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Knowledge absorptive capacity of e-commerce firms: The moderating role of industry competition

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Abstract

This study examines knowledge absorptive capacity (ACAP) in e-commerce firms, focusing on the moderating role of industry competition (IC). Leveraging Partial Least Squares Structural Equation Modeling (PLS-SEM) with data from Vietnamese e-commerce firms, we explore the impact of internal factors, including accumulated knowledge, leadership style, IT capability, knowledge management capability, and organizational structure, on ACAP. Our findings indicate that each factor significantly contributes to enhancing ACAP, with leadership style showing consistently strong effects across different firm sizes. Furthermore, IC amplifies the impact of certain internal factors, especially in medium and large enterprises, emphasizing the importance of accumulated knowledge and leadership in competitive environments. Notably, IT capability, while crucial in medium and large firms, shows limited effects in mega enterprises, suggesting a shift in resource prioritization at higher organizational scales. This study adds to ACAP literature by underscoring the dynamic relationship between competitive pressures and internal resources. Practical recommendations are provided for e-commerce managers to enhance ACAP strategically by aligning resources with market demands. This research highlights the importance of firm size and competitive intensity in shaping the absorptive capabilities crucial for maintaining competitive advantage in fast-evolving markets.

Keywords: Knowledge absorptive capacity; Industry competition; PLS-SEM; E-commerce

1. Introduction

In the context of a rapidly expanding online business market, e-commerce has emerged as a fiercely competitive and highly dynamic sector. E-commerce firms face constantly changing customer demands and must continuously innovate to maintain a competitive edge. In this process, knowledge absorptive capacity (ACAP) has become a crucial strategic factor enabling firms to acquire, transform, and apply external knowledge within their internal operations (Cohen & Levinthal, 1990; Zahra & George, 2002). ACAP optimizes business processes and enhances innovation capacity and adaptability to market fluctuations (Flatten et al., 2011; Lane et al., 2006).

According to Zahra and George (2002), ACAP comprises four key components: Acquisition, Assimilation, Transformation, and Exploitation. Acquisition refers to a firm's ability to identify and acquire new external knowledge; Assimilation involves analyzing and understanding the acquired knowledge; Transformation integrates new knowledge with existing knowledge to create novel insights; and Exploitation involves using this knowledge to generate new value. These concepts highlight the significant role ACAP plays in improving the performance and effectiveness of firms in the e-commerce sector, especially in a highly competitive environment.

Despite the critical role of ACAP, research on this capacity within the e-commerce field remains limited. This is particularly true regarding the impact of internal factors such as accumulated knowledge (AK), leadership style (LS), IT capability (ITC), knowledge management capability (KMC), and organizational structure (OS). These factors are vital in

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developing and strengthening a firm's ACAP, yet they have not been thoroughly explored in e-commerce (Jiménez-Barrionuevo et al., 2011; Lichtenthaler, 2009).

Moreover, industry competition (IC) is another factor that potentially moderates the relationship between these internal factors and a firm's ACAP. In a highly competitive business environment, firms may be more motivated to enhance their absorptive capacity to respond swiftly to market changes (Chang et al., 2014; Vega-Jurado et al., 2008). However, the moderating role of IC in the e-commerce context has not been fully examined, particularly in Vietnam, where the e-commerce market is developing rapidly and characterized by high competition (Nguyen et al., 2020).

Based on these considerations, this paper aims to identify the internal factors influencing the ACAP of e-commerce firms and to examine the moderating role of industry competition. Specifically, this research seeks to answer how factors such as accumulated knowledge, leadership style, IT capability, knowledge management capability, and organizational structure affect the ACAP of e-commerce firms and how industry competition moderates these relationships.

The study utilizes partial least squares structural equation modeling (PLS-SEM) to test the hypotheses and analyze the relationships within the research model. The paper is structured as follows: the first section provides a literature review on ACAP and its influencing factors; the following section discusses the research methodology, including the research design, sample, and data analysis methods; the next part presents the data analysis and hypothesis testing results; the discussion section interprets the main findings and compares them with previous studies; and finally, the paper concludes with theoretical contributions, practical implications, and suggestions for future research.

2. Literature review

2.1. Knowledge absorptive capacity (ACAP)

Knowledge absorptive capacity (ACAP) is a concept introduced by Cohen and Levinthal (1990) to describe an organization's ability to recognize, assimilate, and apply new external knowledge for commercial purposes. ACAP is widely regarded as a crucial driver for innovation, allowing firms to adapt to environmental changes and leverage new information to enhance competitiveness (Zahra & George, 2002). By developing a strong ACAP, firms can effectively capture and exploit knowledge from external sources, facilitating the improvement of organizational processes, products, and services (Lane et al., 2006; Lichtenthaler, 2009).

According to Zahra and George (2002), ACAP consists of four dimensions: Acquisition, Assimilation, Transformation, and Exploitation. Acquisition refers to a firm's ability to identify and acquire valuable external knowledge. Assimilation involves processing and understanding this new knowledge, making it compatible with existing knowledge structures within the firm. Transformation is the process by which firms combine the acquired knowledge with existing capabilities to generate new insights or skills. Finally, Exploitation reflects the firm's capacity to use the newly integrated knowledge in its operations to create value (Flatten et al., 2011; Jansen et al., 2005).

ACAP is particularly relevant in the e-commerce sector due to the rapid technological changes and competitive pressures that characterize the industry. Firms with a high ACAP can quickly adopt innovations in information technology, data analytics, and customer relationship management, which are critical for success in e-commerce (Nguyen et al., 2020). Furthermore, ACAP enables firms to learn from their competitors and industry partners, thus accelerating the adoption of best practices and innovative solutions (Jiménez-Barrionuevo et al., 2011).

2.2. Factors affecting knowledge absorptive capacity (ACAP)

2.2.1. Accumulated knowledge (AK)

Accumulated knowledge (AK) represents the stock of knowledge and expertise a firm has built over time, serving as a foundation for absorbing new knowledge. According to Cohen and Levinthal (1990), accumulated knowledge enables firms to recognize valuable external knowledge, making it easier to assimilate and exploit new information effectively. The concept of accumulated knowledge encompasses both explicit knowledge (e.g., documented procedures and databases) and tacit knowledge (e.g., skills and expertise of employees) (Nonaka & Takeuchi, 1995; Teece, 2007). In this context, accumulated knowledge can significantly impact a firm's ACAP, as it determines the baseline from which new knowledge is understood, integrated, and applied (Lichtenthaler, 2009; Lane et al., 2006).

In e-commerce firms, accumulated knowledge is crucial in adapting to market changes and technological advancements. The rapid evolution of digital technologies and customer preferences in the e-commerce sector requires firms to

continuously update their knowledge base. Firms with a strong foundation of accumulated knowledge are better positioned to acquire and apply innovative solutions that enhance competitiveness (Flatten et al., 2011). For example, firms that have accumulated knowledge in digital marketing or data analytics are more capable of adopting new tools and technologies in these areas, which contributes to their overall ACAP (Nguyen et al., 2020).

Accumulated knowledge not only facilitates the acquisition of external knowledge but also supports the assimilation and transformation processes by providing a contextual framework through which new information can be evaluated and interpreted. Consequently, firms with substantial accumulated knowledge are more likely to leverage ACAP to improve their processes, products, and customer service, ultimately achieving a sustainable competitive advantage in the fast-paced e-commerce environment (Jansen et al., 2005; Jiménez-Barrionuevo et al., 2011).

2.2.2. Leadership style (LS)

Leadership style (LS) is recognized as a critical factor influencing an organization's ability to develop and sustain its absorptive capacity (ACAP). Effective leadership can create an environment conducive to learning, innovation, and knowledge sharing, which are essential for a firm to effectively absorb and utilize external knowledge (Vera & Crossan, 2004). Transformational and participative leadership styles, in particular, have been associated with higher levels of ACAP, as they encourage open communication, employee empowerment, and a proactive approach to knowledge acquisition and application (Garcia-Morales et al., 2008; Jansen et al., 2009).

Transformational leaders inspire employees to go beyond their standard responsibilities, fostering a culture of continuous learning and adaptation. This leadership style promotes employees' motivation to acquire new knowledge and integrate it into existing organizational processes, thereby enhancing ACAP (Bass & Riggio, 2006). Participative leadership, on the other hand, involves engaging employees in decision-making and encouraging a collaborative approach to problem-solving. This can lead to greater openness to external knowledge and more effective knowledge assimilation and transformation (Berson et al., 2006).

In the e-commerce sector, where rapid change and innovation are constant, a leadership style that promotes flexibility, creativity, and knowledge sharing is essential. Leaders in this sector must adapt to the fast-paced environment, fostering a culture that supports ACAP and encourages employees to stay updated with the latest technological advancements and market trends (Nguyen et al., 2020). Additionally, leadership styles that prioritize knowledge-sharing and employee development are more likely to drive the successful adoption and application of external knowledge, which is vital for maintaining competitive advantage in the e-commerce industry (Jiménez-Barrionuevo et al., 2011; Lichtenthaler, 2009).

2.2.3. IT Capability (ITC)

IT capability (ITC) refers to a firm's ability to effectively utilize information technology to support business processes, decision-making, and innovation. Within the context of absorptive capacity (ACAP), ITC plays a significant role by enabling firms to collect, process, and distribute knowledge efficiently, thus facilitating the acquisition, assimilation, transformation, and exploitation of new information (Bharadwaj, 2000; Pavlou & El Sawy, 2006). IT capability provides the necessary technological infrastructure for capturing external knowledge, integrating it with internal systems, and applying it to create value, especially in fast-evolving sectors like e-commerce (Benitez et al., 2018).

In e-commerce, where technological advancements occur at a rapid pace, ITC is essential for firms to stay competitive. Strong IT capabilities allow e-commerce firms to gather valuable data about customer behavior, market trends, and competitor strategies. This data, when processed and analyzed, becomes a source of actionable insights that can be used to enhance ACAP by informing strategic decision-making and innovation (Chae et al., 2014). Moreover, ITC supports knowledge management systems, which are critical for storing, retrieving, and disseminating knowledge throughout the organization, thus promoting a knowledge-sharing culture (Gold et al., 2001).

Firms with robust IT capabilities are better positioned to leverage external knowledge and incorporate it into their operations. For example, firms utilizing advanced data analytics or artificial intelligence tools can more quickly identify patterns in customer data, refine their marketing strategies, and develop new services tailored to customer needs (Nguyen et al., 2020). Consequently, ITC not only enhances a firm's ACAP but also contributes to its long-term competitive advantage by enabling continuous learning and adaptation to market changes (Lichtenthaler, 2009).

2.2.4. Knowledge management capability (KMC)

Knowledge management capability (KMC) refers to a firm's ability to effectively manage the acquisition, storage, sharing, and utilization of knowledge across the organization. KMC is essential for developing absorptive capacity

(ACAP), as it provides a structured approach to integrating external knowledge into the firm's existing knowledge base (Gold et al., 2001). Strong KMC enables organizations to systematically capture valuable knowledge, facilitate knowledge sharing among employees, and leverage that knowledge to foster innovation and improve decision-making (Grant, 1996; Alavi & Leidner, 2001).

In the e-commerce sector, where rapid changes in consumer behavior and technology are prevalent, KMC plays a vital role in sustaining competitive advantage. Effective knowledge management processes ensure that e-commerce firms can quickly absorb and utilize relevant market and technological information, helping them adapt to evolving trends and maintain responsiveness to customer demands (Chuang, 2004). Firms with high KMC are better equipped to organize and disseminate knowledge, which supports ACAP by enabling employees to access and apply critical information when needed (Nguyen et al., 2020).

Moreover, KMC promotes a knowledge-sharing culture, which is essential for maximizing ACAP. Through collaborative tools, training programs, and incentives for knowledge sharing, firms can enhance employees' willingness and ability to assimilate and exploit external knowledge (Andreeva & Kianto, 2012). Consequently, KMC not only strengthens ACAP but also drives organizational performance by creating a foundation for continuous learning and adaptation in the competitive e-commerce environment (Darroch, 2005; Jiménez-Barrionuevo et al., 2011).

2.2.5. Organizational structure (OS)

Organizational structure (OS) defines the formal layout of authority, communication, and workflows within a firm. In the context of absorptive capacity (ACAP), an adaptable and flexible OS is crucial, as it enables firms to efficiently integrate and exploit new knowledge. Structures that are decentralized or organic, as opposed to rigid hierarchies, are more conducive to knowledge sharing, collaboration, and innovation, all of which are essential for enhancing ACAP (Burns & Stalker, 1961; Jansen et al., 2006).

Decentralized structures empower employees, allowing for quicker decision-making and greater autonomy in problem-solving. This flexibility fosters a culture where new ideas and external knowledge can be easily shared and adapted to fit the organization's needs (Gibson & Birkinshaw, 2004). In contrast, hierarchical structures may inhibit knowledge flow due to rigid chains of command and slower decision-making processes. As such, firms with more flexible structures can respond better to the dynamic demands of the e-commerce industry, where speed and adaptability are critical (Ahmadi et al., 2012).

In e-commerce, where technological changes and market demands are highly unpredictable, a flexible organizational structure allows firms to more effectively absorb and leverage external knowledge. By promoting collaboration and open communication channels, a well-designed OS supports ACAP by ensuring that valuable knowledge reaches the right people at the right time. This adaptability enables firms to continuously update their processes, innovate, and stay competitive (Nguyen et al., 2020; Jiménez-Barrionuevo et al., 2011).

2.3. Industry competition as a moderator

Industry competition (IC) plays a significant role in shaping a firm's absorptive capacity (ACAP), as competitive pressures drive firms to rapidly acquire, assimilate, and exploit knowledge to maintain a competitive edge. In highly competitive environments, firms often face intense pressures to innovate and respond quickly to market shifts. As a result, the presence of strong IC can moderate the relationships between internal factors (such as accumulated knowledge, leadership style, IT capability, knowledge management capability, and organizational structure) and ACAP by influencing the urgency and approach with which firms absorb external knowledge (Porter, 1980; Chang et al., 2014).

IC may amplify the effects of internal capabilities on ACAP by motivating firms to leverage their resources more effectively. For instance, when competition is high, firms with strong IT capabilities or robust knowledge management systems are more likely to fully utilize these assets to absorb and apply new knowledge in innovative ways (Tsai, 2001). Similarly, leadership styles that promote adaptability and flexibility become even more valuable, as they facilitate quick responses to market demands (Vega-Jurado et al., 2008). In this context, IC acts as a catalyst, intensifying the need for firms to optimize their internal capabilities to enhance ACAP (Zahra & George, 2002).

In the e-commerce industry, characterized by rapid technological advancements and changing consumer preferences, IC has become increasingly relevant. Firms operating in high-competition markets may adopt a proactive approach toward knowledge acquisition, often seeking to innovate faster than their competitors to capture market share (Nguyen et al., 2020). By moderating the relationship between internal factors and ACAP, IC underscores the importance of a

firm's ability to adapt its strategies and processes to sustain competitive advantage in volatile environments (Lane et al., 2006).

2.4. Hypothesis and research model

2.4.1. Main hypotheses

Research on absorptive capacity (ACAP) has consistently highlighted the influence of various internal factors that enhance a firm's ability to absorb and apply external knowledge. This study builds on prior findings by examining the specific impact of accumulated knowledge (AK), leadership style (LS), IT capability (ITC), knowledge management capability (KMC), and organizational structure (OS) on ACAP in the e-commerce context. The hypotheses for each factor are developed as follows:

Accumulated knowledge and ACAP: Accumulated knowledge (AK) provides a foundation upon which new information can be understood and applied. Firms with substantial AK have a strong base facilitating the acquisition, assimilation, and transformation of external knowledge (Cohen & Levinthal, 1990; Lane et al., 2006). Therefore, the author hypothesizes that:

H1: *Accumulated knowledge positively influences absorptive capacity.*

Leadership style and ACAP: Leadership style (LS), particularly transformational and participative styles, promotes a culture of learning and adaptability, which is essential for enhancing ACAP (Vera & Crossan, 2004; Garcia-Morales et al., 2008). Leaders who encourage open communication and empower employees are likely to strengthen the firm's ability to absorb new knowledge effectively. Hence, the author proposes that:

H2: *Leadership style positively influences absorptive capacity.*

IT Capability and ACAP: IT capability (ITC) is critical for gathering, processing, and sharing knowledge across an organization, thus supporting ACAP by enabling efficient knowledge integration and application (Pavlou & El Sawy, 2006; Chae et al., 2014). Firms with strong IT infrastructure are better positioned to exploit external knowledge. Thus, the author hypothesizes that:

H3: *IT capability positively influences absorptive capacity.*

Knowledge management capability and ACAP: Knowledge management capability (KMC) enables firms to systematically manage the acquisition, storage, and dissemination of knowledge, which enhances ACAP by promoting knowledge sharing and utilization (Gold et al., 2001; Darroch, 2005). The author proposes that:

H4: *Knowledge management capability positively influences absorptive capacity.*

Organizational structure and ACAP: A flexible organizational structure (OS) supports ACAP by facilitating communication and collaboration, which are essential for the effective absorption and application of knowledge (Burns & Stalker, 1961; Jansen et al., 2006). Thus, the author hypothesizes that:

H5: *Organizational structure positively influences absorptive capacity.*

2.4.2. Moderation Hypotheses

The industry competition (IC) level can be a significant moderator in the relationship between internal factors and a firm's absorptive capacity (ACAP). When competition within the industry is high, firms are more likely to leverage their internal resources to adapt quickly and maintain a competitive advantage. The following hypotheses are proposed to examine the moderating role of IC:

Moderating role of IC on the relationship between AK and ACAP: In highly competitive industries, firms with substantial accumulated knowledge (AK) have an advantage in quickly absorbing and applying new information. Strong competition motivates these firms to leverage AK to innovate and respond effectively to market demands (Chang et al., 2014). Thus, the author hypothesizes that:

H6a: *IC positively moderates the relationship between AK and ACAP.*

Moderating role of IC on the relationship between LS and ACAP: Leadership style (LS) that emphasizes adaptability and empowerment becomes even more crucial in a competitive environment. In such settings, leaders are likely to encourage rapid knowledge acquisition and application to keep up with competitors (Vera & Crossan, 2004; Garcia-Morales et al., 2008). Therefore, the author proposes that:

H6b: *IC positively moderates the relationship between LS and ACAP.*

Moderating role of IC on the relationship between ITC and ACAP: Firms with strong IT capabilities (ITC) are better equipped to leverage technology for competitive advantage in high-competition markets. In these environments, ITC enhances ACAP by facilitating the rapid collection and analysis of external knowledge, enabling firms to respond to competitive pressures (Pavlou & El Sawy, 2006; Tsai, 2001). Thus, the author hypothesizes that:

H6c: *IC positively moderates the relationship between ITC and ACAP.*

Moderating role of IC on the relationship between KMC and ACAP: Knowledge management capability (KMC) supports ACAP by ensuring that knowledge is effectively shared and utilized within the firm. In a highly competitive industry, KMC becomes even more valuable as firms are compelled to leverage knowledge resources swiftly to innovate and remain competitive (Gold et al., 2001; Darroch, 2005). Hence, the author proposes that:

H6d: *IC positively moderates the relationship between KMC and ACAP*

Moderating role of IC on the relationship between OS and ACAP: A flexible organizational structure (OS) allows for faster communication and decision-making, which are critical in competitive industries. Firms with adaptable structures can better absorb and exploit external knowledge in response to competitive pressures (Jansen et al., 2006; Burns & Stalker, 1961). Therefore, the author hypothesizes that:

H6e: *IC positively moderates the relationship between OS and ACAP.*

2.5. Research Model

The research model for this study illustrates the relationships between key internal factors—accumulated knowledge (AK), leadership style (LS), IT capability (ITC), knowledge management capability (KMC), and organizational structure (OS)—and absorptive capacity (ACAP) in e-commerce firms. The model further explores the moderating role of industry competition (IC) on these relationships, hypothesizing that high competition intensifies the impact of each internal factor on ACAP.

Each of the main hypotheses (**H1** to **H5**) reflects a direct relationship between the internal factors and ACAP, positing that accumulated knowledge, adaptive leadership, robust IT infrastructure, effective knowledge management practices, and a flexible organizational structure all enhance a firm's absorptive capacity. Meanwhile, the moderation hypotheses (**H6a** to **H6e**) posit that the competitive intensity within the industry strengthens these relationships, encouraging firms to maximize the utilization of their internal resources in response to market pressures.

The figure below presents the conceptual research model, detailing the hypothesized relationships between the internal factors, absorptive capacity, and the moderating influence of industry competition.

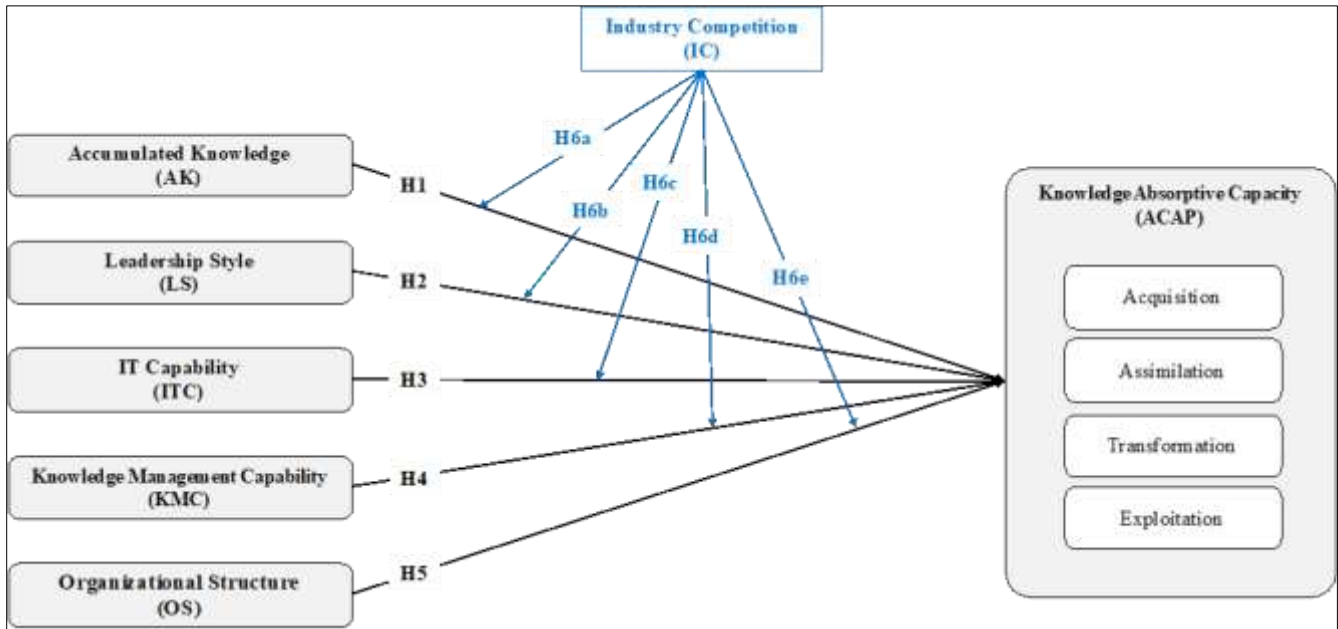


Figure 1 Research model

3. Methodology

3.1. Research Design

This study adopts a quantitative research design to examine the relationships between internal factors (accumulated knowledge, leadership style, IT capability, knowledge management capability, and organizational structure), absorptive capacity (ACAP), and the moderating role of industry competition (IC) within e-commerce firms. A cross-sectional survey approach was used, enabling the collection of data from a sample of e-commerce firms at a single point in time. This approach is well-suited for identifying relationships between variables and testing hypotheses in a dynamic industry context (Hair et al., 2017).

Partial least squares structural equation modeling (PLS-SEM) was employed as the primary data analysis technique. PLS-SEM is particularly advantageous for this study due to its ability to handle complex models with multiple relationships, its robustness with smaller sample sizes, and its suitability for exploratory research (Hair et al., 2019). This method is ideal for examining both the direct effects of the internal factors on ACAP and the moderating influence of industry competition, thus providing a comprehensive understanding of the research model.

3.2. Data Collection

The data for this study were collected through an online survey designed to capture relevant information from employees of e-commerce firms. The survey was distributed via personal networks and professional connections, ensuring a broad and diverse reach within the e-commerce sector. This approach was chosen due to its efficiency and ability to access a geographically dispersed sample quickly and cost-effectively.

The survey included items measuring the constructs of accumulated knowledge, leadership style, IT capability, knowledge management capability, organizational structure, absorptive capacity (ACAP), and industry competition. To enhance response quality, participants were assured of the confidentiality and anonymity of their responses. A total of **463** valid responses were obtained, providing a robust dataset for testing the research hypotheses through PLS-SEM analysis.

3.3. Measurement scales

The measurement scales used in this study were primarily derived and adapted from established literature to ensure both reliability and validity. Each construct—accumulated knowledge (AK), leadership style (LS), IT capability (ITC), knowledge management capability (KMC), organizational structure (OS), absorptive capacity (ACAP), and industry competition (IC)—was measured using multi-item Likert scales, with response options ranging from 1 (strongly

disagree) to 5 (strongly agree). *Accumulated knowledge (AK)*: Items measuring AK were adapted from the works of Cohen and Levinthal (1990) and Lane et al. (2006), focusing on the organization's ability to recognize and assimilate relevant knowledge. *Leadership style (LS)*: LS was assessed based on transformational and participative leadership dimensions, following established scales from Vera and Crossan (2004) and Garcia-Morales et al. (2008), capturing the degree to which leadership encourages learning and knowledge sharing. *IT Capability (ITC)*: ITC was measured using items adapted from Bharadwaj (2000) and Pavlou and El Sawy (2006), assessing the firm's ability to utilize IT infrastructure for effective knowledge processing. *Knowledge management capability (KMC)*: The KMC scale was adapted from Gold et al. (2001) and Darroch (2005), evaluating the firm's capacity to acquire, store, share, and utilize knowledge effectively. *Organizational structure (OS)*: OS was measured using items based on the flexibility and decentralization of the organizational structure, following the models of Burns and Stalker (1961) and Jansen et al. (2006). *Absorptive capacity (ACAP)*: The ACAP construct was assessed following the multi-dimensional model proposed by Zahra and George (2002), covering acquisition, assimilation, transformation, and exploitation processes. *Industry competition (IC)*: IC was measured with items adapted from Porter (1980) and Chang et al. (2014), assessing the perceived intensity of competition within the industry.

All items were translated and adapted to fit the Vietnamese e-commerce context, ensuring clarity and relevance for participants. The scales were further tested for reliability and validity as part of the PLS-SEM analysis.

3.4. Data Analysis

The data analysis was conducted using partial least squares structural equation modeling (PLS-SEM), a method well-suited for examining complex relationships and exploratory research with medium sample sizes. The analysis consisted of three main stages: (1) Measurement model evaluation: Ensured the reliability and validity of constructs by assessing composite reliability, convergent validity, and discriminant validity. (2) Structural model evaluation: Tested the hypothesized relationships, examining the significance of path coefficients to evaluate the direct effects within the model. (3) Multi-Group analysis (MGA): Conducted to investigate the moderating role of industry competition, comparing path coefficients between groups with different levels of competitive intensity.

3.5. Ethical Considerations

This study adhered to ethical standards to ensure the protection and respect of participants throughout the research process. All respondents were informed of the study's purpose, and their participation was entirely voluntary. Anonymity and confidentiality were guaranteed, with all responses collected and stored securely to protect participants' identities. Participants were also assured that their data would be used solely for research purposes, without any risk to their privacy.

Additionally, the survey was designed to avoid any intrusive or sensitive questions, thereby minimizing any discomfort for participants. Ethical approval was obtained in accordance with institutional guidelines to ensure that all aspects of data collection complied with relevant ethical standards.

4. Results

4.1. Measurement model evaluation

To assess the reliability and validity of the constructs, the author evaluated the measurement model through several criteria, including internal consistency reliability, convergent validity, and discriminant validity, Table 1 and Table 2. This evaluation ensures that each construct accurately reflects the theoretical constructs and that they are sufficiently distinct from each other.

The reliability of each construct was first confirmed through high outer loadings on its items, indicating strong representation by the measurement indicators. For instance, the outer loadings for "Accumulated Knowledge" (AK) range from 0.858 to 0.89, while for "IT Capability" (ITC) they range from 0.854 to 0.874, meeting the criteria for item reliability (Hair et al., 2019). Internal consistency was further demonstrated by Cronbach's alpha and Composite Reliability (CR) values, which all exceed the 0.7 threshold. For example, "Industry Competition" (IC) shows Cronbach's alpha of 0.904 and CR of 0.927, establishing reliable internal consistency (see Table 1).

Convergent validity was supported by average variance extracted (AVE) values, which are above the 0.5 threshold for all constructs, signifying that each construct captures a sufficient amount of variance from its items (Fornell & Larcker, 1981). An example is the "Leadership Style" (LS) construct, with an AVE of 0.755, confirming that more than half of its variance is explained by its items (see Table 1).

Table 1 Assessment of measurement model

Constructs	Items	Outer loading	VIF	Cronbach's alpha	CR (rho_c)	AVE
Accumulated knowledge (AK)	AK1	0.89	3.102	0.92	0.94	0.758
	AK2	0.858	2.501			
	AK3	0.866	2.597			
	AK4	0.877	2.825			
	AK5	0.863	2.682			
Industry competition (IC)	IC1	0.821	2.57	0.904	0.927	0.719
	IC2	0.838	2.251			
	IC3	0.869	2.381			
	IC4	0.858	2.343			
	IC5	0.852	2.486			
IT Capability (ITC)	ITC1	0.854	2.491	0.918	0.938	0.753
	ITC2	0.868	2.654			
	ITC3	0.877	2.775			
	ITC4	0.864	2.572			
	ITC5	0.874	2.808			
Absorptive capacity (ACAP)	KAAC1	0.813	2.565	0.961	0.965	0.663
	KAAC2	0.827	2.774			
	KAAC3	0.813	2.613			
	KAAs1	0.82	2.669			
	KAAs2	0.838	2.939			
	KAAs3	0.807	2.565			
	KAAs4	0.802	2.465			
	KAEx1	0.806	2.569			
	KAEx2	0.805	2.508			
	KAEx3	0.803	2.487			
	KATr1	0.818	2.695			
	KATr2	0.803	2.494			
	KATr3	0.825	2.724			
	KATr4	0.822	2.692			
Knowledge management capability (KMC)	KMC1*	0.662	1.666	0.91	0.929	0.655
	KMC2*	0.651	1.612			
	KMC3	0.864	2.807			
	KMC4	0.856	2.789			
	KMC5	0.856	2.724			
	KMC6	0.872	2.969			

	KMC7	0.866	2.975			
Leadership style (LS)	LS1	0.876	2.797	0.919	0.939	0.755
	LS2	0.863	2.608			
	LS3	0.858	2.552			
	LS4	0.873	2.823			
	LS5	0.876	2.792			
Organizational structure (OS)	OS1	0.866	3.013	0.931	0.944	0.681
	OS2	0.85	2.749			
	OS3	0.834	2.596			
	OS4*	0.582	1.403			
	OS5	0.859	2.931			
	OS6	0.858	2.979			
	OS7	0.859	2.884			
	OS8	0.856	2.884			

*: Variables are excluded due to outer loading <0.7

Discriminant validity was assessed using both the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio. According to the Fornell-Larcker criterion, each construct’s square root of AVE exceeds its correlations with other constructs. For example, the square root of AVE for “ACAP” is 0.815, which is higher than its correlations with other constructs, supporting discriminant validity (see Table 2). Additionally, HTMT values were all below the 0.9 threshold, further confirming discriminant validity. For instance, the HTMT between “Accumulated Knowledge” and “Knowledge Management Capability” is 0.742, indicating distinct constructs (see Table 2).

In summary, the results indicate that the measurement model exhibits strong reliability and validity, thus supporting the constructs used in this study for further analysis.

Table 2 The measurements’ discriminant validity

Fornell-Larcker criterion	ACAP	AK	IC	ITC	KMC	LS	OS
ACAP	0.815						
AK	0.699	0.871					
IC	0.073	-0.168	0.848				
ITC	0.706	0.669	-0.066	0.868			
KMC	0.662	0.743	-0.176	0.537	0.809		
LS	0.745	0.59	0.096	0.504	0.658	0.869	
OS	0.734	0.67	-0.021	0.859	0.529	0.588	0.826
HTMT Criterion	ACAP	AK	IC	ITC	KMC	LS	OS
AK	0.742						
IC	0.076	0.187					
ITC	0.751	0.727	0.077				
KMC	0.695	0.804	0.194	0.576			
LS	0.792	0.64	0.099	0.547	0.706		
OS	0.772	0.72	0.05	0.926	0.567	0.632	

4.2. Structural model evaluation

To test the hypothesized relationships within the research model, the author evaluated the structural model using path coefficients, t-values, and p-values to determine the significance and strength of each relationship (see Table 3). The bootstrapping technique with 5,000 resamples was applied to assess the stability and significance of the model estimates, providing robust confidence intervals for the path coefficients (Hair et al., 2017).

The hypothesis testing results provide insight into the relationships between internal factors and absorptive capacity (ACAP) and the moderating effect of industry competition (IC). Using path coefficients, t-values, and p-values from the structural model, each hypothesis was evaluated to confirm its significance within the context of e-commerce firms (See Table 4).

The results support most of the proposed hypotheses, indicating significant positive effects of the internal factors on ACAP. **H1**, which posited that accumulated knowledge (AK) positively influences ACAP, is supported with a path coefficient of 0.151, t-value of 3.334, and p-value of 0.001. Similarly, **H2** confirms that leadership style (LS) positively impacts ACAP, with a path coefficient of 0.364, t-value of 8.876, and p-value < 0.001, indicating a strong effect.

H3, which hypothesized the positive influence of IT capability (ITC) on ACAP, is supported with a path coefficient of 0.203, t-value of 4.181, and p-value < 0.001, showing that technological infrastructure contributes to absorptive capacity. Furthermore, **H4** and **H5**, regarding knowledge management capability (KMC) and organizational structure (OS), respectively, are both supported with path coefficients of 0.133 and 0.171 and p-values < 0.05, indicating their essential role in enhancing ACAP.

The moderation hypotheses also yield significant findings. For instance, **H6b**, hypothesizing that IC moderates the relationship between LS and ACAP, is supported with a path coefficient of 0.157, t-value of 3.751, and p-value < 0.001. Meanwhile, these other hypotheses (**H6a**, **H6c**, **H6d**, **H6e**) are unsupported. These results suggest that industry competition significantly moderates certain relationships, particularly those involving leadership, emphasizing the need for firms to leverage these internal factors in competitive environments.

In summary, the hypothesis testing confirms that internal capabilities significantly impact ACAP, with industry competition playing a notable moderating role in some relationships. These findings highlight the strategic importance of building absorptive capacity through internal resources, especially in high competition.

Table 3 Hypothesis results

Path	Path coefficient	Standard deviation	T statistics	P values	Results
AK -> ACAP	0.151	0.045	3.334	0.001	H1: Supported
LS -> ACAP	0.364	0.041	8.876	0	H2: Supported
ITC -> ACAP	0.203	0.049	4.181	0	H3: Supported
KMC -> ACAP	0.133	0.045	2.994	0.003	H4: Supported
OS -> ACAP	0.171	0.051	3.361	0.001	H5: Supported
IC x AK -> ACAP	0.004	0.044	0.101	0.919	H6a: Not supported
IC x LS -> ACAP	0.157	0.042	3.751	0	H6b: Supported
IC x ITC -> ACAP	-0.051	0.044	1.144	0.253	H6c: Not supported
IC x KMC -> ACAP	-0.019	0.039	0.478	0.633	H6d: Not supported
IC x OS -> ACAP	-0.078	0.054	1.438	0.151	H6e: Not supported

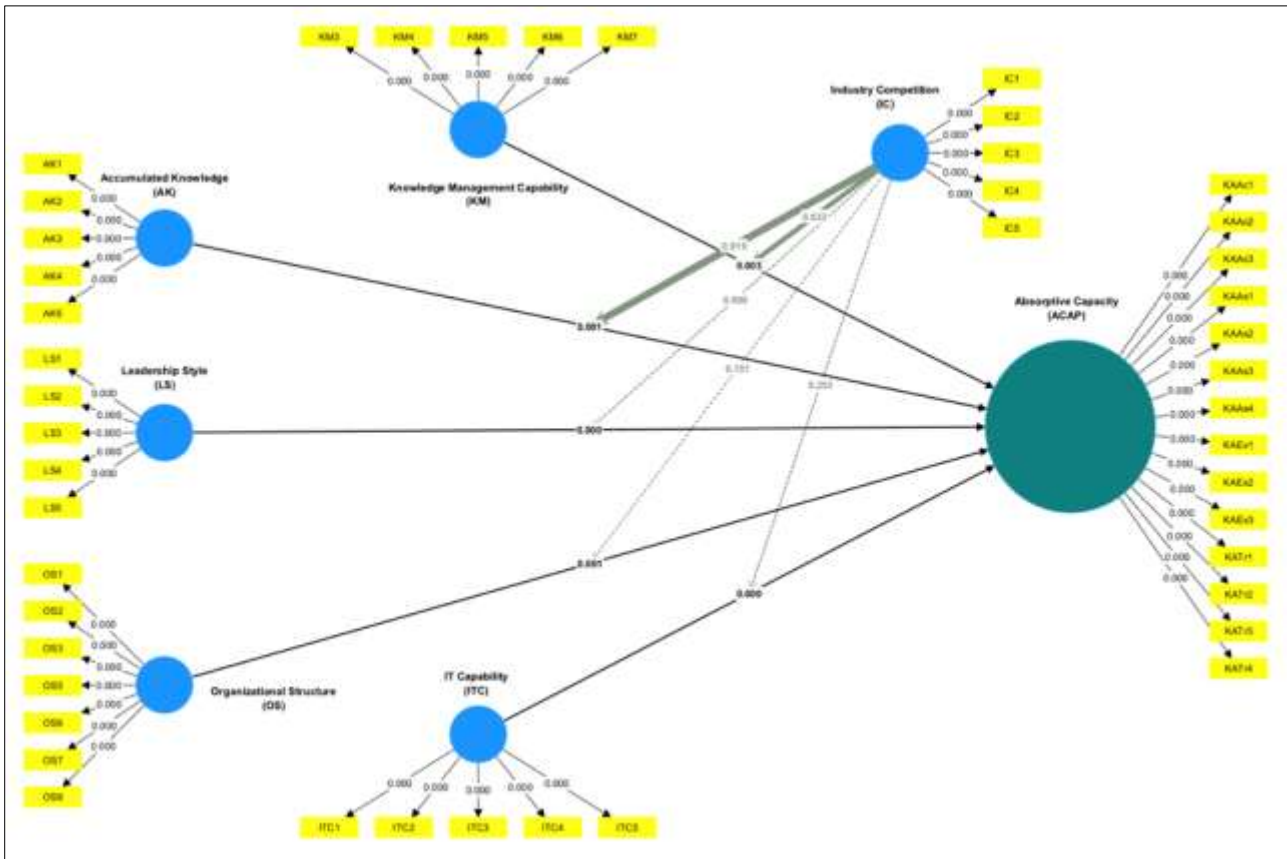


Figure 2 Hypothesis results

4.2.1. Multigroup Analysis (MGA)

The Multigroup Analysis (MGA) examines the moderating effects of enterprise size on the relationships between various internal factors and absorptive capacity (ACAP), using data from large, medium, and mega enterprises.

The results for **accumulated** knowledge (AK) indicate a significant positive effect on ACAP in medium enterprises (ME), with a t-value of 2.411 and p-value of 0.016. In contrast, this effect is not significant for large and mega enterprises. This suggests that accumulated knowledge may be particularly valuable for medium-sized firms, where a well-established knowledge base can substantially enhance ACAP.

For industry competition (IC), the results reveal a strong positive impact on ACAP for large enterprises (LE) ($t = 2.838$, $p = 0.005$), with a marginal effect observed for mega enterprises ($t = 1.898$, $p = 0.058$), and no significant effect for medium enterprises. This finding implies that larger firms in highly competitive markets are driven to enhance their knowledge absorption capabilities and will likely maintain their competitive positioning.

Regarding IT capability (ITC), both large and medium enterprises exhibit significant positive effects on ACAP, with t-values of 2.157 and 2.405 and p-values of 0.031 and 0.016, respectively. This indicates that IT infrastructure is critical in facilitating knowledge absorption for these enterprise sizes. Mega enterprises, however, show no significant effect, potentially reflecting a reliance on alternative capabilities to enhance ACAP.

The analysis of knowledge management capability (KMC) reveals marginal significance for medium and mega enterprises, with t-values of 1.795 ($p = 0.073$) and 1.669 ($p = 0.095$), respectively. This suggests that while KMC has a moderate influence, its importance may vary depending on enterprise size and operational context.

The results for leadership style (LS) show a highly significant positive effect across all enterprise groups. Large, medium, and mega enterprises demonstrate t-values of 6.962, 3.231, and 4.244, with corresponding p-values all below 0.01. This consistency underscores the critical role of effective leadership in fostering ACAP, regardless of enterprise size.

Lastly, organizational structure (OS) exhibits a significant positive effect on ACAP only in mega enterprises, with a t-value of 2.083 and a p-value of 0.037, while large and medium enterprises show no significant effect. This suggests that flexible organizational structures may be particularly important for the largest firms in effectively leveraging external knowledge.

Overall, the MGA findings highlight that the importance of various internal factors in enhancing ACAP differs across enterprise sizes. This provides insights into strategic focus areas for e-commerce firms based on their size and competitive environment.

Table 4 MGA results

MGA	Original (LE)	Original (ME)	Original (MeE)	t (LE)	t (ME)	t (MeE)	p (LE)	p (ME)	p (MeE)
AK -> ACAP	0.112	0.226	0.131	1.279	2.411	1.208	0.201	0.016	0.227
IC -> ACAP	0.136	0.043	0.111	2.838	0.715	1.898	0.005	0.474	0.058
ITC -> ACAP	0.222	0.271	0.13	2.157	2.405	1.496	0.031	0.016	0.135
KMC -> ACAP	0.126	0.142	0.18	1.473	1.795	1.669	0.141	0.073	0.095
LS -> ACAP	0.454	0.26	0.367	6.962	3.231	4.244	0	0.001	0
OS -> ACAP	0.154	0.132	0.205	1.39	1.275	2.083	0.165	0.202	0.037
IC x KMC -> ACAP	0.07	-0.007	-0.106	0.872	0.08	0.93	0.383	0.936	0.352
IC x LS -> ACAP	0.145	0.013	0.155	2.451	0.147	1.596	0.014	0.883	0.111
IC x AK -> ACAP	-0.078	0.102	0.058	0.927	0.714	0.476	0.354	0.475	0.634
IC x ITC -> ACAP	0.036	-0.103	-0.018	0.392	0.784	0.194	0.695	0.433	0.847
IC x OS -> ACAP	-0.173	-0.018	-0.085	1.569	0.146	0.669	0.117	0.884	0.504

Note: LE: Large Enterprises, ME: Medium Enterprises, MeE: Mega Enterprises

5. Discussion

5.1. The moderating role of IC

The results of the Multigroup Analysis (MGA) provide compelling evidence for the moderating role of industry competition (IC) in shaping the relationship between internal factors and absorptive capacity (ACAP) across e-commerce firms of different sizes. Industry competition amplifies the influence of certain internal factors on ACAP, particularly in larger enterprises, suggesting that competitive pressures drive firms to leverage their resources more effectively to sustain a competitive edge.

For instance, the findings reveal that IC significantly enhances the positive impact of accumulated knowledge (AK) on ACAP in medium enterprises. This effect highlights how, under competitive pressures, medium-sized firms prioritize accumulated knowledge to stay adaptive and innovative. In highly competitive markets, accumulated knowledge provides a foundation that enables medium-sized firms to assimilate and exploit new information more efficiently, supporting them in meeting rapidly changing market demands.

In large enterprises, IC also plays a critical role by reinforcing the positive relationship between leadership style (LS) and ACAP. This relationship suggests that in competitive settings, adaptive and transformational leadership becomes more valuable, empowering employees to acquire and apply external knowledge to gain a strategic advantage. The influence of IC on leadership is likely due to these firms' larger-scale operations, where effective leadership can orchestrate complex organizational dynamics to optimize knowledge absorption.

On the other hand, the moderating effect of IC is less pronounced in the relationship between IT capability (ITC) and ACAP, particularly for mega enterprises. The absence of significant moderation for ITC in this group may reflect a saturation effect, where the IT capabilities of mega enterprises are already highly developed and contribute less to ACAP under varying levels of competition. This finding suggests that while IT infrastructure is foundational for all firms, its

marginal benefit to ACAP may diminish in larger, highly competitive firms where other capabilities become more crucial.

The observed moderating effects of IC provide important insights into how competitive pressures shape the strategic priorities of firms in the e-commerce sector. These results emphasize that while all firms benefit from strengthening their internal resources, the intensity of competition influences which resources become critical for enhancing ACAP. For medium and large firms, industry competition reinforces the need for accumulated knowledge and strong leadership, while for mega enterprises, alternative capabilities may take precedence as they navigate intense competitive landscapes.

5.2. Comparison with previous studies

The findings of this study align with and extend prior research on absorptive capacity (ACAP) and the moderating influence of industry competition (IC) in several key ways. Consistent with previous studies, this research reaffirms the critical role of internal factors such as accumulated knowledge, leadership style, IT capability, and knowledge management capability in enhancing ACAP (Cohen & Levinthal, 1990; Zahra & George, 2002). Specifically, the positive impact of accumulated knowledge and IT capability on ACAP aligns with prior findings, suggesting that firms with established knowledge bases and advanced IT infrastructure are better equipped to absorb and leverage external knowledge (Tsai, 2001; Pavlou & El Sawy, 2006).

However, this study also provides new insights by emphasizing the moderating role of IC in shaping these relationships across different firm sizes within the e-commerce sector. Unlike earlier studies focusing on the direct effects of competition on ACAP (Lane et al., 2006; Vega-Jurado et al., 2008), the current research highlights how IC enhances specific internal capabilities in varying degrees, depending on the firm size. For example, while previous studies broadly support the notion that competition drives firms to enhance knowledge absorption (Chang et al., 2014), this study's multigroup analysis reveals that competition amplifies the impact of accumulated knowledge, particularly in medium enterprises, a nuanced finding not widely discussed in the literature.

The influence of leadership style as moderated by IC also extends the findings of previous studies, which emphasize the importance of transformational leadership in knowledge-intensive environments (Vera & Crossan, 2004; Garcia-Morales et al., 2008). The results indicate that in large firms, competitive pressures make adaptive leadership styles even more essential for fostering ACAP, suggesting that leadership plays a distinct role in complex, large-scale organizations within competitive markets.

Finally, this study's findings diverge slightly from prior research on IT capability, where earlier studies suggest that IT plays a universally critical role in knowledge absorption (Bharadwaj, 2000; Chae et al., 2014). However, our findings suggest that the significance of IT capability as a driver of ACAP may vary with firm size, particularly showing reduced importance in mega enterprises. This difference highlights the potential for alternative capabilities, such as organizational agility or network ties, to play a more pronounced role in firms that have already achieved substantial IT integration.

In summary, this study contributes to the existing literature by confirming foundational theories while introducing new insights into the role of IC as a moderating factor. These findings suggest that while internal capabilities remain vital across firm sizes, the competitive environment uniquely shapes the strategic value of each capability, underscoring the dynamic interplay between firm resources and external pressures in enhancing ACAP.

6. Conclusion

6.1. Summary of key findings

This study provides a comprehensive analysis of the factors influencing absorptive capacity (ACAP) within e-commerce firms, specifically focusing on the moderating role of industry competition (IC). Through Partial Least Squares Structural Equation Modeling (PLS-SEM) and Multigroup Analysis (MGA), the findings confirm that internal factors, including accumulated knowledge, leadership style, IT capability, and knowledge management capability, play significant roles in enhancing ACAP. Among these, **leadership style** consistently shows a strong positive impact across firms of varying sizes, underscoring the importance of adaptive and transformational leadership in fostering a culture of knowledge absorption.

The results also indicate that **industry competition** intensifies the influence of specific capabilities on ACAP, particularly for medium and large enterprises. For instance, accumulated knowledge and knowledge management capability become more critical in highly competitive environments, suggesting that firms in such contexts are driven to leverage these resources to maintain an edge. Additionally, the study highlights that IT capability is a vital driver of ACAP in medium and large enterprises, though its impact may be less pronounced in mega enterprises, where other capabilities could take precedence.

The findings contribute to the broader literature on ACAP by demonstrating that while all firms benefit from developing internal resources, the strategic value of each capability is shaped by competitive pressures and organizational scale. This nuanced understanding of ACAP offers valuable insights into how e-commerce firms can adapt their strategies to optimize knowledge absorption based on their size and competitive environment.

6.2. Theoretical contributions

This study makes several key theoretical contributions to the literature on absorptive capacity (ACAP) and competitive dynamics in the e-commerce sector. First, by examining the moderating role of **industry competition (IC)**, this research extends the ACAP framework, which has traditionally emphasized the direct effects of internal resources on knowledge absorption. The results demonstrate that competitive intensity can significantly amplify the impact of certain internal capabilities, such as accumulated knowledge and leadership style, particularly in medium and large firms. This finding offers a nuanced understanding of how external pressures shape the value of internal resources, providing a more dynamic perspective on ACAP.

Additionally, the study contributes to existing theory by revealing that the impact of internal capabilities on ACAP varies according to **firm size**. While previous research has generally considered ACAP as a universal process across different types of firms, this study's multigroup analysis indicates that the strategic importance of capabilities like IT and knowledge management differs substantially between medium, large, and mega enterprises. For instance, accumulated knowledge is particularly impactful for medium-sized firms under high competition, adding complexity to the traditional resource-based view by suggesting that ACAP-related strategies must be tailored to the organizational scale and market context.

Finally, the study challenges some established views regarding **IT capability** by demonstrating that its role as a driver of ACAP may be limited in mega enterprises. This contrasts with the widely held assumption that IT capability is universally critical in knowledge absorption, suggesting that for larger firms, other capabilities, such as organizational flexibility or relational networks, may play a more prominent role. This insight opens avenues for future research to explore alternative resources in fostering ACAP, particularly in the context of large-scale organizations.

In summary, this study advances theoretical discussions on ACAP by highlighting the importance of competitive dynamics and firm size as contextual factors. It thus enriches our understanding of how internal resources and external pressures interact to shape knowledge absorptive capacity in the rapidly evolving e-commerce sector.

6.3. Practical implications

The findings of this study have important practical implications for managers and decision-makers within the e-commerce sector, particularly those seeking to enhance absorptive capacity (ACAP) in response to competitive pressures. First, the significance of accumulated knowledge for medium-sized enterprises suggests that firms of this size should prioritize systematic knowledge retention and documentation practices. By investing in knowledge repositories and implementing processes for capturing experiential knowledge, medium-sized firms can strengthen their ability to absorb and utilize external information, which is essential for sustaining competitiveness in dynamic markets.

The study highlights the critical role of leadership style in fostering ACAP in large enterprises. Managers should adopt adaptive and transformational leadership approaches that encourage cross-functional collaboration, continuous learning, and a culture of open knowledge sharing. Training programs designed to develop these leadership qualities can empower employees to actively participate in knowledge-sharing processes, aligning organizational efforts with the demands of highly competitive markets.

The study also underscores the importance of IT capability as a driver of ACAP for medium and large enterprises. To optimize knowledge absorption, firms in these categories should invest in IT infrastructure that facilitates seamless communication and data integration. Providing employees with access to advanced technological tools can enable more efficient processing and application of external knowledge, allowing firms to respond swiftly to market changes. In high-competition environments, IT investments can serve as a strategic lever for enhancing organizational agility.

Additionally, organizational structure is shown to play a significant role in supporting ACAP for mega enterprises. Large-scale firms should consider adopting more flexible and decentralized structures that allow for faster decision-making and knowledge dissemination. By empowering departments with autonomy and reducing bureaucratic barriers, mega enterprises can create an environment that fosters agility, enabling rapid absorption and application of knowledge in response to market shifts.

Lastly, the results emphasize that industry competition amplifies the impact of certain capabilities on ACAP. Firms in highly competitive environments should focus strategically on strengthening the capabilities most enhanced by competition—such as leadership and knowledge management for large firms and accumulated knowledge for medium-sized firms. Understanding which resources gain value under competitive pressures allows e-commerce firms to prioritize investments that align with external challenges, maximizing their ability to innovate and remain resilient in the face of intense market competition.

In conclusion, this study offers practical guidance for e-commerce firms on strategically enhancing ACAP by aligning internal capabilities with competitive demands. This will enable them to remain adaptive and successful in a fast-paced industry.

6.4. Limitations and Directions for Future Research

While this study is insightful, it has several limitations that suggest directions for future research. The cross-sectional design limits causal inference; thus, future longitudinal studies could better capture how industry competition and internal resource changes impact absorptive capacity (ACAP) over time. Additionally, while valuable, the focus on the e-commerce sector may limit generalizability. Expanding this research to other industries, such as manufacturing or healthcare, could reveal industry-specific influences on ACAP.

Moreover, while industry competition (IC) was considered a moderating variable, other external factors, such as regulatory shifts or technological advancements, could also impact ACAP. Future studies might incorporate these variables for a more comprehensive view of external pressures. Finally, exploring alternative internal capabilities, such as organizational agility or network embeddedness, could provide further insights into building resilient ACAP systems.

Future research can deepen our understanding of ACAP by addressing these limitations. This will help organizations enhance their knowledge absorption across varied competitive landscapes.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Data availability

The authors do not have permission to share data.

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