



Knowledge Dynamics and Absorptive Capacity: Shaping Innovation Performance in the Service Business of Small and Medium-sized Enterprises

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ABSTRACT

This study investigates how knowledge breadth and depth impact innovation within the service industry, drawing from the Knowledge-Based View. Using quantitative methods, it explores the relationship among knowledge breadth, depth, and absorptive capacity in driving innovation performance, especially in small and medium-sized enterprises (SMEs). With active involvement from 237 SME owners and managers, the results reveal significant effects in the pathways from absorptive capacity to innovation performance and from knowledge breadth to absorptive capacity, highlighting their significant influence. Similarly, the path from knowledge breadth to innovation performance demonstrates a notable impact, emphasizing the importance of having a wide range of knowledge. Upon examining the paths from knowledge depth to absorptive capacity and from knowledge depth to innovation performance, the significant effects are confirmed. This study stresses the critical role of both knowledge breadth and depth in shaping organizational absorptive capacity and innovation performance, offering practical insights for businesses. It also emphasizes the pivotal role of absorptive capacity and the advantages of utilizing external knowledge. The practical recommendations advocate for tailored strategies that balance precision to achieve favorable innovation outcomes. While providing valuable contributions, the study acknowledges certain limitations and suggests potential directions for future research.

Keywords: Absorptive Capacity, Innovation Performance, Knowledge Breadth, Knowledge Depth

JEL Classifications: M10, L25, O31

1. INTRODUCTION

While earlier studies highlighted knowledges pivotal role in product innovation, ongoing debates question whether knowledge breadth and depth genuinely contribute to innovation (Zhou and Li, 2012). Investigating the depth and breadth of knowledge across diverse industries, including China's biotechnology sector, Qin (2021) found that the impact of knowledge depth was considered more substantial than that of knowledge breadth in this particular context. The literature also extensively delves into various facets within the framework of absorptive capacity, with one such aspect

being knowledge characteristics (Volberda et al., 2010). Tippakoon et al. (2022) further emphasized that both the breadth and depth of knowledge significantly contribute to the external acquisition of knowledge when evaluating the innovation performance of firms.

In-depth research has extensively explored the interconnection among knowledge breadth, depth, and innovation performance, highlighting their fundamental roles in promoting organizational innovation. However, this association introduces a sense of tension due to resource constraints and the dynamics of knowledge exploration for breadth or exploitation for depth (Jin et al., 2015).

Expanding on this, a preceding study conducted by Li and Qiu (2022) has also emphasized the significance of the depth and breadth of the knowledge base in shaping the overall performance and innovation within firms.

The literature emphasizes that a diverse range of ideas from external knowledge search is crucial for the innovation process, stressing the importance of exploring each domain with sufficient depth (Akram et al., 2020). While prior research suggests the significance of both the breadth and depth of absorptive capacity for firm innovation, there is limited exploration of how the distinct effects of breadth and depth impact innovation performance (Zou et al., 2017; Saah et al., 2024). Chen et al. (2021) highlight the distinction between knowledge breadth and depth, providing valuable insights into how these attributes differentially influence firm innovation. Research on information technology capability and the knowledge base related to digital innovation indicates that IT capability significantly enhances a firm's knowledge breadth and depth, positively affecting innovation outcomes (Wu & Ding, 2020; Wei et al., 2021). Moreover, the assessment of the depth and breadth of knowledge search within a firm's technological innovation network underscores the significance of these dimensions in technological innovation (Long et al., 2021).

Enterprises employ various strategies to accumulate and apply their knowledge reservoir. In this context, knowledge breadth spans multiple domains in the firm's knowledge repository, ensuring comprehensive coverage. Simultaneously, knowledge depth indicates the complexity of knowledge in specific fields, highlighting the sophistication of understanding within those domains (Yang, 2020). The significance of knowledge depth becomes evident when considering the integration and reproduction of both existing and new external knowledge (Duan et al., 2022). This underscores the importance of having a profound understanding and mastery of knowledge for effective integration and application. A trade-off between innovation and output capabilities distinctly shapes the breadth versus depth of firms' knowledge bases, revealing a sophisticated relationship between these dimensions (Awate et al., 2012). This equilibrium emphasizes the need for organizations to strategically manage the breadth and depth of their knowledge to optimize innovation outcomes.

The correlation between external learning and internal knowledge sharing is a crucial factor in shaping a company's knowledge base. As highlighted by Hao and Feng (2016), this dynamic correlation instigates alterations in both the depth and breadth of knowledge, ultimately nurturing innovation within the organizational framework. However, it is imperative to recognize the nuanced association between external search activities and the performance of innovation. Studies, as demonstrated by Ferraris et al. (2017), propose an inverted U-shaped relationship between the breadth and depth of external search and innovation. This suggests that exceeding a certain threshold in external searching may adversely affect innovation performance. Recent academic inquiries, including those spotlighted by Carnabuci and Operti (2013), elucidate the intricate nature of the connection between knowledge diversity and innovation. They emphasize a curvilinear association,

signifying that there exists an optimal level of knowledge diversity positively influencing innovation. This highlights the intricate equilibrium that companies must uphold between knowledge breadth, depth, and innovation to optimize their creative potential.

Knowledge-based view (KBV) literature characterizes knowledge in terms of breadth and depth, emphasizing the importance of these dimensions in understanding the role of knowledge in firm activities (D'Ambrosio et al., 2016). The contribution of activities such as external knowledge acquisition and internal knowledge transfer to innovation development has been explored within the KBV, indicating the significance of these activities in driving innovation (Judge et al., 2014). Innovation search has been found to vary according to breadth and depth, both of which play different roles in innovation (Segarra-Ciprés et al., 2014). Examining the breadth and depth of knowledge in the context of innovation is essential to gain a comprehensive understanding of the factors influencing innovation performance. To comprehend the complexities of external knowledge search dynamics and its impact on organizational absorptive capacity and innovation performance, our inquiry is guided by the following research questions:

- RQ1: How does the depth and breadth of external knowledge search influence absorptive capacity within organizations?
- RQ2: What are the relationships between the depth and breadth of external knowledge search and absorptive capacity and innovation performance?
- RQ3: How does absorptive capacity function as a mediator in the relationship between the depth and breadth of external knowledge searches and innovation performance?

The main objective of this study is to fill existing gaps in the literature by investigating the dynamic relationship among the depth and breadth of external knowledge search, absorptive capacity, and innovation performances. Through these analyses, the research strives to provide a substantial contribution to the current knowledge base in the domains of the Knowledge-Based View, innovation, and absorptive capacity. This contribution is anticipated to present valuable viewpoints for academicians, practitioners, and policymakers. Ultimately, the goal is to improve our comprehension of the factors that impact innovation performance within organizational contexts.

2. LITERATURE REVIEW

2.1. Knowledge Based View

The knowledge-based view (KBV) emphasizes the strategic importance of organizational knowledge and capabilities in gaining a competitive advantage. It focuses on the growth of knowledge within a firm and its capabilities (Nagano, 2020), aligning with Zack and Singh's (2010) perspective. Turner et al. (2018) highlight the concept of ambidexterity, which involves exploitation of existing expertise and exploration of new knowledge generation. KBV is an extension of the resource-based view (RBV) and has gained prominence in understanding organizational behavior, innovation, performance, and competitive advantage (Zhou and Li, 2012). It emphasizes the strategic role of knowledge as a strategic resource for improving capabilities, product and service development, and

gaining a competitive edge (Liu et al., 2022). KBV is associated with the operationalization of knowledge management, the knowledge value chain, and epistemology, encompassing various dimensions such as knowledge management, value creation, and the philosophical underpinnings of knowledge (Farooq, 2019). Two key dimensions of a firm's knowledge base are breadth and depth, which are crucial for effective knowledge management and organizational performance (Awate et al., 2012). The knowledge base is both a premise and constraint for innovation processes (Li and Qiu, 2022), underscoring its foundational role in shaping organizational strategies and actions.

The Knowledge-Based view (KBV) is closely linked to absorptive capacity, which emphasizes an organization's ability to recognize and apply external knowledge effectively for commercial purposes (Rafique et al., 2015). This view highlights the dynamic nature of knowledge within organizations and its interactions with external sources. KBV also intersects with the resource-based perspective (Carnabuci and Operti, 2013), emphasizing the importance of intra-organizational networks and knowledge exchange for innovation. KBV is also linked to strategic management theory (Liu et al., 2022), presenting knowledge as a strategic resource for enhancing enterprise capabilities and gaining a competitive advantage. It also emphasizes the importance of knowledge integration in developing marketing dynamic capabilities (Zhang and Xu, 2019), highlighting the role of knowledge in shaping organizational capabilities and market responses.

2.2. External Knowledge Depth

The depth of external knowledge search refers to the extensive use of various external knowledge sources by firms for innovation inputs, particularly in the services sector (Segarra-Ciprés and Llusar, 2018; Wang et al., 2020). This depth is crucial for firms to address challenges related to imitability and emphasizes a profound acknowledgment of knowledge and a focus on valuable and unique insights (Duan et al., 2022; Segarra-Ciprés and Llusar, 2018). It also exhibits a significant association with a firm's radical innovation (Shi & Zhang, 2018; Ryu et al., 2022), highlighting a positive correlation between the depth of external knowledge search and innovation capabilities within a firm.

The depth of external knowledge search is closely connected to the breadth of knowledge search, which is the diversity of various external sources a firm explores for knowledge (Terjesen and Patel, 2015). Factors such as the industry environment, absorptive capacity, and knowledge nature influence the depth of external knowledge search (Guo and Wang, 2014). Managerial discretion, technology boundary spanning, and firms' ambidextrous knowledge integration also play a role in shaping this depth (Wu & Wu, 2014; Long et al., 2021; Rui and Lyytinen, 2019; Nangpiire et al., 2024). The depth of external knowledge search is closely tied to collaboration and interaction with external sources, fostering cooperative routines and enhancing innovation performance (Rui and Lyytinen, 2019). In-depth external knowledge searches often require close interaction and frequent communication with partners, contributing to a firm's comprehension of diverse external knowledge (Liu, 2021).

2.3. External Knowledge Breadth

Analyzing various knowledge sources is essential for improving innovation performance by enabling companies to conduct more extensive and inclusive searches (Chiang and Hung, 2010). However, it's important to note that expanding the scope of the search can lead to limited benefits, potentially resulting in negative returns (Love et al., 2013). Exploring external knowledge is crucial for a company's knowledge repository, as it enhances its diverse domains and innovative sources (Wang et al., 2020). This process leads to the generation of new knowledge and variations, generating fresh values (Garriga et al., 2013; Gölgeci et al., 2019). Firms may need to extend their search scope by exploring new external knowledge sources to exploit existing knowledge bases at greater depths (Foss et al., 2013). The breadth of external search signifies the degree to which a company employs external knowledge sources, while the depth reflects the extensive application of these sources (Dong and Netten, 2017). The strategic dimensions of breadth and depth in external knowledge search are critical, shaping the diversity of knowledge and the strength of utilization (Segarra-Ciprés and Llusar, 2018; Ryu et al., 2022).

External search strategies involve systematic exploration of firms' environments to acquire external knowledge, leading to organizational change and enhanced knowledge resources (Wang, 2015; Radicic and Pugh, 2017). The integration of external and internal knowledge significantly influences knowledge breadth and depth, fostering innovation (Wu & Wang, 2017; Liu et al., 2013; Zhou and Li, 2012). Openness to external knowledge is crucial for a firm's competitive advantage (Radicic, 2020), and the breadth of external knowledge search is a critical aspect of a firm's innovation performance (Fertó et al., 2016).

2.4. Absorptive Capacity

Absorptive capacity is a crucial concept in organizational theory, especially in knowledge management and innovation. It refers to an organization's ability to recognize, assimilate, and apply new knowledge (Melkas et al., 2010) to improve its performance and competitive advantage. (Gong et al., 2021). This concept has been extensively studied in fields such as information systems research (Roberts et al., 2012), knowledge sharing and innovation performance (Zhao et al., 2020), multinational corporations' knowledge transfer (Minbaeva et al., 2014), and the impact of IT ambidexterity on competitive advantage (Chang et al., 2019). The literature emphasizes that absorptive capacity directly contributes to firm performance, as it involves the ability to identify, examine, digest, and absorb new knowledge, ultimately reaching organizational goals. (Zhao et al., 2020) It is more likely to develop and maintain as a routine activity when the knowledge domain being exploited is closely related to the current knowledge base (Minbaeva et al., 2014). The literature distinguishes between potential absorptive capacity, which pertains to knowledge acquisition and assimilation capabilities, and realized absorptive capacity, which pertains to knowledge transformation and exploitation capabilities ((Cohen & Levinthal, 1990; Jansen et al., 2005; Chang et al., 2019). Absorptive capacity is a crucial aspect of an organization's internal learning and problem-solving abilities, as it is a function of its existing knowledge base (Li and Hou, 2023). It is an accumulation of the absorptive capacity of

its members (Handayani et al., 2017), highlighting the role of individuals in contributing to the overall capacity. Absorptive capacity is essential for encouraging innovation throughout an organization (García-Sánchez et al., 2018), with strong knowledge absorptive capacity leading to higher innovation performance (An et al., 2021). This highlights the importance of absorptive capacity in driving organizational innovation and adaptation to changing environments.

2.5. Innovation Performance

Innovation performance is a critical factor for organizational success, influenced by factors such as customer interaction, innovation types, entrepreneurial orientation, and organizational practices. Research has shown that involving employees in decision-making can connect market orientation to innovation performance (Foss et al., 2011), emphasizing the importance of organizational practices. In-house R&D is crucial for enhancing innovation performance, but other factors also contribute (Varis and Littunen, 2010). Entrepreneurial orientation plays a significant role in driving innovation performance (Hou et al., 2019). Measuring innovation performance supports reflective sessions and motivates goal-setting (Saunila, 2017). Abdallah et al. (2019) assessed performance across various dimensions, providing a comprehensive perspective. Fu et al. (2015) used innovation as a performance outcome, illustrating the multifaceted nature of innovation performance. Nielsen (2019) highlighted the complexity of defining and measuring innovation performance. Shin et al. (2019) emphasized the importance of measuring innovation efficiency in converting inputs into outputs. Svandová and Jirásek (2019) emphasized the need for a holistic approach to innovation performance measurement. Škiltere and Jesiļevska (2021) discussed how innovative output reflects on the institutional and socio-economic structures of the innovation system, emphasizing broader systemic influences on innovation performance.

2.6. Hypotheses Development

Absorptive capacity refers to an organization's ability to recognize the value of external knowledge and use that knowledge effectively for commercial purposes (Zhao et al., 2020), which significantly impacts innovation performance. Studies consistently show a positive correlation between absorptive capacity and innovation across various industries and contexts (Wang et al., 2017; Chen et al., 2014; Zhai et al., 2018). Absorptive capacity is crucial for increased innovation and productivity (Wang et al., 2017), as well as innovation frequency, speed, and overall performance (Chen et al., 2014; Zhai et al., 2018). It also significantly influences green process innovation (Du and Wang, 2022) and facilitates co-innovation by providing greater access to external resources and encouraging collaborative generation of new ideas (Pérez and Lozada, 2020). Organizations with strong knowledge absorptive capacity are more likely to achieve higher innovation performance (An et al., 2021). Overall, the literature consistently affirms that absorptive capacity plays a crucial role in enhancing innovation performance across diverse organizational settings and industries. Therefore, we propose the following hypothesis:

H1: Absorptive capacity is positively related to innovation performance.

The concepts of external knowledge breadth and absorptive capacity are essential for understanding how organizations acquire, assimilate, and apply external knowledge for innovation and performance. Absorptive capacity is dynamic and adapts to changes in the external knowledge environment (Pu and Liu, 2023). It is divided into potential and realized absorptive capacity, with potential involving identifying external knowledge sources and realized focusing on how much firms benefit from them (Radicic and Pugh, 2017). Absorptive capacity is crucial for transforming external knowledge into innovative performance (Zhao and Zheng, 2018), considering factors like coordination among members and knowledge diversity within the collective entity (Roberts et al., 2012). The breadth of external knowledge search refers to the use of diverse external knowledge sources or information from external parties (Ryu et al., 2022), representing the number of external entities a firm relies on for knowledge (Mun, 2022). Firms with higher absorptive capacity are more likely to innovate (Gómez et al., 2016). In conclusion, the extent of external knowledge search and absorptive capacity significantly influences how firms access and utilize external knowledge for innovation. From this perspective, we propose the following hypothesis:

H2: The breadth of the external knowledge search is positively related to absorptive capacity.

Research shows that incorporating external knowledge significantly improves a firm's innovation performance (Si et al., 2020). Open innovation suggests that incorporating external knowledge sources can enhance learning, innovation, and overall firm performance (Vrontis et al., 2016). Both developers and adopters use external knowledge sources to improve innovation performance (Segarra-Ciprés and Llusar, 2018). However, factors like ambidextrous knowledge search strategies and absorptive capacity can moderate the impact of external knowledge on performance (Wang et al., 2020). The effectiveness of external knowledge sourcing depends on a firm's internal knowledge network (Ye et al., 2019), which is crucial in evaluating the effectiveness of external knowledge sourcing choices (Martínez-Ros & Kunapatarawong, 2019; Grigoriou and Rothaermel, 2016). Therefore, firms must actively seek and integrate external knowledge into their innovation processes to enhance their performance. Accordingly, we propose the following hypothesis:

H3: The breadth of external knowledge search is positively related to innovation performance.

The absorptive capacity of a firm, which refers to its ability to recognize the value of external knowledge, assimilate external knowledge, and apply external knowledge to commercial ends, is a critical determinant of innovation performance (Flor et al., 2018). The depth of external knowledge search has been identified as a significant factor influencing absorptive capacity (Nguyen, 2021; Flor et al., 2018). Nguyen (2021) demonstrated that absorptive capacity positively influences both knowledge breadth and knowledge depth. Furthermore, external search from universities, research organizations, and value chain partners may increase the chance of acquiring valuable knowledge that can be used to develop realized absorptive capacity (Aliasghar et al., 2019). This indicates that the depth of external knowledge search

holds a crucial role in enhancing a firm's absorptive capacity. Moreover, the significance of external search depth suggest that the interaction effect of external search breadth and absorptive capacity is significantly positive only among those with high levels of external search depth (Kim et al., 2019). This underscores the importance of not only the breadth but also the depth of external knowledge search in influencing absorptive capacity. Additionally, the evidence supporting the positive influence of absorptive capacity on knowledge acquisition and processing capabilities, which in turn impacts innovation performance (Nguyen, 2021). This further underscores the critical role of absorptive capacity in leveraging external knowledge (Monteiro et al., 2017). It is important to note that the overall consensus supports the positive and significant effect of depth of external knowledge search towards absorptive capacity (Flor et al., 2018; Nguyen, 2021; Aliasghar et al., 2019; Kim et al., 2019). Therefore, we propose the following hypothesis:

H4: The depth of external knowledge search is positively related to absorptive capacity.

The impact of external knowledge search strategies on innovation performance is significant, with research suggesting that maintaining high levels of both breadth and depth can improve a firm's product innovation performance (Kim et al., 2019). Organizational ambidexterity refers to a firm's ability to pursue high levels of external search simultaneously (Wu & Liu, 2018; Kim et al., 2019). The influence of external knowledge search on innovation performance is also influenced by absorptive capacity and firm heterogeneity. Gölgeci et al. (2019) found that the way external search is conducted can influence knowledge transfer into innovation performance. Wang (2015) suggested that technological leaders rely more on nonlocal knowledge search breadth than depth for their product innovation. The relationship between the depth of external knowledge search and innovation performance is complex and multifaceted, with some studies showing a positive influence of search depth on performance (Chiang and Hung, 2010). Therefore, understanding the mechanisms through which external knowledge search influences innovation performance is crucial for firms to effectively leverage external knowledge. Hence, we propose the following hypothesis:

H5: The depth of external knowledge search is positively related to innovation performance.

Innovation performance is crucial for organizational success and sustainability, influenced by both internal and external factors. The breadth of external knowledge search has a positive and significant effect on innovation performance, mediated by absorptive capacity. Absorptive capacity refers to an organization's ability to recognize the value of external knowledge, assimilate knowledge, and apply such insight to commercial ends (Zhao et al., 2020). It plays a crucial role in the relationship between external knowledge search and innovation performance, enabling organizations to effectively utilize the knowledge acquired from external sources to drive innovation (Zhang et al., 2022; Kostopoulos et al., 2011). Studies have shown that absorptive capacity significantly impacts organizational innovation performance, emphasizing its importance in leveraging external knowledge for innovation (Akram et al., 2020). The mediating role of absorptive capacity in

the relationship between external knowledge search breadth and innovation performance has been highlighted in various studies (Wang et al., 2022). Li and Han (2019) found that absorptive capacity has a full-mediated effect between external knowledge search and innovation performance, emphasizing its critical role as a mediator. Kapoor and Aggarwal (2021) identified complementary partial mediation, indicating that knowledge transfer impacts innovation performance through absorptive capacity in a positive manner. However, it is essential to consider the moderating effects of absorptive capacity on the relationship between external knowledge search breadth and innovation performance (Li et al., 2019). Santoro et al. (2020) suggested that absorptive capacity does not have a significant moderating effect on innovation performance, highlighting the complexity of the relationship between these factors and the need for further research to fully understand their interactions. Based on these evidences, we propose the following hypothesis.

H6: Absorptive capacity mediates the relationship between the breadth of external knowledge searches and innovation performance.

The relationship between the depth of external knowledge search and innovation performance, mediated by absorptive capacity, has been extensively researched. Studies have shown that intensively accessing knowledge from a limited number of external channels (open search depth) positively impacts a company's incremental innovation performance (Chiang and Hung, 2010). Absorptive capacity plays a crucial role in organizational innovation performance, promoting the sustainability of knowledge sharing behavior (Zhao et al., 2020). Firms' search strategies for external knowledge also impact their innovative performance (Garriga et al., 2013). The mediating effect of absorptive capacity on the relationship between IT capability and open innovation performance is also highlighted (Wu et al., 2019). The positive interaction effect of external search breadth and absorptive capacity is particularly significant among those with high levels of external search depth (Kim et al., 2019). Wang et al. (2020) emphasize the catalytic role of an ambidextrous strategy in the contribution of openness to external knowledge to innovation performance. Li and Han (2019) found that absorptive capacity has a full-mediated effect between external knowledge search and innovation performance, signifying its significance in assimilating valuable knowledge and increasing innovation performance. Dong and Netten (2017) also documented the positive association between external search breadth and depth with innovation performance. Segarra-Ciprés and Llusar (2018) and Wang et al. (2022) also emphasized the mediating role of absorptive capacity between external knowledge and innovation. Overall, the literature consistently supports the positive and significant effect of the depth of external knowledge search towards innovation performance, with absorptive capacity playing a crucial role. Therefore, the study proposes the following hypothesis.

H7: Absorptive capacity mediates the relationship between depth of external knowledge search and innovation performance.

The conceptual framework for this study (see Fig. 1) depicts the link between the primary variables investigated.

3. METHODOLOGY

3.1. Population and Research Sampling

The study employs a quantitative research design, specifically utilizing a survey method to investigate small and medium-scale enterprises (SMEs) in North Sumatera, Indonesia. The study population consists of owners and managers of SMEs in North Sumatera, Indonesia, and a sample is randomly selected from this population. A total of 237 SME owners and managers actively participated in the survey, resulting in a response rate of 62%. The data collection process involved self-administered surveys, with enumerators providing assistance in gathering information from SME owners and managers. Utilizing the survey method, questionnaires were distributed, and data were systematically collected to ensure the timely and accurate accumulation of information on a large scale from the targeted SME population.

3.2. Measurement Items

Yang et al. (2017) conducted a comprehensive study to understand the impact of knowledge breadth and depth on new product performance. They used four items to assess knowledge depth, supplemented by four additional items to measure knowledge breadth, employing a Likert scale for the perceptual aspects. Similarly, Du (2021) used three items for knowledge breadth and four items for knowledge depth. We measured knowledge breadth and depth by using four items adapted from Yang et al. (2017) and Du (2021). Respondents rated various aspects of knowledge on a 5-point Likert scale (ranging from 5 = strongly agree to 1 = strongly disagree). Ferreras-Méndez et al. (2015) utilized an 18-item scale to evaluate how SMEs apply external knowledge for innovation, emphasizing the mediating role of absorptive capacity. Guo et al. (2015) employed a 5-item scale to assess a firm's ability to integrate product systems, proficiency in absorbing and applying external technology and knowledge, and vigilance in monitoring technological trends. To evaluate how SMEs strategically leverage external knowledge to enhance innovation performance, absorptive capacity was measured using an 8-item scale derived from previous research (Ferreras-Méndez et al., 2015; Guo et al., 2015). Participants provided their evaluations of absorptive capacity using a 5-point Likert scale (ranging from 5 = strongly agree to 1 = strongly disagree). For innovation performance, we adopted Lu et al.'s (2021) measurement scale, which includes six statements assessing various facets of innovation. Respondents ranked their firm's performance relative to their industry peers on a five-point Likert scale (ranging from 5 = strongly agree to 1 = strongly disagree).

4. RESULTS AND DISCUSSION

4.1. Respondents Profile

Table 1 displays a diverse group of 237 participants contributed to the survey, offering a comprehensive representation of the business community in North Sumatera. Culinary and café services emerged as the predominant sector, constituting 43% of the total and encompassing small eateries, cafés, catering services for local events, and local culinary businesses. Local delivery and logistics services constituted 17%, including local goods delivery services, specialized courier services for specific regions, and logistics services. Local accommodation services

Table 1: Respondent profile

Characteristics	Distributions	Percentage
Type of service business		
Culinary and cafe services	102	43
Delivery and logistics services	40	17
Accommodation services	52	22
Health and beauty services	43	18
Total	237	100
Size of business		
Small enterprises	128	54
Medium enterprises	109	46
Total	237	100
Experiences		
<3 years	54	23
3-8 years	90	38
8-13 years	57	24
>13 years	36	15
Total	237	100
Demographic characteristics		
Male	135	57
Female	102	43
Total	237	100
Age below 30 years	38	16
Age 30-45 years	107	45
Age 45-60 years	76	32
Age above 60 years	16	7
Total	237	100
High school education	90	38
Bachelor's degree	97	41
Master's degree	29	12
Other education	21	9
Total	237	100

represented 22%, featuring guesthouse management or rental homes, homestay services, and accommodation services. Local health and beauty services accounted for 18%, including family health clinics, traditional massage or spa services, and local beauty salons. Regarding business size, the majority comprised small enterprises (54%), while the remaining 46% fell into the medium enterprise category. Experiences among respondents varied: 23% had <3 years, 38% had 3-8 years, 24% had 8-13 years, and 15% had over 13 years of experience. Demographically, the majority were male (57%) and 43% were female. The age distribution was 16% below 30 years, 45% between 30 and 45 years, 32% between 45 and 60 years, and 7% above 60 years. Educational levels varied: 38% had high school education, 41% held a bachelor's degree, 12% had a master's degree, and 9% had other forms of education. These findings provide a nuanced understanding of the business landscape in North Sumatera, offering valuable insights for further analysis and strategic considerations.

4.2. Non Response Bias

Table 2 presents the P-values for all constructs (Knowledge Depth, Knowledge Breadth, Absorptive Capacity, and Innovation Performance). All $P > 0.05$, indicating that there are no statistically significant differences between the two groups (G1 and G2) for these constructs. This suggests that non-response bias is not a concern for this data set, meaning that the responses from the earlier group (G1) are consistent with those from the later group (G2).

4.3. Common Method Variance

Table 3 shows that all VIF values are well below the threshold of

3.3. This means there are no significant collinearity issues among the latent variables in the model. As a result, the model is free from common method variance, based on the criteria established by Kock and Lynn (2012).

4.4. Measurement Model

Table 4 presents the factor loadings for each item corresponding to the latent variables: Knowledge Depth, Knowledge Breadth, Absorptive Capacity, and Innovation Performance. All factor loadings exceed the commonly accepted threshold of 0.70, indicating a substantial relationship between the observed items and their respective latent variables.

Table 5 summarizes the measurement model's results, revealing reliability and validity across all variables. Absorptive capacity

(AC), innovation performance (IP), knowledge breadth (KB), and knowledge depth (KD) all exhibit composite reliability scores exceeding 0.70, indicating good reliability. Additionally, Cronbach's alpha values for each variable are above 0.70, signifying high internal consistency. The average variance extracted (AVE) for each variable surpasses the recommended threshold of 0.50, indicating that the constructs are well-measured and the items are reliable in capturing the underlying constructs.

Table 6 demonstrates the discriminant validity of the measurement model using the Fornell-Larcker criterion. The square root of the average variance extracted (AVE) for each construct is higher than its correlations with other constructs, indicating discriminant validity.

Table 2: Non response bias test

Construct	Mean (G1=71)	Mean (G2=166)	P-value	Remarks
Knowledge depth	3.7535	3.8404	0.421	Not significant
Knowledge breadth	3.7113	3.7816	0.554	Not significant
Absorptive capacity	3.6479	3.7274	0.458	Not significant
Innovation performance	3.7864	3.7952	0.935	Not significant

Table 3: Common method variance

???	Absorptive capacity	Innovation performance	Knowledge breadth	Knowledge depth
Absorptive capacity		1.456		1.000
Innovation performance				
Knowledge breadth	1.482		1.629	
Knowledge depth	1.482		1.629	

Table 4: Factor loading

Code	Knowledge depth	Knowledge breadth	Absorptive capacity	Innovation performance
KD1	0.794			
KD2	0.761			
KD3	0.750			
KD4	0.768			
KB1		0.777		
KB2		0.779		
KB3		0.817		
KB4		0.797		
AC1			0.729	
AC2			0.719	
AC3			0.741	
AC4			0.741	
AC5			0.721	
AC6			0.707	
AC7			0.727	
AC8			0.723	
IP1				0.742
IP2				0.769
IP3				0.772
IP4				0.756
IP5				0.745
IP6				0.712

Table 5: Measurement model

Variable	Composite reliability	Cronbach's alpha	AVE
Absorptive capacity	0.899	0.872	0.527
Innovation performance	0.885	0.844	0.561
Knowledge breadth	0.871	0.803	0.629
Knowledge depth	0.852	0.769	0.591

AVE: Average variance extracted

Table 7 presents the findings from the discriminant validity assessment using the Heterotrait-Monotrait Ratio (HTMT). According to this approach, all values fall below 0.85, indicating that the data meet the criteria for discriminant validity.

Table 8 suggest that the model has moderate predictive accuracy for both Absorptive Capacity and Innovation Performance, as evidenced by the R^2 values of 0.313 and 0.407, respectively. Additionally, the positive Q^2 values of 0.162 for Absorptive Capacity and 0.223 for Innovation Performance indicate that the model is relevant and useful for predicting these constructs. The Q^2 values above zero indicate that the model has predictive relevance (Chin, 1998). These metrics are crucial in evaluating the performance of a model and ensuring that it is capable of accurately predicting the outcome variable based on the input variables.

Table 9 provides several fit indices for both the Saturated Model and the Estimated Model, which are essential for assessing the quality of model fit in structural equation modeling (SEM). SRMR values below 0.08 are generally considered indicative of a good fit (Hu and Bentler, 1999). The Saturated Model's SRMR value of 0.065 suggests a better fit compared to the Estimated Model's 0.091, though both values indicate acceptable fit. Lower d_ULS values indicate a better fit. The Saturated model, with a d_ULS of 0.729, demonstrates a considerably better fit than the Estimated model, which has a d_ULS of 1.415. Similar to d_ULS, a lower d_G value is indicative of a better fit. The saturated model has a slightly better fit with a d_G of 0.219 compared to 0.243 for the estimated model. A lower Chi-square value suggests a better model fit. The saturated model's Chi-square value is lower than that of the estimated model, indicating a better fit. NFI values above 0.90 indicate a good fit, while values above 0.80 are acceptable (Bentler and Bonett, 1980). Both models

Table 6: Discriminant validity using fornell-larcker criterion

Variable	AC	IP	KB	KD
AC	0.726			
IP	0.577	0.749		
KB	0.497	0.497	0.793	
KD	0.495	0.475	0.570	0.769

AC: Absorptive capacity, IP: Innovation performance, KB: Knowledge breadth, KD: Knowledge depth

Table 7: Discriminant validity using heterotrait-monotrait ratio (HTMT)

Variable	AC	IP	KB	KD
AC				
IP	0.667			
KB	0.593	0.594		
KD	0.603	0.585	0.722	

AC: Absorptive capacity, IP: Innovation performance, KB: Knowledge breadth, KD: Knowledge depth

Table 8: Predictive accuracy and relevance

Variable	Predictive accuracy		Predictive relevance	
	R^2		Q^2	
Absorptive capacity	0.313		0.162	
Innovation performance	0.407		0.223	

have acceptable NFI values, with the Saturated Model slightly outperforming the Estimated Model.

Table 10 presents the effect size (f^2) of each variable in the context of absorptive capacity (AC) and innovation performance (IP). The f^2 value indicates the strength of the predictor variable's impact on the dependent variable, with benchmarks suggesting that values of 0.02, 0.15, and 0.35 correspond to small, medium, and large effects, respectively (Cohen, 1988). The effect size of absorptive capacity (AC) on innovation performance (IP) is 0.179, indicating a medium effect. The effect size of knowledge breadth (KB) on absorptive capacity (AC) is 0.099, which represents a small to medium effect. The effect size of knowledge breadth (KB) on innovation performance (IP) is 0.046, indicating a small effect. The effect size of knowledge depth (KD) on absorptive capacity (AC) is 0.097, which also falls within the small to medium range. The effect size of knowledge depth (KD) on innovation performance (IP) is 0.027, indicating a small effect.

4.5. Structural Model

Table 11 presents the results of the direct effect analysis for various paths in the model, including the path coefficient (β), sample mean, standard deviation, t-statistics, P-values, and remarks indicating the statistical significance of each effect.

For the path from absorptive capacity (AC) to innovation performance (IP), the path coefficient is $\beta = 0.393$, indicating a positive direct effect of absorptive capacity on innovation performance. The t-statistic is 5.765, and the $P = 0.000$, both of which confirm that this effect is statistically significant. Thus, the hypothesis that absorptive capacity positively influences innovation performance is supported.

Regarding the path from knowledge breadth (KB) to absorptive capacity (AC), the path coefficient is $\beta = 0.317$, showing a positive direct effect of knowledge breadth on absorptive capacity. With a t-statistic of 4.741 and a $P = 0.000$, the effect is statistically significant, supporting the hypothesis that Knowledge Breadth positively influences Absorptive Capacity.

For the path from knowledge breadth (KB) to innovation performance (IP), the path coefficient is $\beta = 0.210$, indicating a positive direct effect of Knowledge Breadth on Innovation Performance. The t-statistic of 3.372 and $P = 0.001$ suggest that this effect is statistically significant. Therefore, the hypothesis that Knowledge Breadth positively influences Innovation Performance is accepted.

The path from knowledge depth (KD) to absorptive capacity (AC) has a path coefficient of $\beta = 0.314$, indicating a positive direct effect of knowledge depth on absorptive capacity. The t-statistic is 4.884, and the $P = 0.000$, confirming that this effect is statistically

significant. This supports the hypothesis that Knowledge Depth positively influences Absorptive Capacity.

Finally, for the path from knowledge depth (KD) to innovation performance (IP), the path coefficient is $\beta = 0.160$, showing a positive direct effect of Knowledge Depth on Innovation Performance. With a t-statistic of 2.380 and a $P = 0.018$, this effect is statistically significant, supporting the hypothesis that Knowledge Depth positively influences innovation performance.

Table 12 presents the results of the indirect effect analysis, including the path coefficient (β), sample mean, standard deviation, t-statistics, P-values, and remarks indicating the statistical significance of each effect. For the indirect path from knowledge breadth (KB) to innovation performance (IP) through absorptive capacity (AC), the path coefficient is $\beta = 0.125$. This indicates that knowledge breadth positively affects innovation

performance indirectly via absorptive capacity. The t-statistic is 3.625, and the $P = 0.000$, both of which confirm that this indirect effect is statistically significant. Therefore, the hypothesis that knowledge breadth positively influences innovation performance through absorptive capacity is supported. Similarly, for the indirect path from knowledge depth (KD) to Innovation Performance (IP) through absorptive capacity (AC), the path coefficient is $\beta = 0.124$. This suggests that Knowledge Depth positively impacts Innovation Performance indirectly through absorptive capacity. The t-statistic is 3.757, and the $P = 0.000$, indicating that this indirect effect is statistically significant. Hence, the hypothesis that Knowledge Depth positively influences innovation performance through absorptive capacity is supported.

The results from Table 13 shed light on the mediation effects and variance accounted for (VAF) estimates for different paths in the model.

Firstly, regarding the relationship between knowledge depth (KD) and innovation performance (IP), the analysis reveals significant direct paths from KD to absorptive capacity (AC) ($\beta = 0.314$, $P < 0.05$) and from AC to IP ($\beta = 0.393$, $P < 0.05$). Additionally, the indirect effect of KD on IP via AC ($\beta = 0.124$) is statistically significant ($P < 0.05$), with a VAF of 43.6%. These findings suggest that absorptive capacity partially mediates the relationship between knowledge depth and innovation performance. Similarly, concerning the relationship between Knowledge Breadth (KB) and innovation performance (IP), significant direct paths exist from KB to AC ($\beta = 0.317$, $P < 0.05$) and from AC to IP ($\beta = 0.393$, $P < 0.05$). Moreover, the indirect effect of KB on IP via AC ($\beta = 0.125$) is statistically significant ($P < 0.05$), with a VAF of 37.3%. These results indicate that Absorptive Capacity

Table 9: Fit summary

Metrics	Saturated model	Estimated model
SRMR	0.065	0.091
d_ULS	0.729	1.415
d_G	0.219	0.243
Chi-square	308.949	328.683
NFI	0.825	0.814

Table 10: Effect size

Variable	f^2 (effect size)	
	AC	Innovation performance
AC		0.179
Knowledge breadth	0.099	0.046
Knowledge depth	0.097	0.027

AC: Absorptive capacity

Table 11: Direct effect

Path	β	Sample mean	Standard deviation	t-statistics	P-values	Remarks
AC -> IP	0.393	0.400	0.068	5.765	0.000	Accepted
KB -> AC	0.317	0.318	0.067	4.741	0.000	Accepted
KB -> IP	0.210	0.210	0.062	3.372	0.001	Accepted
KD -> AC	0.314	0.321	0.064	4.884	0.000	Accepted
KD -> IP	0.160	0.156	0.067	2.380	0.018	Accepted

AC: Absorptive capacity, IP: Innovation performance, KB: Knowledge breadth, KD: Knowledge depth

Table 12: Indirect effect

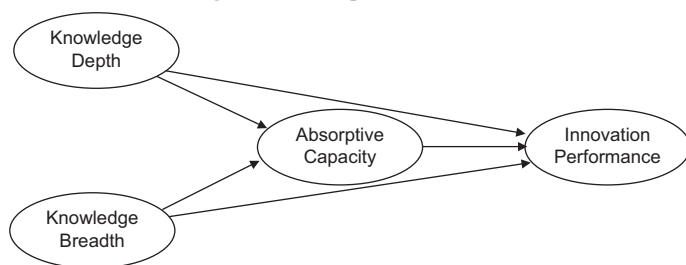
Path	β	Sample mean	Standard deviation	t-statistics	P-values	Remarks
KB -> AC -> IP	0.125	0.127	0.034	3.625	0.000	Accepted
KD -> AC -> IP	0.124	0.128	0.033	3.757	0.000	Accepted

AC: Absorptive capacity, IP: Innovation performance, KB: Knowledge breadth, KD: Knowledge depth

Table 13: VAF estimates

Path	β	Sample mean	Std. Dev	LB	UB	t-statistics	P-values	VAF	Type of mediation
KD -> AC	0.314	0.321	0.064	0.183	0.425	4.884	0.000	43.6%	Partial mediation
KD -> IP	0.160	0.156	0.067	0.023	0.296	2.380	0.018		
KD -> AC -> IP	0.124	0.128	0.033	0.064	0.191	3.757	0.000		
KB -> AC	0.317	0.318	0.067	0.194	0.463	4.741	0.000		
KB -> IP	0.210	0.210	0.062	0.089	0.332	3.372	0.001	37.3%	Partial mediation
KB -> AC -> IP	0.125	0.127	0.034	0.069	0.204	3.625	0.000		
AC -> IP	0.393	0.400	0.068	0.246	0.512	5.765	0.000		

VAF: Variance accounted for, LB: Lower bound of confidence interval, UB: Upper bound of confidence interval, AC: Absorptive capacity, IP: Innovation performance, KB: Knowledge breadth, KD: Knowledge depth

Figure 1: Conceptual framework

partially mediates the relationship between knowledge breadth and innovation performance.

The statistical findings on the AC to IP pathway not only confirm but also enhance our understanding of the critical role of absorptive capacity in propelling innovation performance. The significant effect further validates and extends this understanding, illustrating the substantial influence of absorptive capacity on innovation performance. This aligns with studies by Chen et al. (2014) and Zhai et al. (2018), supporting the positive impact of absorptive capacity on radical and incremental innovation performance, as well as overall innovation frequency, speed, and performance. The findings also reflect the broad applicability of absorptive capacity in driving innovation across different domains, particularly in process innovation (Du and Wang, 2022), consistent with An et al.'s (2021) findings indicating that organizations with strong absorptive capacity are more likely to achieve higher innovation performance. The confirmed substantial influence of absorptive capacity on innovation performance further underscores Pérez and Lozada's (2020) assertion on how absorptive capacity facilitates co-innovation through enhanced access to external resources and stimulation of joint idea generation.

Additionally, the observed effect on the KB to AC path aligns with existing literature emphasizing the dynamic nature of absorptive capacity. This represents a tangible manifestation, supporting the conversion of external knowledge into direct innovation and distinguishing between potential and realized absorptive capacity, as demonstrated by Radicic and Pugh (2017). It also echoes Pu and Liu's concepts (2023), which highlight how absorptive capacity adapts to changes in the external knowledge environment. Furthermore, the results are in line with Zhao and Zheng's proposition (2018) that absorptive capacity plays a crucial role in transforming external knowledge into innovation performance. They also correspond with the introduced concepts of the breadth and depth of absorptive capacity (Zou et al., 2017), emphasizing the importance of accessing diverse external knowledge sources and engaging in meaningful knowledge exchanges for firm innovation. The direct effect from KB to AC consistently aligns with the critical role of effectively coordinating and utilizing external knowledge to contribute to the overall absorptive capacity of the organization, as suggested by Roberts et al. (2012). Therefore, the significant direct effect of KB on AC firmly supports the indispensable role of absorptive capacity in organizational development and innovation.

Furthermore, the observed effect on the KB to IP path underscores the significant influence of external knowledge acquisition

on a firm's innovation performance. The broader the external knowledge search, the higher the likelihood of achieving optimal innovation performance. This aligns with the findings of Si et al. (2020), who emphasize the crucial role of external knowledge sources in enhancing a firm's innovation performance. Similarly, the substantial influence of KB on IP aligns with Vrontis et al. (2016), highlighting that active engagement with external knowledge sources not only enriches learning but also fosters innovation and overall firm performance.

The results further support the proposition that external knowledge sources are vital in enhancing firm innovation performance. This is consistent with Segarra-Ciprés and Llusar's (2018) assertion that both the breadth and depth of external knowledge search positively impact innovation performance. Furthermore, the direct effect observed in the KB to IP path suggests that purposeful and integrated external knowledge seeking actively contributes to innovation performance. This corresponds with the idea that internal knowledge networks play a crucial role in evaluating the effectiveness of external knowledge sourcing strategies, as emphasized by Grigoriou and Rothaermel (2016). Therefore, the significant effect on the KB to IP path aligns with the cumulative evidence from previous research, providing empirical validation for the pivotal role of external knowledge acquisition—particularly through comprehensive knowledge search—in enhancing a firm's innovation performance.

Likewise, the observed effect on the KD to AC path aligns with the established literature on absorptive capacity, confirming its pivotal role in the search for external knowledge. This is consistent with the evidence provided by Garriga et al. (2013), who documented a positive relationship between the depth of external knowledge search and a firm's innovative performance. The results also confirm the adaptability of absorptive capacity to the dynamics of external knowledge, as suggested by Pu and Liu (2023), emphasizing its responsiveness to changes in the external knowledge environment. Additionally, the findings of this study support the absorptive capacity theory articulated by Terjesen and Patel (2015), lending credence to the relationship between search depth and process innovation. The results of this study are also consistent with Radicic and Pugh (2017), who underscore that knowledge depth contributes to the realization of absorptive capacity, and the realized absorptive capacity is associated with deriving benefits.

The observed effect in the KD to IP path validates the substantial influence of knowledge depth (KD) on innovation performance (IP), aligning seamlessly with existing literature. This study's evidence is consistent with Chiang and Hung (2010), who assert that the depth of external knowledge search is pivotal for firms' innovation performance. The positive correlation between intensive knowledge access from a limited number of external channels and incremental innovation performance underscores the significance of this relationship. Similarly, our findings resonate with Garriga et al. (2013), emphasizing the connection between an abundance of innovation-relevant external knowledge and the breadth and depth of knowledge search. This also aligns with Foss et al. (2013), advocating that firms exploit existing external

knowledge bases in greater depth while extending their search scope to new external knowledge sources. Additionally, our results align with Gölgeci et al. (2019), emphasizing the importance of attention to detail and a profound appreciation of valuable knowledge associated with external search depth for innovation performance. The positive impact of a deep search for external knowledge, represented by Knowledge Depth, underscores an understanding of the significance of valuable knowledge. Furthermore, empirical support for the observed effect is consistent with insights provided by Liu (2021) regarding close interaction and frequent communication with partners engaged in a deep search for external knowledge. This suggests that deep search involves close collaboration, leading to an enhanced understanding of diverse external knowledge and a positive influence on innovation performance.

The observed effect in the KB to AC to IP pathway aligns with and supports existing literature on the mediating role of absorptive capacity in the relationship between the breadth of external knowledge search and innovation performance. These results provide empirical validation, reinforcing the pivotal role of absorptive capacity in this specific context. The pathway suggests that a broader external knowledge search contributes to absorptive capacity, thereby exerting a positive influence on innovation performance. The evidence of this study is consistent with the assertion by Chiang and Hung (2010) that accessing knowledge from a large number of external sources is positively related to radical innovation performance. Similarly, the concepts of breadth and depth in individual firms' external search strategies, as elucidated by Flor et al. (2018), indicate that absorptive capacity, acting as a mediator, plays a crucial role, particularly in the context of radical innovation.

Moreover, the pathway results offer empirical evidence supporting the role of absorptive capacity as a mediating mechanism linking external knowledge search breadth to innovation performance. This is in line with Chang et al. (2020), who revealed that realized absorptive capacity mediates the relationships between open innovation breadth and depth strategies and innovation performance. Furthermore, the pathway result suggests that absorptive capacity mediates the relationship between the breadth of external knowledge search and innovation performance, underscoring the importance of both components in driving positive outcomes. This was supported by Kim et al. (2019), specifically the significantly positive interaction effect of external search breadth and absorptive capacity, especially among those with high levels of external search depth.

The observed effect in the KD to AC to IP pathway enhances the existing body of literature, emphasizing the essential role of absorptive capacity as a mediator in relationships. This underscores the pivotal function of absorptive capacity in mediating the influence of external knowledge search on innovation performance. The findings of this study align with those of Zhao et al. (2020), who explored the mediating role of absorptive capacity in the correlation between knowledge sharing and innovation performance, highlighting its significance in

various knowledge-related contexts.

The results from the pathway are in line with these findings, providing additional empirical support for the mediating role of absorptive capacity. Similarly, this study concurs with the conclusions of Chang et al. (2020), who demonstrated that absorptive capacity mediates the connections between open innovation (OI) breadth and depth strategies and innovation performance, thereby reinforcing the consistent mediating influence of absorptive capacity.

The pathway results further elaborate on this understanding, emphasizing the role of absorptive capacity in mediating various innovation strategies. Additionally, the study aligns with insights from Flor et al. (2018) and Kim et al. (2019), who investigated the relationship between external knowledge search strategies and innovation performance, coupled with the indication that absorptive capacity shapes the connection between external search activities and innovation outcomes. Therefore, the pathway results contribute to the cumulative evidence, underscoring the crucial role of absorptive capacity as a mediator in shaping the impact of external knowledge search on innovation performance.

5. CONCLUSION

This study validates its primary research objectives by investigating the relationship among absorptive capacity (AC), knowledge breadth (KB), knowledge depth (KD), and innovation performance (IP) within an organizational context. Through comprehensive data analysis, it confirms the significant positive influence of AC on IP, aligning with the widely acknowledged idea that integrating external knowledge significantly enhances organizational innovation capabilities. Moreover, the study reveals significant positive effects of both KB and KD on AC and IP, emphasizing the importance of considering both depth (KD) and breadth (KB) in external knowledge acquisition. This finding enriches our comprehension of the inherent relationships within organizational innovation dynamics.

The results shed light on the interconnectedness among AC, KB, KD, and IP, elucidating the pivotal roles these variables play in attaining organizational innovation objectives. The practical implications are significant, urging organizations to refine their innovation strategies by prioritizing the development of absorptive capacity and expanding their external knowledge horizons. Nevertheless, it's crucial to acknowledge the study's restricted scope, which focuses solely on SMEs in the service sector of a single province. This acknowledgment aims to inform future research endeavors in this domain. To deepen these insights, future studies could investigate specific aspects, such as the impact of contextual factors.

Overall, this study significantly contributes to the literature on the knowledge-based view by enhancing our understanding of the intricate correlations among AC, KB, KD, and IP. Leveraging these determinants enables organizations to sustain a trajectory of enduring innovation.

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