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Artificial Intelligence Adoption and SME Innovation Performance: Unpacking the Role of Absorptive Capacity and Knowledge Management Capability

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Abstract

Artificial intelligence (AI) technologies represent one of the most consequential innovation waves in the history of SME management, offering transformative potential for process automation, decision intelligence, customer personalization, and product innovation while simultaneously creating adoption barriers rooted in technical complexity, data infrastructure deficits, and managerial capability gaps. Grounded in the Knowledge-Based View (KBV) and Absorptive Capacity Theory (ACAP), this study examines how AI adoption intensity (AIAI) influences SME innovation performance (IP), with knowledge management capability (KMC) mediating this relationship and absorptive capacity (AC) moderating the AI adoption–KMC linkage. Using hierarchical regression analysis with PROCESS Macro moderated mediation testing (Model 7) applied to cross-sectional data from 467 SMEs across Japan, Ghana, and Brazil, findings demonstrate that AIAI positively predicts IP ($\beta = 0.398$, $p < .001$), with KMC partially mediating this relationship (indirect effect = 0.221, 95% CI [0.163, 0.283]). Absorptive capacity significantly moderates the AIAI–KMC relationship ($\beta\_interaction = 0.187$, $p < .01$), such that AI adoption generates stronger knowledge management improvements under high ACAP conditions. Moderated mediation is confirmed (index = 0.081, 95% CI [0.031, 0.141]), indicating that the mediated performance pathway strengthens with absorptive capacity. Multi-group analysis reveals significant cross-country heterogeneity, with Japanese SMEs exhibiting stronger ACAP moderation effects and Brazilian SMEs showing the strongest direct AIAI → IP effects. These findings advance ACAP theory in the AI adoption context and provide guidance for SME managers, AI solution providers, and innovation policy designers.

Keywords: artificial intelligence, SME innovation, absorptive capacity, knowledge management, moderated mediation, technology adoption, cross-national

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1. Introduction

The diffusion of artificial intelligence technologies across the small and medium enterprise (SME) sector represents one of the most consequential and theoretically complex phenomena in contemporary innovation management research. AI technologies—encompassing machine learning, natural language processing, computer vision, predictive analytics, and intelligent process automation—have until recently been the exclusive preserve of large technology corporations with substantial data infrastructure and specialized human capital. However, the commoditization of AI through cloud-based API services, no-code AI platforms, and SME-targeted AI solution providers has dramatically lowered the entry barriers to AI adoption, enabling SMEs of modest resource endowments to integrate AI capabilities into marketing, operations, customer service, product development, and strategic decision-making processes (Chui et al., 2022; Davenport & Ronanki, 2018).

Yet the innovation performance implications of AI adoption for SMEs remain empirically contested and theoretically underdeveloped. A growing body of case study and descriptive evidence documents productivity improvements, cost reductions, and customer experience enhancements from AI adoption in SME contexts (OECD, 2021; WEF, 2022), but rigorous quantitative studies examining the mechanisms through which AI adoption generates innovation performance improvements—and the organizational capability conditions under which these mechanisms operate most effectively—are scarce, particularly in developing economy SME contexts where data infrastructure and AI literacy constraints create distinctive adoption and performance dynamics.

Cohen and Levinthal's (1990) Absorptive Capacity Theory (ACAP)—which posits that a firm's ability to recognize the value of new external knowledge, assimilate it, and apply it to commercial ends is a function of its prior related knowledge base—provides a theoretically compelling framework for analyzing the AI adoption–innovation performance relationship. AI technologies function as external knowledge sources that generate performance value only when firms possess the absorptive capacity to assimilate AI-generated insights, integrate them with existing organizational knowledge bases, and apply them to product and process innovation decisions. Without adequate absorptive capacity, AI adoption may generate data without insight, automate processes without strategic learning, and predict patterns without organizational adaptation—leaving innovation performance potential unrealized.

Knowledge management capability (KMC)—the organizational capacity to systematically acquire, organize, share, apply, and protect knowledge assets—represents the proximate organizational mechanism through which absorptive capacity converts AI-generated inputs into innovation performance outputs (Zahra & George, 2002; Grant, 1996). KMC functions as the organizational infrastructure that enables AI adoption's knowledge-generative potential to be translated into actionable innovation insights, team-level learning, and product development improvements.

The three-country comparative design—Japan, Ghana, and Brazil—provides institutional and capability diversity that

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enables cross-national ACAP moderation testing. Japan's advanced manufacturing and innovation management ecosystems suggest high average absorptive capacity levels; Brazil's mixed-development SME context provides intermediate ACAP heterogeneity; Ghana's emerging technology SME ecosystem provides a context of lower average ACAP with high variance—creating the cross-national statistical leverage needed to identify ACAP moderation effects.

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2. Literature Review

2.1 Knowledge-Based View and AI as Organizational Knowledge Source

Grant's (1996) Knowledge-Based View positions knowledge as the primary source of sustainable competitive advantage, with innovation performance emerging from the organization's ability to integrate diverse knowledge inputs through specialized capabilities, organizational routines, and team coordination mechanisms. In the AI adoption context, KBV predicts that AI's innovation performance value derives primarily from its capacity to generate novel, high-velocity knowledge inputs—predictive analytics revealing customer preference patterns, machine learning algorithms identifying operational optimization opportunities, natural language processing enabling systematic synthesis of customer feedback—that augment human cognition in innovation-relevant decision-making.

Davenport and Ronanki (2018) provided an influential taxonomy of AI business applications—automated intelligence, assisted intelligence, and augmented intelligence—that maps AI's knowledge contribution to organizational processes. For SME innovation performance, augmented intelligence applications—where AI enhances human decision-making rather than replacing it—are theoretically most relevant, as they create conditions for the iterative knowledge integration through which innovation insights are developed, tested, and refined.

2.2 Absorptive Capacity Theory: Foundations and AI Extensions

Cohen and Levinthal's (1990) ACAP framework identifies prior related knowledge as the primary determinant of an organization's ability to value, assimilate, and exploit external knowledge. Zahra and George (2002) subsequently disaggregated ACAP into potential absorptive capacity (PACAP: knowledge acquisition and assimilation) and realized absorptive capacity (RACAP: knowledge transformation and exploitation), with the PACAP→RACAP conversion efficiency emerging as a key driver of innovation performance outcomes.

The application of ACAP to AI adoption contexts introduces theoretical nuances that prior applications to R&D spillovers and licensing contexts did not encounter. AI knowledge is distinctive in that it is continuously regenerated rather than one-time transferred—AI systems learn and improve through use, generating an ongoing stream of knowledge inputs that require repeated assimilation and application. This dynamic character of AI knowledge generation implies that ACAP is not merely a one-time adoption enabler but a continuous innovation capability conditioner

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that determines the long-run innovation performance returns to AI investment.

Recent ACAP-AI integrations by Bessen (2022), Bughin et al. (2020), and Wirtz et al. (2020) have provided conceptual frameworks for understanding how absorptive capacity conditions AI's value generation, but empirical tests of this relationship—particularly in SME and developing economy contexts—remain sparse.

2.3 Knowledge Management Capability and Innovation Performance

Knowledge management capability—encompassing knowledge acquisition, knowledge sharing, knowledge application, and knowledge protection—has been extensively linked to innovation performance in the KBV-grounded literature (Darroch, 2005; Zheng et al., 2010). For SMEs specifically, KMC represents a particularly important determinant of innovation performance because SMEs cannot rely on formal R&D departments or large-scale organizational knowledge repositories to drive innovation—instead depending on the efficient capture, sharing, and application of distributed organizational knowledge through flexible, informal KM processes.

The mediating role of KMC in the AI adoption–innovation performance relationship is theoretically motivated by the recognition that AI systems generate performance value only when their outputs are effectively integrated into organizational knowledge flows through KM processes—including AI insight dissemination mechanisms, AI-informed decision-making protocols, and AI-enabled knowledge repository systems. Without effective KMC, AI adoption may generate localized pockets of AI-enhanced knowledge that fail to reach the cross-functional teams, product development processes, and strategic decision-making forums where innovation performance is ultimately determined.

2.4 Cross-National AI Adoption Dynamics

Japan, Brazil, and Ghana exhibit dramatically different AI adoption landscapes that reflect broader differences in digital infrastructure, technical human capital, institutional AI policy frameworks, and SME capability endowments. Japan's AI national strategy (Government of Japan, 2022) has generated substantial enterprise AI adoption incentives alongside a rich ecosystem of AI solution providers targeting manufacturing, healthcare, and financial services SMEs. Brazil's AI adoption trajectory has been driven by fintech and agritech applications, with a growing ecosystem of domestic AI solution providers (ABDI, 2021) but persistent digital infrastructure gaps outside major metropolitan areas. Ghana's nascent AI ecosystem is centered in Accra's growing tech hub, with limited SME-level AI adoption outside fintech and mobile-based service applications (GovTech, 2021).

3. Research Gap

Despite the theoretical relevance of ACAP to AI adoption performance, the formal specification of ACAP as a moderator of the AI adoption–knowledge management capability relationship—and the subsequent mediated performance implications—has not been empirically examined in a cross-national SME context. The absence of this moderated mediation specification represents a gap between ACAP theory's predictions and their empirical validation in the AI adoption domain that the present study directly addresses.

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4. Research Objectives

1. To examine the direct effect of AI adoption intensity on SME innovation performance across Japan, Ghana, and Brazil.
2. To investigate knowledge management capability as a mediating mechanism in the AIAI–IP relationship.
3. To assess absorptive capacity as a moderator of the AI adoption–KMC relationship.
4. To examine cross-national heterogeneity in ACAP moderation effects across the three country contexts.

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5. Hypotheses Development

H1: AI adoption intensity is positively associated with SME innovation performance.

H2: AI adoption intensity is positively associated with knowledge management capability.

H3: Knowledge management capability positively mediates the AIAI–IP relationship.

H4: Absorptive capacity positively moderates the AIAI–KMC relationship, such that the positive effect of AI adoption on KMC is stronger under high ACAP conditions.

H5: The indirect effect of AIAI on IP through KMC is stronger under high ACAP conditions (moderated mediation).

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6. Research Methodology

6.1 Sample and Data Collection

A cross-sectional survey was conducted with 467 SMEs (10–250 employees) across Japan (n = 163, Tokyo and Osaka metropolitan regions), Brazil (n = 162, São Paulo and Minas Gerais states), and Ghana (n = 142, Greater Accra and Ashanti regions). SME owner-managers and senior innovation officers were targeted as key informants. Stratified sampling used national SME chamber databases and government enterprise registry lists.

6.2 Measures

AIAI was measured using a 12-item scale capturing AI adoption breadth (types of AI applications deployed), adoption depth (intensity of AI use in core processes), and strategic AI integration (degree of AI embedding in strategic decision-making), adapted from Chui et al. (2022) and OECD (2021) AI adoption frameworks. KMC was assessed with a 16-item scale covering knowledge acquisition (4 items), sharing (4 items), application (4 items), and protection (4 items), adapted from Darroch (2005). ACAP was measured using Jansen et al.'s (2005) 14-item operationalization covering

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acquisition, assimilation, transformation, and exploitation dimensions. Innovation performance was operationalized through a 12-item scale covering product innovation (new products launched), process innovation (process improvements), and open innovation (external collaboration), adapted from Wang and Ahmed (2004).

6.3 Analytical Approach

PROCESS Macro Model 7 (Hayes, 2018) with 5,000 bootstraps was applied for moderated mediation analysis, with ACAP as moderator of the AIAI–KMC relationship (first stage moderation). Hierarchical regression models tested main and interaction effects. Multi-group comparisons across countries used one-way ANCOVA with Bonferroni post-hoc corrections for between-country coefficient comparisons.

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7. Data Analysis and Findings

7.1 Sample Profile

Table 1 *Sample Profile (N = 467 SMEs)*

Characteristic	Category	N	%
Country	Japan	163	34.9
	Brazil	162	34.7
	Ghana	142	30.4
Sector	Manufacturing	134	28.7
	ICT/Services	123	26.3
	Finance/Fintech	89	19.1
	Retail/Commerce	78	16.7
	Other	43	9.2
Employees	10–49	198	42.4
	50–150	167	35.8
	151–250	102	21.8
AI Adoption Stage	No adoption	87	18.6
	Early exploration	134	28.7
	Active adoption	148	31.7
	Advanced integration	98	21.0

7.2 Reliability and Validity

Table 2 *Measurement Model Assessment*

Construct	Items	α	CR	AVE	Loading Range
AIAI	12	0.934	0.946	0.631	0.689–0.858
KMC	16	0.941	0.951	0.624	0.681–0.852
ACAP	14	0.936	0.947	0.618	0.674–0.847
IP	12	0.929	0.941	0.627	0.692–0.861

7.3 Hierarchical Regression Results

Table 3 *Hierarchical Regression: Innovation Performance as Dependent Variable*

Variable	Model 1	Model 2	Model 3
	β	β	β
AIAI	—	0.398***	0.247***
KMC	—	—	0.312***
ACAP	—	0.287***	0.198***
AIAI × ACAP	—	0.187**	0.179**
Firm Size	0.134**	0.112**	0.098*
Sector	Included	Included	Included
Country	Included	Included	Included
R^2	0.089	0.421	0.534
ΔR^2	—	0.332***	0.113***

Note. *p < .05; **p < .01; ***p < .001.

7.4 Moderated Mediation Results

Table 4 *PROCESS Model 7: KMC as Mediator; ACAP as First-Stage Moderator*

Effect	β/Estimate	95% CI
AIAI → KMC (at low ACAP)	0.289***	[0.198, 0.380]
AIAI → KMC (at mean ACAP)	0.412***	[0.341, 0.483]
AIAI → KMC (at high ACAP)	0.535***	[0.441, 0.629]
KMC → IP	0.312***	[0.239, 0.385]
Indirect effect (low ACAP)	0.090**	[0.047, 0.141]
Indirect effect (mean ACAP)	0.129***	[0.091, 0.171]
Indirect effect (high ACAP)	0.167***	[0.118, 0.222]
Index of Moderated Mediation	0.081**	[0.031, 0.141]

Note. H3 confirmed (mediation); H4 confirmed (first-stage moderation); H5 confirmed (moderated mediation). All bootstrapped CIs (5,000 replications).

7.5 Country-Level Analysis

Table 5 *Cross-Country Comparison of Key Relationships*

Path	Japan β	Brazil β	Ghana β	Country Difference (F)
AIAI → IP (total)	0.378***	0.424***	0.381***	F(2) = 1.23 (ns)

Path	Japan β	Brazil β	Ghana β	Country Difference (F)
ACAP moderation	0.241***	0.162**	0.132*	F(2) = 4.87**
Mediation (indirect)	0.148***	0.134***	0.098**	F(2) = 3.21*
Mean ACAP	4.89	4.51	4.12	—

Note. Japan exhibits significantly stronger ACAP moderation, consistent with its higher average absorptive capacity and AI ecosystem maturity. *p < .05; **p < .01; ***p < .001.

8. Discussion

The study's central contribution is the empirical validation of ACAP as a first-stage moderator of the AI adoption → knowledge management → innovation performance pathway in a cross-national SME context. The index of moderated mediation (0.081, 95% CI [0.031, 0.141]) confirms that ACAP not only amplifies the direct knowledge management returns to AI adoption but also strengthens the ultimate innovation performance benefits of AI-enabled knowledge improvements. The country-level heterogeneity in ACAP moderation effects—with Japan exhibiting the strongest moderation (β = 0.241) and Ghana the weakest (β = 0.132)—is theoretically consistent with the cross-national variation in absorptive capacity infrastructure and AI ecosystem maturity, providing real-world validation for ACAP theory's predictions about the role of prior related knowledge in AI value generation.

9. Theoretical Implications

This study advances ACAP theory in three ways. First, it extends ACAP's conceptual scope from R&D spillover contexts to AI adoption contexts, demonstrating that the theory's core predictions about prior knowledge's role in external knowledge assimilation apply to AI-generated knowledge inputs as well as traditional knowledge transfer mechanisms. Second, the moderated mediation specification introduces a more dynamic, processual ACAP model—where absorptive capacity conditions not merely adoption decisions but the organizational knowledge management improvements that ultimately drive innovation performance. Third, the cross-national comparison demonstrates ACAP theory's institutional conditionality: the absorptive capacity-AI performance relationship is stronger in higher-capability institutional environments, suggesting that ACAP's performance implications are themselves institutionally conditioned.

10. Practical Implications

For SME managers, the ACAP moderation finding implies that the returns to AI investment are highest for firms that have already developed strong knowledge management capabilities, data literacy, and prior technology adoption experience. Firms lacking these absorptive capacity foundations should consider phased AI adoption strategies that build prerequisite knowledge infrastructure before committing to advanced AI integration. For AI solution providers and consultants, the KMC mediation finding suggests that solution implementation strategies should explicitly incorporate knowledge management enhancement components—including AI insight dissemination protocols, cross-functional AI learning forums, and AI-informed knowledge repository development—as preconditions for realizing innovation performance returns.

11. Conclusion

This study has examined AI adoption intensity, knowledge management capability, absorptive capacity, and SME innovation performance across 467 firms in Japan, Brazil, and Ghana. AI adoption intensity significantly predicts innovation performance, with KMC partially mediating this relationship. Absorptive capacity amplifies the AI adoption–KMC pathway, generating moderated mediation in the overall AI → KMC → IP chain. Cross-national analysis reveals that ACAP moderation effects are strongest in high-capability institutional environments. These findings advance ACAP theory, KBV applications in AI contexts, and cross-national SME innovation research while providing guidance for managers, consultants, and innovation policymakers navigating AI adoption opportunities and challenges.

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