-term environmental and economic benefits.

Despite these challenges, research plays a crucial role in demonstrating how innovation aligned with CE principles can ultimately improve the performance and competitiveness of batik products. Studies need to explore cost-effective strategies and provide evidence on how adopting sustainable practices can increase efficiency, reduce waste, and enhance the quality of batik, making it more durable and valuable in the market. On a global scale, the potential of CE is immense, with estimates showing that only about 9% of the economy currently operates in a circular manner, highlighting significant opportunities for growth and improvement [7]. Integrating CE principles into business models not only promotes sustainability but also enhances competitive advantage. Companies that adopt CE practices can reduce costs, innovate their products, and increase resource efficiency, positioning themselves well in a global market with limited resources. For example, CE encourages companies to rethink their resource management strategies, leading to optimal resource use and waste reduction [8]. This transformation is particularly relevant in industries such as construction and fashion, where adopting circular practices can significantly enhance market differentiation and competitiveness [9]. However, many Batik SMEs do not fully understand the benefits associated with the circular model.

This study examines and evaluates the application of innovation within Indonesia's batik SME sector, focusing on the simultaneous impact of open innovation and circular economy principles—an area that has been largely unexplored within this specific sector. While previous research has looked at these constructs individually, this study fills a critical gap by addressing their dynamic interactions within the unique context of batik SMEs. This includes cultural heritage, a unique case, and a crucial economic driver in Indonesia. This study highlights the critical need for open innovation and circular economy principles to take root in the batik SME sector. These concepts are essential for fostering sustainability and business growth, yet they remain underutilized in this traditional industry.

By developing a comprehensive model that integrates these concepts, this study offers a deeper understanding of how innovation can enhance the performance of batik SMEs. It not only addresses theoretical gaps in the literature but also provides practical strategies for implementation, enabling batik SMEs to evolve in line with global market demands. The research aims to promote sustainability, increase competitiveness, and strengthen the economic and cultural significance of batik, ensuring its continued relevance in an increasingly complex and eco-conscious business environment.

2. Materials and Methods

2.1. Open Innovation

Open innovation is a concept that has garnered increasing attention in innovation management. It involves the systematic exploration, retention, and exploitation of knowledge both within and beyond organizational boundaries during the innovation process [9]. This approach emphasizes the inflow and outflow of knowledge to accelerate internal innovation and expand markets for external use of innovation [10]. OI contrasts with traditional closed innovation models, where firms rely solely on their internal resources and capabilities. The shift towards OI reflects a growing recognition that collaboration with external partners—such as customers, suppliers, and even competitors—can lead to more effective and efficient innovation outcomes [11,12]. A systematic literature review highlights the various themes in OI research, including the motivations for adopting OI, the types of external partners involved, and the impact of OI on innovation performance [13]. Their findings suggest that SMEs that engage in OI activities tend to achieve higher levels of innovative performance, particularly in terms of new product development and market success. This is supported by researchers who found that OI activities positively correlate with multiple dimensions of innovation performance, including financial success and customer satisfaction [11].

Open innovation, characterized by collaborating with external stakeholders to develop new ideas and technologies, has been recognized as a pivotal driver in the transition to a circular economy. The shift to a circular economy poses practical challenges for businesses as they move from a linear to a circular economic model [14].

2.2. Circular Economy

The circular economy represents a sustainable economic model to minimize waste and resource consumption. Industries known for their traditional craftsmanship and cultural values, such as the batik industry, can benefit from circular economy practices like material reuse, waste reduction, and sustainable production processes [15]. Research indicates that SMEs adopting CE practices can experience improved operational performance and innovation outcomes. For instance, it discusses how cooperation—collaboration between competitors—can facilitate sharing of the resources and knowledge necessary for implementing CE initiatives [16]. This collaborative approach is particularly beneficial for SMEs, which often lack the resources to develop circular solutions independently.

However, the transition to a circular economy is fraught with challenges. Barriers such as limited access to funding, lack of awareness, and insufficient regulatory support can impede the adoption of CE practices in SMEs [17,18]. A systematic review identifies key barriers to implementing CE in a regional context, emphasizing the need for supportive policies and frameworks that encourage SMEs to embrace circular practices [17]. By embracing the principles of the circular economy, the batik industry can play a significant role in environmental protection, resource efficiency, and sustainable economic development.

2.3. Organizational Performance

Organizational performance is a multifaceted concept that encompasses various dimensions, including financial performance, operational efficiency, and overall effectiveness in achieving strategic goals. It is a central focus in management research, with numerous studies investigating factors that influence and contribute to organizational success [19]. The structure of organizations is influenced by economic constraints and contextual variables, subsequently impacting organizational performance [20].

A study highlights the importance of internal control systems in enhancing the organizational performance of SMEs in Nigeria. The research found that effective internal control mechanisms significantly contribute to business growth, profitability, and operational efficiency, suggesting that SMEs must prioritize robust control environments to achieve their performance objectives [21]. Similarly, research on ambidextrous organizational learning reveals that absorptive capacity—an organization's ability to recognize, assimilate, and

apply external knowledge—positively influences performance outcomes in SMEs [22]. This finding underscores the importance of fostering a learning-oriented culture, encouraging innovation and adaptability. This perspective highlights the interconnectedness of operational practices and performance outcomes, emphasizing the need for SMEs to adopt sustainable approaches to remain competitive.

Research demonstrates that integrating green human resource management with circular economy initiatives positively impacts organizational performance in the service sector [23]. This study highlights the importance of aligning human resource practices with sustainability goals to foster a culture of innovation and responsibility within SMEs. Additionally, it discusses the role of absorptive capacity in developing circular economy business models, emphasizing that SMEs must enhance their ability to absorb and utilize external knowledge to successfully implement CE practices [24].

2.4. Institutional Theory

Coercive pressures arise from regulatory requirements or policies that mandate sustainable practices, compelling organizations to comply with legal and environmental standards. For instance, Rizos et al. highlight that regulatory frameworks can serve as both barriers and enablers for SMEs in adopting circular economy practices, emphasizing the necessity for compliance with environmental regulations to enhance sustainability [25]. Similarly, Yu et al. discuss how institutional pressures drive firms to engage in eco-innovation, suggesting that adherence to external regulations is crucial for gaining legitimacy and competitive advantage [26].

Normative pressures reflect the influence of industry norms and societal expectations that advocate for eco-friendly practices. This aligns with findings by Zamfir et al., who indicate that the national context and sector-related factors significantly affect sustainable business decisions among SMEs, thereby reinforcing the importance of societal expectations in shaping organizational behavior [27]. Furthermore, Marino emphasizes the role of societal and economic dynamics in the transition to a circular economy, suggesting that SMEs must align their practices with these evolving norms to remain competitive [28]. In the context of Batik SMEs, these institutional pressures collectively drive the adoption of sustainable business models. By aligning with external expectations, SMEs can improve resource efficiency, minimize waste, and enhance overall organizational performance. This framework positions institutional theory as a vital lens through which to analyze the integration of open innovation and circular economy practices, as it underscores the significance of external influences in shaping organizational strategies and behaviors.

2.5. Formulation of Hypotheses

The first step is to create a conceptual model. This model serves as a basic structure to visually and theoretically represent abstract concepts and the relationship between their constructs. Figure 1 is an elaboration scheme illustrating the relationship between *Open Innovation*, *Circular Economy*, and *Organizational Performance*. *Open Innovation* (Inbound/Outbound) drives the circular economy, which impacts organizational performance (both Financial and Non-Financial). Sustainability pillars, such as the environment, economy, social, and community, support the implementation of the circular economy to holistically enhance organizational performance. Figure 2 shows the model elaboration scheme used to obtain the conceptual model of this research. This elaboration scheme illustrates the linkages between open innovation, circular economy, and organizational performance. It highlights two dimensions of open outbound innovation, emphasizing their role in stakeholder engagement and their impact on financial and non-financial performance. The circular economy is a key framework, integrating sustainable practices that improve resource efficiency and drive green innovation across environmental, economic, and social dimensions.

This framework identifies open innovation as an independent variable, characterized by dimensions such as inbound innovation and outbound innovation [29]. The circular

economy, also considered an independent variable, includes environmental, economic, and social dimensions [30,31]. In contrast, organizational performance is the dependent variable, including financial and non-financial performance dimensions [32]. This structure makes it possible to examine how open innovation and circular economy practices impact different aspects of organizational performance.

This hypothesis posits that the principles of open innovation significantly enhance the capacity of small and medium-sized enterprises (SMEs) to adopt circular economy practices. As defined by Chesbrough, open innovation emphasizes the importance of leveraging external ideas, knowledge, and technologies alongside internal resources to foster innovation [33]. In the circular economy context, which focuses on minimizing waste and maximizing resource efficiency, integrating external insights can provide SMEs with the necessary tools and strategies to transition from linear to circular business models. Research indicates that SMEs often face barriers such as limited resources, lack of expertise, and insufficient access to information, which can impede their ability to implement circular practices effectively [27]. By engaging in open innovation, SMEs can collaborate with external stakeholders, including suppliers, customers, and research institutions, to co-create solutions that address these challenges. For instance, partnerships can facilitate knowledge sharing about sustainable materials, recycling technologies, and innovative product designs that align with circular economy principles [34]. This collaborative approach not only enhances the innovation capacity of SMEs but also fosters a culture of sustainability that is essential for the successful adoption of circular practices.

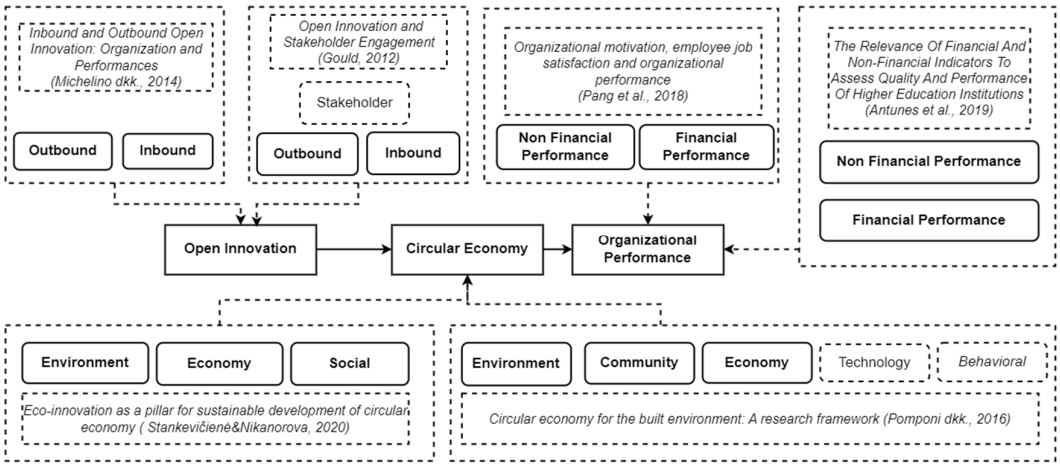

Figure 1. Elaboration scheme [31–39].

Furthermore, open innovation can lead to the development of new business models prioritizing circularity, such as product-as-a-service or take-back schemes. These models reduce waste and create new revenue streams for SMEs, enhancing their economic viability [40]. By embracing open innovation, SMEs can position themselves as leaders in sustainability within their industries, ultimately contributing to a broader transition towards a circular economy.

H1: *Open innovation positively influences the adoption of circular economy practices in SMEs.*

This hypothesis suggests that adopting circular economy principles, facilitated by open innovation, leads to improved organizational performance in SMEs. The circular economy framework emphasizes resource efficiency, waste reduction, and sustainable practices, which can significantly enhance the operational effectiveness of SMEs [41]. By integrating these principles into their business models, SMEs can achieve cost savings, improve their competitive positioning, and foster customer loyalty. Research has shown that SMEs implementing circular economy practices often experience enhanced perfor-

mance metrics, including increased profitability and market share [42]. The emphasis on sustainability can enhance brand reputation and attract environmentally conscious consumers, further driving sales and customer retention. Furthermore, the interaction between the circular economy and open innovation can foster a positive feedback loop of ongoing enhancement. As SMEs engage in open innovation to develop circular products and services, they enhance their operational capabilities and generate valuable insights to inform future innovations [43]. This iterative process fosters a culture of learning and adaptation, enabling SMEs to respond effectively to changing market demands and regulatory pressures related to sustainability.

H2: *The integration of circular economy principles enhances the organizational performance of SMEs through open innovation.*

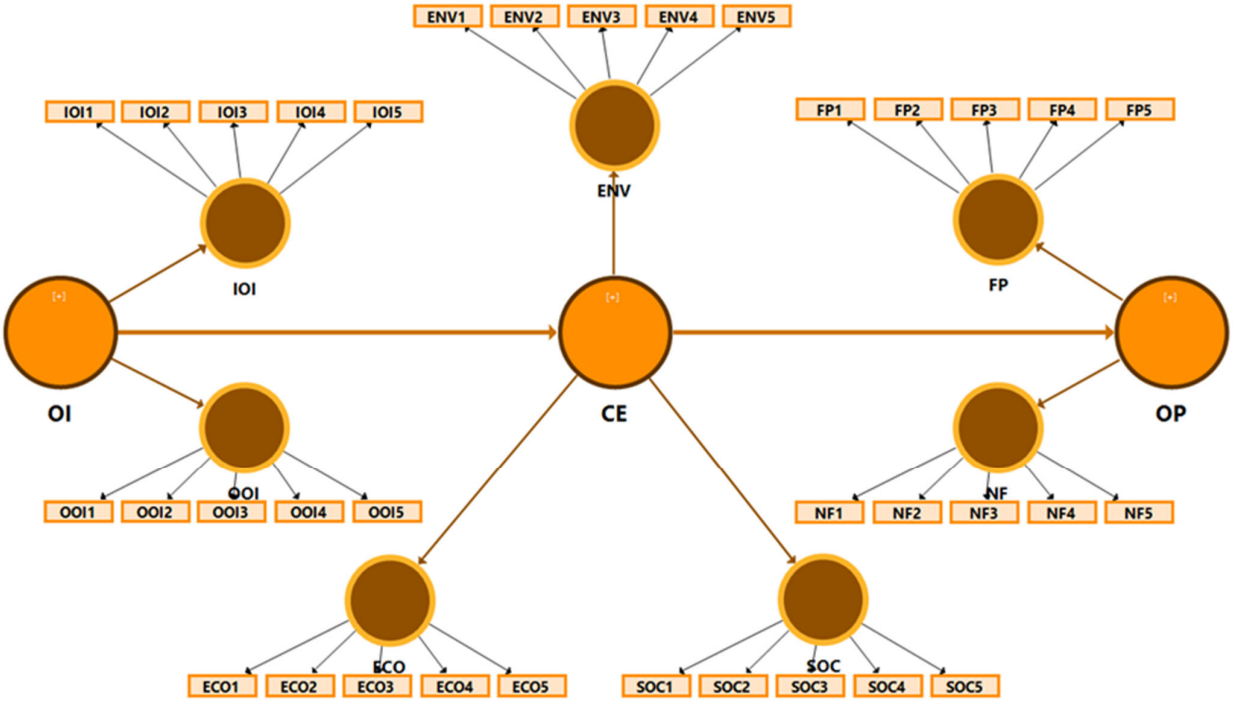

Figure 2. Relationships among the structural model in PLS-SEM (self-produced).

3. Research Methodology

3.1. Sample and Data Collection

In this study, questionnaires were used as the primary data collection instrument. The items were developed based on three main constructs: organizational performance, open innovation, and circular economy practices, discussed in Section 2. The research involved two phases of data collection: a pilot test to refine the questionnaire and the main data collection phase to evaluate the research model. The pilot test was conducted with 15 respondents from Batik SMEs in Banyuwangi, East Java, to ensure clarity and comprehension of the questions. Based on the feedback from this phase, adjustments were made to improve the wording and clarity of the questionnaire items.

The target population consisted of Batik SMEs in Banyuwangi, Indonesia. Purposive sampling was employed to ensure the inclusion of SMEs engaged in CE and OI practices. A total of 75 questionnaires were distributed, yielding 70 valid responses, which represents a 93% response rate. This high response rate indicates strong engagement from the target population, composed of business owners, managers, and other key decision-makers actively involved in innovation and sustainability strategies. Assistance was provided to ensure accurate and complete responses while maintaining respondent autonomy. Table 1

provides a detailed breakdown of respondent demographics, ensuring transparency and demonstrating the representativeness of the sample.

Table 1. Characteristics of the respondents.

Profile of Respondent	Category	Number of Respondents	(%)
Gender	Female	33	47.14
	Male	37	52.86
Respondent's role	Owner	42	60.00
	Stakeholder	23	32.86
	Employee	4	5.71
	Manager	1	1.43
Type of collection	Hardcopy	39	55.71
	Softcopy	31	44.29
Respondent's age	25–35 years	27	38.57
	35–45 years	2	2.86
	40–60 years	11	15.71
	45–65 years	30	42.86

The sample size of 70, while relatively small, is appropriate given the exploratory nature of this study and the focus on a specific SME subgroup. The inclusion of diverse roles, such as owners and managers, ensures that the findings reflect multiple perspectives on CE and OI adoption. Additionally, the collection period spanned from January to February 2024, allowing insights into practices during a stable operational period for Batik SMEs. Table 1 summarizes the characteristics of the respondents in this study.

3.2. Instrument Development

The survey was conducted by distributing 4-point Likert scale questionnaires through printed questionnaires to measure assessment indicators with a scale of 1, meaning strongly disagree, to a scale of 4, meaning strongly agree. Then, the collected data were processed using Smart-PLS 3 software and analyzed using structural equation modeling techniques with alternative partial least square methods. SEM is a robust statistical technique that allows for the examination of complex relationships among variables, including direct and indirect effects, which aligns more closely with our research objectives. Due to the small sample size of 70 respondents and the complexity of the research model involving direct interaction and mediation, it is suitable to use the Partial Least Squares (PLS) method [44]. The model evaluation techniques used are measurement models and structural models [45]. The construction description and related measurement indicators are given in Table 2.

Table 2. Measurement indicators for each variable.

Variable	Definition		
Open Innovation (OI)	**A collaborative and inclusive approach to innovation involves actively seeking and incorporating external ideas, knowledge, and resources. It represents a change from the traditional closed model of innovation.**		
	Definition	Code	Item(s)
Inbound Open Innovation (IOI)	Refers to the process of acquiring external knowledge, ideas, and technologies from outside sources to drive innovation within an organization.	IOI1	There is an acquisition of knowledge from external sources to drive innovation.
		IOI2	Ideas are acquired from external sources to drive innovation.
		IOI3	There is the acquisition of external technology from external sources to drive innovation.
		IOI4	There is expertise from external partners.
		IOI5	There is the development of new products or services.
Outbound Open Innovation (OOI)	The process of commercializing and leveraging internal knowledge, ideas, and technologies to create value outside the organization.	OOI1	There is a commercialization process to create value outside the organization.
		OOI2	Knowledge is utilized to create value outside the organization.
		OOI3	Ideas are utilized to create value outside the organization.
		OO4	Technology is utilized to create value outside the organization.
		OOI5	There are licensing agreements, joint ventures, or spin-offs to enhance organizational intellectual assets.
Circular Economy (CE)	**Sustainability paradigm that challenges traditional linear models of production and consumption. It aims to create a closed-loop system that maximizes resource efficiency and minimizes waste.**		
Environment (ENV)	It involves recovering and recycling materials, managing waste, and assessing the environmental consequences of the production and consumption of goods, such as textiles.	L1	There is environmental recovery due to the production/consumption of goods.
		L2	Materials are recycled due to the production/consumption of goods.
		L3	There is waste management.
		L4	There is an assessment of environmental consequences in the production of goods.
		L5	There is an assessment of the environmental consequences of the consumption of goods.
Economy (ECO)	It is creating circular business models that enhance value throughout the product lifecycle. It includes tackling economic challenges, adopting eco-friendly strategies, and assessing the return on investment (ROI) in circular economy initiatives.	E1	There is a development of circular business models.
		E2	There is a value-creation process in the product cycle.
		E3	There are strategies to address economic challenges.
		E4	Implementing environmentally friendly strategies.
		E5	Evaluating return on investment in circular economy initiatives.

Table 2. *Cont.*

Variable	Definition		
Social (SOC)	The social implications and benefits of circular practices, such as promoting sustainable production, addressing social challenges, engaging stakeholders in the transition towards circularity, and involving consideration of social and institutional dimensions to address material and energy outputs in the economy.	S1	There are social implications and benefits of circular economy practices.
		S2	There is a promotion of sustainable production.
		S3	There are strategies to address social challenges, involving stakeholders in the transition towards circularity.
		S4	Some institutions address material outputs in the economy.
		S5	Some institutions address energy in the economy.
Organizational Performance	**A comprehensive concept that includes various dimensions and indicators. Performance measurement and evaluation are important for organizations to identify areas for improvement, make informed decisions, and achieve long-term success.**		
Financial Performance (FP)	The assessment and measurement of an organization's financial results and outcomes as a component of its overall performance	FP1	There is a good understanding of financial performance.
		FP2	There is an assessment of financial performance to measure success.
		FP3	There is a financial evaluation.
		FP4	There is cost management.
		FP5	There is financial effectiveness reflecting organizational capability.
Non-Financial Performance (NF)	Refers to the evaluation and measurement of an organization's performance using indicators and metrics that are not directly related to financial outcomes	NF1	There is an evaluation of non-financial performance.
		NF2	There are aspects of customer satisfaction.
		NF3	There are aspects of operational efficiency.
		NF4	There is the use of non-financial indicators.
		NF5	There is a good understanding of non-financial performance.

4. Result and Findings

4.1. Measurement Model Evaluation

The formation of structural models is based on theory, logic, or the experience/research results of previous researchers. Reflective model measurement is seen from the loading factor and AVE, internal consistency (CR), convergent validity (AVE), and discriminant validity (Fornell–Larker criterion). The loading factor is the standardized estimated weight (estimate weight) that connects the factor with indicators. Standard factor loading is between 0 and 1. The loading factor is significantly valid if it is close to the value of 1; then the value of the weight (estimate weight) measurement model is becoming stronger. The AVE test can be used to see convergent and divergent validity [44].

The Average Variance Extracted (AVE) test results reflect the amount of variance captured by each latent construct in the reflective model. For a reflective model to be considered adequate, the AVE value must exceed 0.50, as values below this threshold indicate high levels of measurement error [46]. Additionally, the AVE value must surpass the cross-loading correlation values to confirm the model's discriminant validity. Table 3 shows the AVE results in this study, constructs such as "Open Innovation (OI)" and "Social (SOC)" show particularly strong AVE values of 0.785 and 0.967, respectively, demonstrating high convergent validity. These results indicate that the reflective model adequately captures the variance in the constructs while minimizing error. Furthermore, composite

reliability was used as an alternative to the Cronbach's Alpha test to measure convergent validity, with researchers noting that composite reliability values are typically higher and provide a more robust assessment of reliability.

Table 3. Composite reliability value and AVE.

Measurement Instrument	Cronbach Alfa	Composite Reliability (CR)	Average Variance Extracted (AVE)
Open Innovation (OI)	0.922	0.935	0.617
Economy (ECO)	0.868	0.910	0.717
Financial Performance (FP)	0.908	0.933	0.737
Inbound Open Innovation (IOI)	0.878	0.912	0.674
Environment (ENV)	0.895	0.927	0.761
Non-Financial Performance (NF)	0.872	0.908	0.663
Circular Economy (CE)	0.932	0.943	0.623
Outbound Open Innovation (OOI)	0.843	0.895	0.682
Organizational Performance (OP)	0.939	0.948	0.648
Social (SOC)	0.931	0.966	0.935

The loading factors represent the strength of the relationship between latent variables and their observed indicators. In this research, the standardized loading factors across all constructs are strong, as they are significantly closer to 1, indicating robust relationships between the factors and their indicators. The AVE values, which measure convergent validity, are all greater than 0.50, confirming that the latent constructs capture sufficient variance from their indicators. Constructs like "Open Innovation (OI)" and "Social (SOC)" show particularly strong AVE values of 0.617 and 0.935, respectively, implying high convergent validity. These results demonstrate that the model's constructs explain more than half of the variance in their indicators, with minimal measurement errors.

The composite reliability (CR) for all constructs exceeds the threshold of 0.70, which suggests strong internal consistency and reliability across the model. For instance, the CR for "Open Innovation," with a value of 0.935, and "Social," with a value of 0.966, indicate highly reliable constructs, while the lowest CR value, "Outbound Open Innovation," with a value of 0.895, still comfortably exceeds the minimum required threshold. These CR values are supported by high Cronbach Alpha scores, all above 0.70. While CR is generally more sensitive to latent variable reliability, the fact that both CR and Cronbach Alpha are consistently high highlights the robustness and internal consistency of the model.

Convergent validity is demonstrated through AVE scores, where all constructs show values above the minimum requirement of 0.50 [42]. The "Circular Economy", with a value of 0.623, and "Financial Performance", with a value of 0.737 constructs, for example, have AVE values indicating that they adequately represent their respective variables. Discriminant validity was assessed using the Fornell–Larcker criterion. The values in Table 4 suggest that all of the constructs meet the discriminant validity criteria. Specifically, the diagonal elements (square roots of the AVE) are higher than the off-diagonal correlations, indicating that each construct is distinct from the others. For instance, the "Circular Economy" (CE) construct has a value of 0.789, higher than its correlations with other constructs, confirming good discriminant validity.

Table 4. Structural model result.

	R-Square	R-Square Adjusted
Circular economy	0.584	0.578
Organizational performance	0.672	0.667

Discriminant validity relates to the principle that measures (manifest variables) of different constructs should not be correlated. The way to test discriminant validity is by looking at the following: (1) The cross-loading correlation value for each construct variable

must be > 0.70; (2) Comparing the Fornell–Larker Criterion value for each construct with the correlation value between constructs in the model; (3) Good discriminant validity is indicated by the Fornell–Larker Criterion value for each construct [44].

4.2. Structure Model Evaluation

The structural model evaluation is performed to test the hypotheses. There are several criteria for assessing the inner model based on R^2. The R-value for each construct is the predictive power of the structural model. The R-squared value is the result of a linear regression test, namely the amount of endogenous variability that can be explained by exogenous variables. An R^2 value of 0.67 indicates strong model strength, 0.33 indicates moderate strength, and 0.19 indicates weak strength. Less than 0.19 is considered no structural model strength [47]. Then, collinearity analysis was conducted using the Variance Inflation Factor (VIF).

In this research, the R^2 for "Organizational Performance", with a value of 0.672, demonstrates strong predictive power, meaning that 67.2% of the variance in organizational performance can be explained by the model. This suggests a solid ability to predict organizational performance based on the independent variables, notably the circular economy. Meanwhile, the R^2 for "Circular Economy" is 0.584, indicating a moderate-to-strong predictive power, with 58.4% of the variance in the circular economy explained by the model. This further reinforces the significance of the variables associated with circular economy practices, such as environmental and social factors, in predicting organizational outcomes. The adjusted R^2 values are slightly lower, as expected, due to adjustments for the number of predictors, but they remain robust, indicating that the model is well-fitted and stable. Collinearity was assessed using the Variance Inflation Factor (VIF), which helps to ensure that independent variables are not highly correlated with each other. A VIF value above 10 indicates the presence of multicollinearity, which can distort the regression coefficients and weaken the model's interpretability.

Table 5 shows that all VIF values are 1.00, well below the threshold, indicating no collinearity between variables. This result suggests that each construct independently contributes to the model without inflating the variance in other constructs, ensuring the accuracy and reliability of the results. This is crucial for understanding the relationships between open innovation, circular economy, and organizational performance. The structural model exhibits strong predictive power for organizational performance, with the R^2 values supporting the validity of the hypothesized relationships. The absence of multicollinearity, as indicated by VIF results, further confirms that the model's constructs are distinct and contribute meaningfully to the explanation of circular economy practices and organizational performance.

Table 5. Statistical test of collinearity.

Measurement Instrument	VIF	Conclusion
Open Innovation " Circular Economy	1.00	No collinearity
Circular Economy " Organizational Performance	1.00	No collinearity
Open Innovation " Inbound Open Innovation	1.00	No collinearity
Open Innovation " Outbound Open innovation	1.00	No collinearity
Circular Economy " Economy	1.00	No collinearity
Circular Economy " Environment	1.00	No collinearity
Circular Economy " Social	1.00	No collinearity
Organizational Performance " Financial Performance	1.00	No collinearity
Organizational Performance" Non-Financial Performance	1.00	No collinearity

4.3. Hypothesis Test

The path coefficient will describe the contribution or influence between construct variables. The significance value is expressed in the t-statistic test value, which uses a (two-tailed) t-value of 1.96 (significant level 5%). On the other hand, a path coefficient value close to +1 indicates a positive relationship, and a value close to -1 indicates a strong negative relationship [44]. The path coefficient values in this study suggest positive correlations between constructs, with the circular economy significantly influencing organizational performance and open innovation having a significant impact on the circular economy. The significance evaluation through the bootstrapping procedure confirms the rejection of the null hypothesis, indicating that both circular economy and open innovation constructs significantly contribute to the respective dimensions, supporting the research hypotheses. Additionally, as shown in Tables 6–8, significance values in the structural model relationships will be provided as constructs within each dimension of Open Innovation (OI), Circular Economy (CE), and Organizational Performance (OP).

Table 6. Significance of structure relationship.

Hypothesis		Path Coefficient	T-Statistic	*p*-Value	Conclusion
H1	CE " OP	0.820	104.016	0.000	Accept
H2	OI " CE	0.764	32.094	0.000	Accept

Table 7. Significance of open innovation with its dimension.

Hypothesis	Path Coefficient	T-Statistic	*p*-Value	Conclusion
OI " OOI	0.943	193.462	0.000	Accept
OI " IOI	0.963	261.902	0.000	Accept

Table 8. Significance of circular economy with its dimension.

Hypothesis	Path Coefficient	T-Statistic	*p*-Value	Conclusion
CE " ENV	0.927	4.427	0.000	Accept
CE " SOC	0.799	102.154	0.000	Accept
CE " ECO	0.919	208.422	0.000	Accept

As seen in Table 6, the relationship between "Circular Economy" (CE) and "Organizational Performance" (OP) has a path coefficient of 0.820, indicating a strong positive influence of circular economy practices on organizational performance. The t-statistic of 104.016, with a *p*-value of 0.000, supports the rejection of the null hypothesis, confirming the significant impact of CE on OP. Similarly, "Open Innovation" (OI) shows a strong positive relationship with "Circular Economy" (CE), as indicated by the path coefficient of 0.764. The t-statistic of 32.094 and a *p*-value of 0.000 further confirm the significance of this relationship, suggesting that open innovation practices positively drive circular economy initiatives within organizations.

Table 7 highlights the path coefficients and significance values for open innovation and its dimensions: inbound open innovation (IOI) and outbound open innovation (OOI). The path coefficients for "OI " IOI", with a value of 0.963, and "OI " OOI", with a value of 0.943, indicate that open innovation has a highly significant influence on both dimensions. The t-statistic values for each dimension, namely IOI and OOI, are 193.426 and 261.902, with the same *p*-values of 0.000, suggesting that both inbound and outbound innovation are crucial components of the overall open innovation construct. These dimensions significantly contribute to driving organizational openness and innovation practices.

The results in Table 8 show that the circular economy significantly influences its underlying dimensions: environment (ENV), social (SOC), and economy (ECO). The path

coefficients, all close to or exceeding 0.80, reflect strong positive relationships. For instance, "CE " ECO" has a path coefficient of 0.919 and a t-statistic of 208.422, indicating a significant impact of circular economy practices on economic performance. Similarly, "CE " ENV" and "CE " SOC" are also significant, with *p*-values of 0.000, confirming the influence of the circular economy on both environmental and social outcomes within organizations.

Table 9 provides insights into the relationship between organizational performance and its financial (FP) and non-financial (NF) performance dimensions. Both dimensions show strong positive path coefficients: "OP " FP", with a value of 0.966, and "OP " NF", with a value of 0.959, with extremely high t-statistics (326.674 and 143.618, respectively). This suggests that organizational performance, as influenced by circular economy and innovation, strongly drives both financial and non-financial outcomes. The *p*-values of 0.000 further confirm that these relationships are highly significant.

Table 9. Significance of organizational performance with its dimensions.

Hypothesis	Path Coefficient	T-Statistic	*p*-Value	Conclusion
OP " FP	0.966	326.674	0.000	Accept
OP " NF	0.959	143.618	0.000	Accept

The path coefficient analysis confirms the significance of the relationships between open innovation, circular economy, and organizational performance. All path coefficients are positive and significant, with t-statistics and *p*-values demonstrating strong support for the research hypotheses. Open innovation significantly influences both inbound and outbound innovation practices, while circular economy practices positively impact environmental, social, and economic outcomes. Ultimately, these factors lead to improved organizational performance, both in financial and non-financial terms.

In addition to analyzing the relationships between variables, it is crucial to examine the magnitude of their influence using effect sizes (f^2). According to [48], an f^2 value of 0.02 suggests a low effect size; values between 0.02 and 0.15 indicate a moderate effect size; and values of 0.35 or higher reflect a strong effect size [47,49]. Any f^2 value below 0.02 can be disregarded as having an insignificant impact. Table 10 shows that the f^2 value between circular economy and organizational performance is 0.205, which means that the effect size value is included in the medium category because the f^2 value is in the range of 0.15–0.35. In comparison, the f^2 value for the relationship between open innovation and circular economy is 0.192, which indicates that the effect size value is included in the moderate category.

Table 10. f^2 values.

Construct	f^2
Circular Economy " Organizational Performance	0.205
Open Innovation " Circular Economy	0.192

The predictive relevance of the model is assessed using the Q^2 value. A Q^2 value higher than zero indicates that the model has predictive relevance for the dependent construct, meaning the model can accurately predict the outcome. Conversely, a Q^2 value below zero indicates that the model has little or no predictive power for that construct [44]. Table 11 shows the results of the Q2 values for this study.

Table 11. Q^2 values.

Construct	Q^2
Organizational Performance	0.430
Circular Economy	0.360
Open Innovation	-

5. Discussion

The measurement model evaluation reveals that Social (SOC) is the most significant construct, with the highest loading factor, an AVE value of 0.967, and a CR of 0.966. However, the Outbound Open Innovation (OOI) construct has the lowest values among the constructs. The AVE for OOI is 0.682, and its Composite Reliability (CR) is 0.895, both of which, while above the required thresholds for validity and reliability, are comparatively lower than those of SOC.

This comparison indicates that while OOI remains a valid and reliable measurement instrument, it has a weaker influence than SOC. The lower AVE and CR values suggest that OOI explains slightly less variance than its indicators and has lower internal consistency. Therefore, while SOC has the most substantial impact on organizational outcomes, OOI is less significant in driving performance, highlighting the varying degrees of influence across different constructs in the model.

In the structural model evaluation, Organizational Performance (OP) has an R^2 value of 0.672, indicating strong predictive power, meaning that the model explains 67.2% of the variance in OP. This highlights that variables such as Circular Economy (CE) significantly influence OP, making this relationship highly reliable for predicting organizational outcomes. Meanwhile, the circular economy has a slightly lower R^2 value of 0.584, indicating moderate-to-strong predictive power, meaning 58.4% of CE is explained by variables like Open Innovation (OI). The practical implication is that improving CE practices—such as resource efficiency and sustainability—can directly enhance OP. The absence of collinearity, shown by VIF values of 1.00, ensures that each variable independently contributes to the model, reinforcing the stability and reliability of these findings. This indicates that adopting OI and CE strategies can effectively drive higher organizational performance, particularly in SMEs where innovation and sustainability are key drivers of success.

The path coefficient analysis provides clear insights into the relationships between variables. Circular Economy (CE) significantly impacts Organizational Performance (OP), with a strong path coefficient of 0.820 and a t-statistic of 104.016, confirming its substantial influence on improving organizational outcomes. Similarly, Open Innovation (OI) strongly affects CE, with a path coefficient of 0.764, suggesting that innovation practices are key drivers of sustainable initiatives within organizations. These results, with *p*-values of 0.000, confirm the rejection of the null hypothesis, meaning that both CE and OI contribute significantly to enhancing organizational performance.

Further analysis reveals that OI significantly influences both Inbound Open Innovation (IOI) and Outbound Open Innovation (OOI), with path coefficients of 0.963 and 0.943, respectively, indicating that these dimensions are crucial to the overall innovation process within organizations. Additionally, CE positively influences its underlying dimensions—environment, social, and economy—further confirming that CE practices are essential for sustainability. The path coefficient for CE to ECO is particularly strong, at 0.919, highlighting its substantial impact on economic performance. For instance, the analysis shows that all constructs—OI, CE, and OP—are strongly connected, and their positive relationships significantly improve both financial and non-financial organizational outcomes. The model also demonstrates strong predictive relevance, with Q^2 values of 0.430 for OP and 0.360 for CE, indicating that the model accurately predicts organizational outcomes.

CE significantly affects economic, environmental, and social outcomes, showing that sustainable practices benefit all of these areas. In turn, organizational performance drives financial and non-financial results, confirming that integrating CE and OI leads to broad,

impactful improvements. This implies that by adopting open innovation strategies, batik SMEs are better equipped to integrate CE practices into their business models, contributing to sustainable organizational growth. These results align with existing studies that emphasize the role of OI in promoting sustainable practices, further supported by the research of [50], who highlight the role of eco-innovation in the context of CE and firm growth. Additionally, the results align with institutional theory, emphasizing the importance of external drivers in shaping organizational strategies. By responding to these pressures, batik SMEs not only meet external expectations but also achieve improved financial and non-financial performance.

The adoption of Open Innovation (OI) and Circular Economy (CE) practices is evident among Batik SMEs, offering valuable insights for other sectors, such as construction, textiles, or other sectors. In the construction industry, OI emphasizes material innovations and collaborative partnerships to enhance sustainability, demonstrated by the integration of eco-friendly technologies to reduce environmental impacts [51]. Conversely, batik SMEs rely on informal and localized knowledge for OI, yet they share the construction sector's commitment to sustainability through practices. In agriculture, CE strategies focus on transforming agricultural byproducts into valuable resources, often supported by structured frameworks and government involvement [52]. While batik SMEs also work to repurpose production waste, they generally lack the systematic approaches seen in agriculture, relying instead on fragmented and informal methods [53]. The textile industry presents a closer comparison, emphasizing recycling and sustainable sourcing. However, both textile and batik SMEs face barriers like limited stakeholder engagement and restricted access [54]. Despite these challenges, the textile sector has made more progress, benefiting from investments in research and development and collaborative frameworks, which are often underutilized by Batik SMEs [55]. These differences highlight the unique financial, operational, and collaborative challenges that batik SMEs face, indicating a need for tailored interventions to effectively bridge gaps and adopt best practices from other sectors.

This study overall shows that adopting circular economy practices significantly enhances organizational performance in batik SMEs, especially within traditional industries. However, despite the clear benefits, various challenges and complexities may arise, potentially hindering the full realization of these advantages. Financially, adopting eco-friendly tools and natural dyes often requires substantial investments, with natural dyes being more expensive than synthetic alternatives due to their sourcing and production costs. Additionally, the lack of access to financial support mechanisms, such as loans or grants tailored for small enterprises, further exacerbates this challenge [55]. Furthermore, Batik SMEs often operate in isolation, limiting collaboration with external stakeholders and reducing their exposure to innovative ideas and structured CE frameworks. These challenges are compounded by bureaucratic complexities, such as navigating sustainability regulations, which hinder their participation in formal CE initiatives [56]. Addressing these barriers requires targeted financial assistance, such as subsidies or grants, alongside capacity-building initiatives and collaboration platforms to empower SMEs and support the effective implementation of OI and CE principles.

Recognizing and addressing these obstacles is essential for a more complete understanding of the CE-to-OP relationship in SMEs. Furthermore, circular economy practices act as a mediator in the relationship between open innovation and organizational performance. This suggests that the impact of OI on OP is partly achieved through the adoption of CE principles. SMEs that successfully combine OI and CE strategies are likely to experience higher performance outcomes compared to those relying solely on traditional innovation approaches. It is recommended that SMEs adopt CE and OI principles to improve efficiency and sustainability and strengthen external collaboration. Theoretically, further research across different sectors and geographical contexts is required to extend the validity of these findings, as well as adding new variables or using a longitudinal approach to gain a deeper understanding.

6. Conclusions

This study identifies organizational performance through a circular economy supported by open innovation. Each plays a role simultaneously in achieving more optimal organizational performance and supporting organizational goals. Through the research model produced in this study, the relationship and influence of the circular economy through open innovation support for organizational performance will be identified, as well as its analysis and implications; both implications for relevant theories or sciences and implications for managerial activities in the organization.

The magnitude of open innovation's influence on the circular economy in achieving optimal organizational performance will be a reference in evaluating the ability of SMEs to innovate and efforts to create a circular economy that supports the achievement of sustainable SMEs. This study was conducted using purposive sampling techniques, involving sample data of 70 SMEs. The results of this study provide empirical evidence showing the positive influence of the circular economy on organizational performance, where the circular economy is significantly influenced by open innovation. For example, a batik SME in Solo successfully adopted natural dyes sourced from agricultural waste, demonstrating how collaboration with local farmers can reduce production costs and environmental impact. Evidence from similar case studies shows that leveraging partnerships and knowledge-sharing platforms enables small enterprises to overcome financial and operational barriers, such as high costs of eco-friendly materials and a lack of formal training in sustainable practices. These examples emphasize that the practical application of OI and CE not only improves resource efficiency and market competitiveness but also aligns with growing consumer demands for sustainability. However, these benefits are achievable only with targeted interventions, including government subsidies, industry collaboration, and capacity-building programs. By drawing lessons from successful implementations, Batik SMEs and similar small enterprises can bridge the gap between theory and practice, integrating sustainability into their operations while preserving their cultural heritage.

Organizations that prioritize implementing a circular economy supported by open innovation are more likely to improve their performance more optimally, especially to survive the challenges of today's increasingly competitive business world. This can be achieved in various ways, such as optimizing the understanding and implementation of business activities that not only pay attention to economic aspects but also social and environmental aspects. Production activities that pay attention to waste for the environment need to achieve maximum orientation, especially for batik craftsmen in each SME. However, efforts to implement the circular economy concept need to obtain support from the abilities of each individual or stakeholder involved in making batik in SMEs. Support for innovation, especially open innovation, is very important for stakeholders to improve their ability to implement a circular economy. Open innovation is a powerful tool for organizations to tap into external sources of knowledge and ideas, which can lead to significant performance improvements. In addition, open innovation can be a valuable strategy for SMEs who want to tap into external sources of knowledge and ideas, which can lead to significant performance improvements. Organizations must be aware that, to implement the circular economy concept, there are several aspects that are needed, including environmental and social aspects.

6.1. Theoritical Implications

This research investigates the connection between Open Innovation (OI) and the Circular Economy (CE) within small and medium-sized batik businesses (batik SMEs) and its impact on organizational performance (OP). The analysis reveals a positive and significant relationship between OI practices and CE adoption in batik SMEs. Implementing OI strategies helps these businesses integrate CE principles into their business models, aligning with previous studies that emphasize the role of OI in promoting sustainable practices. Additionally, adopting CE directly contributes to improved organizational performance in traditional industries like batik, although some challenges remain in optimizing these

outcomes. These findings are consistent with earlier research highlighting the role of open innovation in fostering sustainable practices within organizations. Incorporating insights from Demirel and Danışman [50], who discuss the integration of eco-innovation and firm growth in the context of the circular economy, provides further depth to the discussion. Their findings highlight the evolving nature of SME operations in response to CE principles, indicating that organizational restructuring to align with CE concepts can significantly enhance performance. This highlights the multifaceted nature of factors influencing organizational performance beyond innovation alone.

6.2. Practical Implications

The results demonstrate that Circular Economy (CE) practices positively influence the organizational performance of batik SMEs, emphasizing the potential for CE strategies to improve operational efficiency, reduce waste, and enhance market competitiveness. However, challenges such as limited funding, lack of expertise, and regulatory hurdles can hinder the full realization of these benefits. Addressing these barriers is essential for maximizing the impact of CE on batik SMEs' performance.

The findings also reveal the mediating role of CE practices in the relationship between Open Innovation (OI) and organizational performance. This suggests that combining OI and CE can produce superior results, as businesses leveraging external knowledge networks while adopting circular business models achieve greater competitive advantages. Policymakers can play a pivotal role by introducing financial incentives, such as subsidies or grants, to encourage the adoption of CE practices. Additionally, educational programs and knowledge-sharing platforms can equip batik SMEs with the necessary skills to implement sustainable innovations. On a broader scale, collaborative industry initiatives, such as establishing sustainability-focused hubs or resource-sharing networks, can enhance the effectiveness of CE practices. These networks can facilitate partnerships between batik SMEs, suppliers, and academic institutions to co-develop innovative solutions for challenges like waste management and sustainable production. By integrating OI and CE strategies, batik SMEs can align with global sustainability goals, enhancing their contribution to environmental protection and economic development. These insights offer valuable guidance for policymakers, industry leaders, and entrepreneurs aiming to promote sustainability in traditional industries.

6.3. Limitations and Future Lines of Investigation

This study has several limitations that should be acknowledged. First, the sample was limited to batik SMEs in specific regions of Indonesia, which may not fully represent the diversity of the Indonesian SME sector. Expanding the geographic scope would provide a more comprehensive understanding of how Open Innovation (OI) and Circular Economy (CE) practices are adopted across various industries and contexts. Second, the reliance on self-reported questionnaire data introduces the possibility of respondent bias, which could affect the accuracy of the findings. Incorporating alternative data collection methods, such as interviews or observational studies, could provide deeper insights and validate the results. Additionally, this research is contextualized within the batik industry, which has unique cultural and operational characteristics. Therefore, the findings may not be generalizable to other sectors without adaptation to their specific contexts.

Future research can focus on the following key areas to build upon the findings of this study:

1. Future studies could employ more comprehensive methodology like Hierarchical Linear Modelling (HLM) to account for nested data structures, such as regional or industry-level variations in SME performance. This approach would enable a deeper understanding of how organizational-level factors and contextual influences shape the adoption and outcomes of Open Innovation (OI) and Circular Economy (CE) practices.
2. This study aligns with institutional theory by considering external pressures, such as regulations, market demands, and cultural norms, in influencing the adoption

of Open Innovation (OI) and Circular Economy (CE) practices. However, these aspects were not explicitly incorporated into the measurement model. Future research could integrate institutional theory or other complementary frameworks, such as the Resource-Based View (RBV), to analyze how external pressures interact with internal resources and capabilities. This approach would provide a more comprehensive understanding of the drivers, barriers, and enabling factors for sustainability in SMEs

3. Broadening the Scope with cross-sector and longitudinal studies. Expanding the research to include SMEs across various sectors and conducting longitudinal studies would offer insights into industry-specific challenges and the evolution of OI and CE practices over time. This approach could also identify best practices and sustainable strategies that are adaptable across diverse contexts.

By addressing these areas, future research can enhance the theoretical and practical understanding of the dynamics between innovation, circular economy, and organizational performance.

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