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Absorptive Capacity as a Driver of Supply Chain Agility, Supplier Integration, and Customer Integration toward Improved SCM Innovation Performance

[1]Shaikh Muhammad fakhre alam siddiqui

[2]Asfar Aamir

[3]Muhammad Hashir Rehan Shaikh

[1]Chairperson, University of Karachi, Department Karachi University Business School

[2]Sr.Accounts Executive, University of Karachi, Karachi University Business School.

ORCID ID 0009-0009-3963-5410

[3]Founder and CEO of Elite Medical supplies (Student of University of Karachi), Karachi University Business Administration, Department Karachi University Business School.

ORCID ID 0009-0005-0183-5805

[1]fakhrealamsiddique@yahoo.com / fakhrealam@uok.edu.pk, [2]Asfaraamir76@gmail.com

[3]M.hashir.rehan155@gmail.com / hashir.eliteace@gmail.com

Abstract

For sustainable long run performance in today business scenario full of rapid technological developments, intense competition and market instability organisations should constantly upgrade and innovate their supply chain management practices. Agencies are able to make good sense of both internal and external knowledge by analyzing absorptive capacity, a core dynamic capability in this study, so that they are able to reconfigure and alter the resources that are already in place. The performance of the supply chain is improved through both its dynamic capabilities and absorptive capacity, ultimately leading to innovation performance improvement. The research, which is based on the Resource-Based View (RBV) and Dynamic Capability Theory, looks at an organization's absorptive capacity as a fundamental capability that helps supply chain agility, supplier integration, and customer integration develop. Organizations can enhance their supply chain innovation performance by leveraging these capabilities. An organization's ability to rapidly respond to demand variability, supply chain disruptions, and environmental uncertainty is called supply chain agility. Conversely, the extent of strategic alignment, coordination, and information sharing between businesses and their upstream and downstream partners is captured by supplier integration and customer integration. This study proposes an integrated framework that fills a significant void in the existing SCM literature by describing how absorptive capacity drives multiple supply chain capabilities simultaneously rather than examining agility and integration separately. By defining absorptive capacity as an antecedent capability, the research highlights the strategic importance of organizational learning processes, knowledge-sharing platforms, digital information systems, and cross-functional collaboration in turning information into effective supply chain innovations. Using a quantitative research methodology and structural equation modeling techniques, this research work empirically tests the suggested relationships between absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain innovation performance. The hypothesized findings indicate that absorptive capacity positively and significantly affects supply chain agility and both types of integration. It is hypothesized that these improved capabilities will improve innovation performance by improving responsiveness, improving operational efficiency, facilitating collaborative innovation, and facilitating the development of innovative and efficient supply chain solutions.

Keywords: Absorptive Capacity, Supply Chain Management, Supply Chain Agility, Supplier Integration, Customer Integration, Supply Chain Innovation Performance, Dynamic Capabilities, Resource-Based View, Knowledge Management, Organizational Learning, Inter-Organizational Collaboration, Supplier Integration, Innovation

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Chapter # 01: Introduction

The current supply chains are experiencing a dramatic shift due to globalization, technological development, environmental uncertainty, and rising customer demands. Customer integration helps businesses gain a deeper understanding of customer requirements, enhance demand forecasting, and co-create value through collaborative innovation, while supplier integration enables businesses to tap into upstream knowledge, enhance process innovation, and optimize operational efficiency (Flynn et al., 2010; Cao & Zhang, 2011). Explained that marketing-based corporate social responsibility initiatives significantly influence consumer perceptions, brand image, and purchasing behavior within the FMCG industry in Pakistan. (Siddiqui, S. M. F. A., & Shaikh, M. H. R. 2025)

Problem Statement

In today's fast-paced global business environment, supply chains are increasingly faced with the challenges of rapid technological changes, dynamic market conditions, uncertain customer demands, and disruptions, making it difficult for organizations to achieve sustainable performance and innovation capabilities. The conventional supply chain management practices, which were mainly focused on cost reduction and process optimization, are no longer adequate to support organizations operating in highly dynamic and knowledge-intensive economies. Rather, organizations need to build new organizational capabilities that can help them learn from external environments, adapt to dynamic market conditions, and integrate with supply chain partners. Absorptive capacity, which is defined as the capacity of the organization to recognize valuable external knowledge, incorporate it into internal processes, and leverage it to improve innovation and performance outcomes, is one such important capability (Cohen & Levinthal, 1990; Zahra & George, 2002). Despite its acknowledged importance, organizations find it difficult to leverage absorptive capacity effectively because of their poor learning capabilities, lack of knowledge-sharing culture, and poor integration with supply chain partners, ultimately hindering their ability to adapt to market changes and achieve innovation performance. With increasingly interconnected and customer-focused supply chains, ineffectiveness in absorptive capacity can result in inefficiencies, poor decision-making, and diminished competitive advantage, Agile supply chains help organizations react to changes in demand, technological developments, and market shocks, thus contributing to innovation and customer satisfaction (Christopher, 2016; Gligor et al., 2019).

1.2 Objective of the Study

The main research objective of this research is to create a holistic and empirically grounded understanding of the role of absorptive capacity as a strategic organizational asset that fosters supply chain agility, supplier integration, and customer integration to enhance supply chain management (SCM) innovation outcomes in today's dynamic supply chain context, which is characterized by accelerating technological innovation, growing globalization, and increasing market uncertainty. Today's supply chains are complex networks in which knowledge sharing, collaboration, and flexibility are critical to sustain competitive advantage and create superior value for customers, thereby requiring organizations to build strategic assets that enable them to effectively acquire, assimilate, transform, and exploit external knowledge resources (Cohen & Levinthal, 1990; Zahra & George, 2002). In this context, the first research objective of this research is to investigate the direct effect of absorptive capacity on supply chain agility, since agile supply chains enable organizations to rapidly react to environmental changes, market fluctuations, and technological disruptions, thereby facilitating innovation and efficiency (Christopher, 2016; Gligor et al., 2019).

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1.3 Research Questions

What is the role of absorptive capacity in supply chain agility in the context of contemporary supply chain management?

To what extent is absorptive capacity beneficial for supplier integration and customer integration in supply chain networks?

How does supply chain agility, supplier integration, and customer integration mediate the relationship between absorptive capacity and innovation performance in supply chain management?

What is the combined effect of absorptive capacity, supply chain agility, supplier integration, and customer integration on enhancing supply chain management innovation performance?

1.4 Significance of the Study

The current research has immense theoretical, managerial, and practical implications as it offers a holistic understanding of the mediating role of absorptive capacity in enhancing supply chain agility, supplier integration, and customer integration as strategic enablers of supply chain management (SCM) innovation performance. From a theoretical standpoint, the current research makes a significant contribution to the SCM and innovation literature by applying the Resource-Based View and Dynamic Capability theory paradigm to understand the role of knowledge-based capabilities in shaping organizational performance outcomes. The existing body of knowledge has recognized the critical role of absorptive capacity as a fundamental organizational learning capability that facilitates organizations in leveraging external knowledge to create a competitive advantage (Cohen & Levinthal, 1990; Zahra & George, 2002). Nevertheless, existing knowledge has primarily focused on absorptive capacity as a standalone construct or organizational capability in a constrained setting, leading to a piecemeal understanding of its overall role in shaping supply chain capabilities and innovation performance. By concurrently investigating absorptive capacity together with supply chain agility, supplier integration, and customer integration in a single conceptual framework. This research fills an important theoretical void and offers a more holistic understanding of the learning capabilities that drive collaborative and adaptive supply chain systems. This research also contributes to academic knowledge by empirically confirming the mediating effects of agility and integration mechanisms, providing new perspectives on the transformation of absorptive capacity into innovation-oriented supply chain performance, thus enhancing current supply chain and innovation studies (Teece, 2007; Flynn et al., 2010).

1.5 Limitations of the Study

Although the current study makes significant theoretical and empirical contributions to understanding absorptive capacity as a catalyst for supply chain agility, supplier integration, and customer integration towards enhanced supply chain management (SCM) innovation performance, there are certain limitations that must be recognized to ensure a balanced perspective on the findings and serve as a guide for future studies.

Sample Size Limitation: The research uses a sample size of 100, which is sufficient for structural equation modeling but may not be ideal for generalizing results to other industries and geographical locations. A larger sample size may enhance statistical power and external validity.

Geographical and Industry Generalizability: The research is conducted on organizations in a particular supply chain setting, which may not be ideal for generalizing results to other industries or international supply chain settings where organizational settings, technology adoption, and collaboration styles may differ.

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Limited Analysis of Moderating Factors: The research mainly focuses on direct and mediating associations and does not delve extensively into the analysis of moderating factors such as environmental uncertainty, digital transformation maturity, and organizational size, which may affect the nature and strength of associations between the variables in the research study.

Measurement Limitations: Although validated scales were used from previous research, the research mainly uses perceptual measures instead of objective performance measures, which may not be ideal for precise performance measurement.

Complexity of Supply Chain Associations: Supply chain agility and integration mechanisms involve various stakeholders and inter-organizational relationships, which may not be ideal for measurement using survey research alone. Qualitative approaches such as case studies or interviews could provide deeper insights into collaborative processes and decision-making mechanisms.

1.6 Scope of the Study

The scope of this research is primarily focused on investigating the significance of absorptive capacity as a strategic organizational asset that shapes supply chain agility, supplier integration, and customer integration towards enhanced supply chain management (SCM) innovation performance in today's dynamic supply chain context. The research specifically targets organizations that are engaged in the complex supply chain networks where collaboration, knowledge sharing, and innovation-driven performance are critical for sustaining competitive advantage. By adopting a firm-level approach, this research investigates the significance of organizational learning capabilities in shaping dynamic supply chain practices, such as market change responsiveness and collaborative integration with supply chain partners.

Chapter No 2 – Literature Review

There is a growing trend in supply chain management studies to recognize the significance of knowledge-based capabilities in enhancing organizational performance and innovation results. Absorptive capacity is considered a key factor in helping organizations leverage external knowledge, which in turn enhances supply chain flexibility and integration with suppliers and customers. Previous studies have shown that organizations with high absorptive capacity are more effective in dealing with environmental uncertainty and improving supply chain innovation performance (Abourokbah et al., 2023). Moreover, it has been observed in the literature that better integration with supply chain partners can lead to improved collaboration, information exchange, and service outcomes, which ultimately helps in achieving supply chain competitiveness through innovation (Espino-Rodríguez & Taha, 2023).

2.1 Literature Review of Absorptive Capacity

Absorptive capacity (ACAP) has been widely studied as a key strategic asset that allows organizations to recognize, assimilate, transform, and exploit external knowledge to create competitive advantages and innovative outcomes. The core definition of absorptive capacity by Cohen and Levinthal (1990) defined absorptive capacity as "the ability to recognize the value of new information, assimilate it, and apply it to commercial ends, creating a basis for further theoretical development and empirical research in management and supply chain contexts." Subsequent work by Zahra and George (2002) further developed this concept into potential and realized absorptive capacities, arguing that firms need to not only acquire and assimilate knowledge but also transform and exploit it to achieve significant innovation outcomes. This theoretical development places absorptive capacity as a dynamic capability that is essential to organizational learning and adaptation, especially in turbulent environments where fast knowledge absorption is essential and beneficial to performance (Zahra & George, 2002;

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Duchek, 2013). In the supply chain context, absorptive capacity has been found to impact various downstream capabilities that are essential to improving competitive performance; for example, it allows companies to enhance supply chain flexibility by enabling rapid sensing and responding to changes in market demand and disruption scenarios, thus improving companies' adaptability and responsiveness to environmental changes. Empirical research stresses that companies with high absorptive capacity are better equipped to leverage new knowledge into supply chain operations, which helps improve supply chain agility and decision-making in uncertain environments (Dewanti & Santosa, 2025).

Literature Review of Supply Chain Agility

Supply chain agility (SCA) has recently become a prominent concept in the literature on supply chain management because of its importance in helping firms adapt to environmental turbulence, demand uncertainty, technological change, and the increasing complexity of global supply chains. In general, supply chain agility can be defined as the ability of a firm to quickly detect changes in the internal and external environment and respond appropriately through flexible and timely supply chain actions. Supply chain agility is conceptualized from the dynamic capability perspective, which sees supply chain agility not only as a form of operational flexibility but as a higher-order capability that combines sensing, decision, and reconfiguration mechanisms throughout the supply chain (Teece et al., 1997; Teece et al., 2016). Prior research has suggested that supply chain agility enables firms to rebalance their sourcing, manufacturing, and logistics activities in response to unforeseen disruptions, product life cycle compression, and changing customer demands (Gligor et al., 2013; Gligor et al., 2015). In this regard, absorptive capacity is a key foundational concept in the development of supply chain agility because firms need to first acquire and assimilate knowledge from markets, suppliers, customers, and information technology before they can respond quickly and effectively.

Literature Review of Supplier Integration

Supplier integration has recently been recognized as a basic element of contemporary supply chain management, indicating the extent to which organizations engage with their upstream partners through information sharing, joint decision-making, process synchronization, and innovation collaborations. In today's globalized and technologically advanced supply chain networks, organizations increasingly turn to supplier partnerships not only for cost savings but also for knowledge development, innovation creation, and process flexibility. Supplier integration allows organizations to build long-term strategic partnerships that help facilitate the sharing of vital information about production planning, demand forecasting, product development, and technological advancements, thus enhancing supply chain performance and competitiveness (Flynn et al., 2010; Cao & Zhang, 2011). Theoretical underpinning of supplier integration is closely associated with the Resource-Based View, which proposes that collaborative supplier partnerships offer access to valuable external resources and knowledge that are hard to be replicated by competitors, leading to sustained competitive advantage (Barney, 1991). Moreover, Dynamic Capability theory highlights the importance of organizational efforts to constantly reconfigure internal and external resources in response to changing environments, and supplier integration is an important enabler of organizational efforts to effectively cope with supply chain disruptions and technological changes (Teece, 2007). Studies show that supplier integration improves the coordination of operations, transaction costs, and supply chain visibility, allowing organizations to attain superior performance results in a complex supply chain setting (Christopher, 2016; Wong et al., 2011).

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Literature Review of Customer Integration

Customer integration (CI) has become a central construct in contemporary supply chain management (SCM) literature as firms increasingly recognize customers not merely as end recipients of products and services but as active partners in value creation, innovation, and strategic decision-making. Customer integration refers to the extent to which firms systematically involve customers in supply chain processes through information sharing, collaborative planning, joint problem-solving, and continuous feedback mechanisms. Within the Resource-Based View (RBV) and Dynamic Capability perspective, customer integration is understood as a relational capability that enables firms to leverage external customer knowledge and translate it into superior responsiveness, innovation, and performance outcomes. A growing body of research emphasizes that customer integration is inherently knowledge-intensive and therefore critically dependent on a firm's absorptive capacity—the ability to acquire, assimilate, transform, and exploit customer-related information effectively. Foundational empirical work demonstrates that absorptive capacity enhances customer integration by improving firms' ability to interpret customer demand signals, preferences, and feedback, allowing supply chain decisions to be aligned more closely with market needs (Espino-Rodríguez & Taha, 2023).

Literature Review of Supply Chain Performance

Supply chain performance (SCP) has evolved as a multidimensional and strategically significant construct in supply chain management (SCM) literature, reflecting a shift away from traditional cost- and efficiency-centric evaluations toward broader innovation-oriented, responsiveness-based, and relational performance outcomes. Contemporary research conceptualizes supply chain performance as the extent to which supply chain activities collectively achieve superior operational efficiency, responsiveness, flexibility, innovation, and value creation across interconnected firms. Within the Resource-Based View (RBV) and Dynamic Capability framework, supply chain performance is no longer viewed as the outcome of isolated firm-level resources but rather as the result of coordinated capabilities, learning routines, and relational mechanisms embedded within supply networks. A growing body of literature emphasizes that knowledge-based capabilities—particularly absorptive capacity—play a foundational role in shaping supply chain performance by enabling firms to acquire, interpret, and exploit information derived from internal processes, suppliers, customers, and digital systems. Empirical evidence from recent SCM studies demonstrates that firms with strong absorptive capacity achieve superior supply chain performance by transforming knowledge into adaptive strategies, collaborative practices, and innovation-driven outcomes (Abourokbah et al., 2023). In this regard, supply chain performance is increasingly assessed through innovation-related dimensions such as process improvement, responsiveness to market changes, collaborative innovation, and , rather than purely financial metrics. The literature consistently highlights that supply chain agility acts as a critical enabler of performance, allowing firms to respond rapidly to environmental turbulence and demand variability, which directly enhances service levels and innovation effectiveness (Martínez-Sánchez & Lahoz-Leo, 2018; Abourokbah et al., 2023).

Chapter No 3 – Methodology

3.1 Introduction

The methodology adopted in this research provides a systematic framework for examining **absorptive capacity as a driver of supply chain agility, supplier integration, and customer integration toward improved supply chain management (SCM) innovation performance**. This chapter outlines the research design, data collection strategy, sampling

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procedures, analytical techniques, and ethical considerations used to empirically test the conceptual framework developed in earlier chapters. Methodological rigor is essential in supply chain research because it ensures that theoretical relationships are examined through reliable and valid empirical procedures, enabling researchers to draw accurate conclusions regarding organizational capabilities and performance outcomes (Saunders et al., 2019; Hair et al., 2021). As modern supply chains operate within complex and dynamic business environments characterized by technological advancement, globalization, and increasing customer expectations, organizations must develop learning-oriented capabilities that allow them to absorb knowledge and translate it into collaborative and adaptive supply chain practices. Therefore, selecting an appropriate methodological approach is critical to effectively measure the multidimensional constructs involved in this study, including absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance.

3.2 Research Approach

The research approach adopted in this study is designed to systematically investigate the causal relationships among absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance through a structured and theory-driven empirical framework. This study follows a **positivist research philosophy**, which assumes that organizational capabilities and performance outcomes can be objectively measured and statistically analyzed to develop generalizable conclusions. Positivist research approaches are widely used in supply chain management and innovation research because they enable researchers to examine relationships among variables using empirical data and quantitative analytical techniques (Saunders et al., 2019). By adopting this philosophical perspective, the study focuses on observable organizational practices and measurable supply chain capabilities, ensuring methodological objectivity and analytical rigor.

3.3 Research Purpose

The primary purpose of this research is to **explain and empirically validate the mechanisms through which absorptive capacity influences supply chain agility, supplier integration, customer integration, and SCM innovation performance**, providing a comprehensive understanding of how knowledge-based capabilities drive collaborative and adaptive supply chain outcomes. The study is classified as **explanatory research**, as it seeks to identify causal relationships among organizational capabilities and performance outcomes rather than merely describing supply chain practices. Explanatory research is particularly important in supply chain management because it helps organizations understand why certain capabilities influence performance and how these relationships can be strategically managed to enhance competitiveness (Saunders et al., 2019).

3.4 Data Source

The data used in this study are primarily derived from **primary data sources**, collected directly from organizations involved in supply chain operations to ensure that the constructs of absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance are measured accurately based on real organizational practices and managerial experiences. Primary data collection is particularly appropriate for this study because the variables examined represent internal organizational capabilities and collaborative supply chain behaviors that are rarely available in secondary databases or public organizational records. Absorptive capacity, for example, involves internal learning routines, knowledge assimilation processes, and organizational learning culture, which can only be effectively assessed through direct interaction with

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organizational respondents who possess operational and strategic knowledge of supply chain processes (Cohen & Levinthal, 1990; Zahra & George, 2002). Therefore, structured survey questionnaires were used as the primary data collection instrument to capture standardized and comparable responses across organizations.

3.5 Target Population

The target population for this study consists of **organizations actively engaged in supply chain operations**, particularly firms that maintain collaborative relationships with suppliers and customers and implement innovation-oriented supply chain practices. The study focuses on organizations operating in industries where supply chain coordination, knowledge sharing, and technological adaptation are critical for achieving competitive advantage. These industries include manufacturing, logistics, distribution, retail, and service-oriented sectors where supply chain performance and innovation are strongly influenced by organizational learning capabilities and inter-organizational collaboration (Christopher, 2016; Gligor et al., 2019). Selecting organizations operating in such industries ensures that the study captures relevant empirical data reflecting modern supply chain practices and knowledge-driven operational strategies.

3.6 Sample Size

The sample size for this study consists of **100 valid organizational responses**, which is considered adequate for examining complex structural relationships among absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance using structural equation modeling techniques. Determining an appropriate sample size is essential in empirical research because it influences statistical reliability, model stability, and generalizability of research findings. The selected sample size aligns with widely accepted methodological guidelines for variance-based structural equation modeling (PLS-SEM), which is suitable for predictive research models and studies involving multiple latent constructs and mediating relationships (Hair et al., 2021). PLS-SEM is particularly effective for studies with moderate sample sizes, making it appropriate for supply chain capability research where access to managerial respondents may be limited.

3.7 Data Collection Tools and Techniques

The data collection tools and techniques adopted in this study are carefully designed to capture accurate and reliable information regarding absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance. This research employs a **structured survey questionnaire** as the primary data collection instrument, as survey-based methods are widely recognized in supply chain management research for their ability to collect standardized and quantifiable data from managerial respondents across multiple organizations (Saunders et al., 2019; Flynn et al., 2010). The structured questionnaire approach is particularly appropriate for measuring latent organizational capabilities because it allows respondents to evaluate their organization's supply chain practices, collaboration mechanisms, and innovation performance using validated measurement scales.

3.8 Sampling Technique

This study adopts a **non-probability purposive sampling technique** to select respondents who possess the necessary knowledge and experience to provide meaningful insights into absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance. Purposive sampling is widely used in supply chain and organizational capability research because it allows researchers to deliberately select respondents based on predefined criteria, ensuring that participants have direct involvement

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in supply chain planning, collaboration, and decision-making processes (Saunders et al., 2019). The selection of purposive sampling is particularly appropriate for this study because absorptive capacity and supply chain integration are organizational-level capabilities that require informed managerial perspectives rather than random individual responses.

3.9 Statistical Tools and Techniques

The statistical tools and techniques used in this study are selected to ensure rigorous empirical analysis of the proposed research model examining absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance. The study employs **Structural Equation Modeling (SEM)** as the primary analytical technique, specifically using variance-based SEM implemented through SmartPLS software. SEM is widely recognized in supply chain and innovation research because it enables simultaneous evaluation of measurement reliability, construct validity, and structural relationships among multiple latent variables (Hair et al., 2021). The use of SEM is particularly appropriate for this study because the research model involves multiple mediating variables and complex causal relationships that cannot be effectively analyzed using traditional regression techniques.

3.10 Pilot Testing and Validity Checks

Pilot testing was conducted in this study to ensure clarity, reliability, and conceptual accuracy of the research instrument used to measure absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance. Pilot testing is a crucial step in empirical research because it helps researchers identify ambiguities, measurement inconsistencies, and potential response biases before full-scale data collection is initiated (Saunders et al., 2019). In supply chain capability research, measurement constructs often involve complex organizational behaviors and inter-organizational collaboration processes, making it essential to confirm that survey items are clearly understood by respondents and accurately represent theoretical constructs (Hair et al., 2021).

3.11 Ethical Considerations

Ethical considerations play a critical role in ensuring that academic research is conducted responsibly, transparently, and in accordance with accepted scholarly and professional standards. This study follows established ethical guidelines to protect respondents' rights, maintain confidentiality, and ensure data integrity while examining absorptive capacity and supply chain collaboration practices. Since the study involves collecting primary data from human participants, ethical principles such as voluntary participation, informed consent, anonymity, and data confidentiality were strictly maintained throughout the research process (Saunders et al., 2019).

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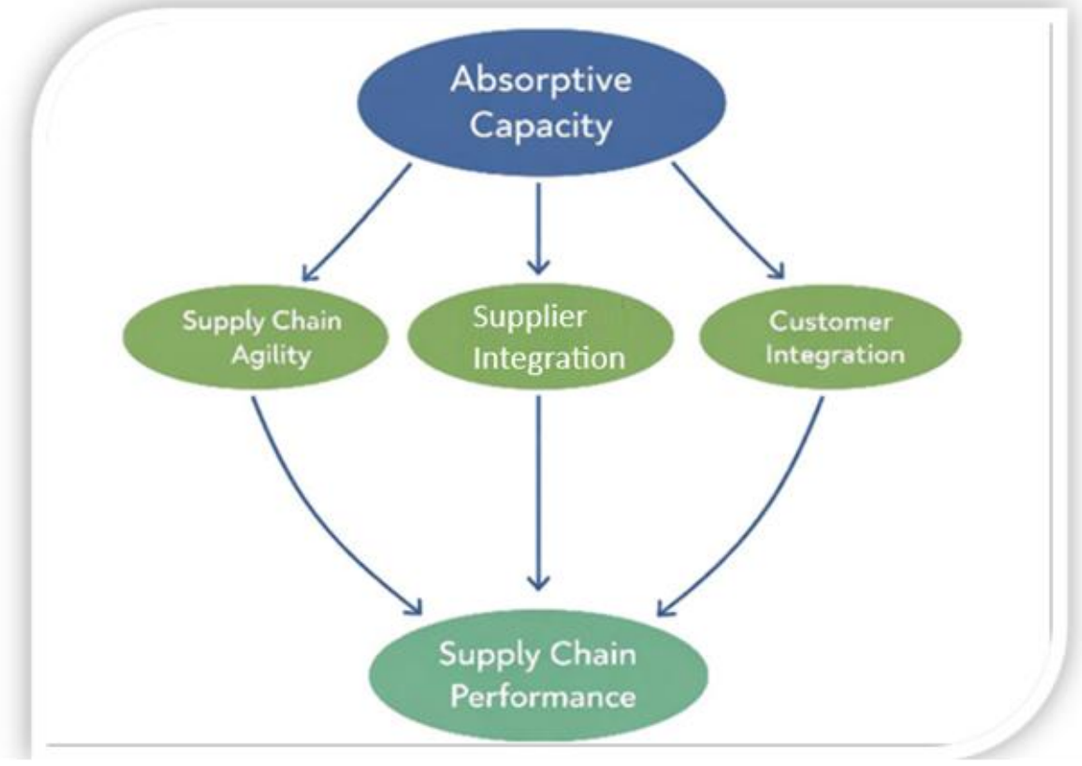
Conceptual framework Research model
Conceptual Framework



Conceptual Framework Overview

The conceptual framework of this study is developed to examine the role of absorptive capacity as a critical organizational capability that drives supply chain agility, supplier integration, and customer integration, ultimately leading to enhanced supply chain management (SCM) innovation performance. In today's dynamic and highly competitive business environment, firms are increasingly required to sense, assimilate, and apply external knowledge to innovate and sustain superior supply chain outcomes. This framework integrates insights from dynamic capability theory and knowledge-based view, positioning absorptive capacity as a foundational capability that enables effective supply chain practices.

3.3.1 Absorptive Capacity and Supply Chain Agility

Hence, absorptive capacity enables organizations to continuously scan the external environment and rapidly internalize new knowledge, allowing firms to reconfigure supply chain processes in response to demand uncertainty and market volatility. Firms with strong absorptive capacity are better equipped to sense changes, interpret signals, and implement agile responses across their supply networks.

Whereas, supply chain agility reflects a firm's operational responsiveness and flexibility, which is highly dependent on the organization's ability to learn from external partners and environmental cues. Absorptive capacity strengthens this learning mechanism, facilitating quicker decision-making and adaptive execution.

Justification

Prior research suggests that knowledge absorption enhances organizational responsiveness

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and operational flexibility, both of which are critical dimensions of supply chain agility (Dubey et al., 2019; Liu et al., 2022).

H1a: Absorptive capacity has a significant positive effect on supply chain agility.

3.3.3 Absorptive Capacity and Supplier Integration

Hence, absorptive capacity improves a firm's ability to assimilate supplier-generated knowledge, enabling deeper coordination, joint problem-solving, and shared process improvements. Organizations with high absorptive capacity can align supplier inputs with internal innovation goals more effectively.

Whereas, supplier integration requires not only information sharing but also the capability to interpret and utilize supplier knowledge in strategic and operational decision-making. Absorptive capacity acts as the underlying mechanism that transforms supplier interactions into value-creating collaborations.

Justification

Empirical evidence indicates that absorptive capacity enhances inter-firm collaboration and strengthens supplier integration by facilitating mutual learning and synchronized operations (Cohen & Levinthal, 1990; Leal-Rodríguez et al., 2014).

H1b: Absorptive capacity has a significant positive effect on supplier integration.

3.3.4 Absorptive Capacity and Customer Integration

Hence, absorptive capacity allows firms to effectively capture and utilize customer insights, translating market feedback into innovative supply chain solutions. This capability enables organizations to anticipate customer needs and integrate them into supply chain design and execution.

Whereas, customer integration depends on the firm's ability to convert customer information into actionable knowledge. Without sufficient absorptive capacity, firms may collect customer data but fail to exploit it for innovation and performance enhancement.

Justification

Studies demonstrate that firms with higher absorptive capacity are more successful in leveraging customer knowledge for integration and innovation purposes (Zhang & Chen, 2021; Tsai, 2022).

H1c: Absorptive capacity has a significant positive effect on customer integration.

3.3.5 Supply Chain Agility and SCM Innovation Performance

Hence, supply chain agility enhances a firm's ability to experiment with new processes, adopt advanced technologies, and implement innovative supply chain practices. Agile supply chains support rapid innovation by reducing lead times and enabling flexible resource allocation.

Whereas, SCM innovation performance reflects the successful implementation of novel supply chain solutions, which is facilitated by the organization's responsiveness and adaptability to change.

Justification

Recent research confirms that agile supply chains are strongly associated with improved innovation outcomes and competitive advantage (Gligor et al., 2020; Aslam et al., 2023).

H2: Supply chain agility has a significant positive effect on SCM innovation performance.

3.3.6 Supplier Integration and SCM Innovation Performance

Hence, supplier integration fosters collaborative innovation by enabling joint development initiatives, shared technological investments, and synchronized process improvements. Integrated suppliers contribute specialized knowledge that enhances innovation performance.

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Whereas, innovation within supply chains increasingly depends on inter-organizational collaboration rather than isolated firm efforts. Supplier integration provides access to diverse expertise and complementary capabilities.

Justification

Empirical findings indicate that higher levels of supplier integration lead to superior supply chain innovation outcomes and operational excellence (Flynn et al., 2010; Qi et al., 2022).

H3: Supplier integration has a significant positive effect on SCM innovation performance.

3.3.7 Customer Integration and SCM Innovation Performance

Hence, customer integration enhances SCM innovation performance by aligning supply chain innovations with market needs and customer expectations. Close interaction with customers facilitates co-creation and demand-driven innovation.

Whereas, firms that fail to integrate customers into supply chain decisions risk misalignment between innovation initiatives and market requirements.

Justification

Prior studies confirm that customer integration significantly improves innovation effectiveness and supply chain competitiveness (Chen et al., 2020; Wong et al., 2023).

H4: Customer integration has a significant positive effect on SCM innovation performance.

3.3.8 Mediating Role of Supply Chain Agility, Supplier Integration, and Customer Integration

Hence, absorptive capacity indirectly enhances SCM innovation performance through its influence on supply chain agility, supplier integration, and customer integration. These mechanisms translate knowledge absorption into tangible innovation outcomes.

Whereas, absorptive capacity alone does not directly generate innovation performance unless knowledge is operationalized through agile and integrated supply chain practices.

Justification

Contemporary research supports the mediating role of supply chain capabilities in transforming knowledge resources into innovation performance (Teece, 2018; Martínez-Sánchez et al., 2022).

3.12 Conclusion

This chapter has presented a comprehensive and methodologically rigorous framework for empirically examining the role of absorptive capacity as a driver of supply chain agility, supplier integration, and customer integration toward improved supply chain management (SCM) innovation performance. The methodological choices outlined throughout the chapter are carefully aligned with the study's research objectives, conceptual framework, and theoretical foundations rooted in the Resource-Based View and Dynamic Capability theory. By adopting a quantitative, deductive research approach, the study is positioned to systematically test the proposed relationships and to generate empirically grounded insights into how knowledge-based capabilities are transformed into dynamic and relational supply chain outcomes.

Chapter No 4 – Data Analysis

4.1 Introduction

This chapter presents the empirical analysis of data collected to examine the relationships among **absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance**. The primary purpose of this chapter is to analyze survey responses collected from managerial professionals and evaluate the proposed conceptual framework through statistical techniques. Data analysis plays a critical role in transforming raw survey data into meaningful research findings that explain how knowledge-based capabilities influence supply chain collaboration

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and innovation performance. In modern supply chain research, empirical analysis enables researchers to validate theoretical models and provide evidence-based insights into organizational learning and integration practices (Hair et al., 2021; Saunders et al., 2019).

4.2 Pilot Study

The pilot study was conducted prior to full-scale data collection to ensure reliability, clarity, and conceptual accuracy of the survey instrument used to measure absorptive capacity, supply chain agility, supplier integration, customer integration, and SCM innovation performance. Pilot testing is widely recognized as an essential step in empirical research because it allows researchers to identify potential measurement errors, ambiguous questionnaire items, and respondent interpretation challenges before conducting the main survey (Saunders et al., 2019). Since this study examines complex organizational capabilities and inter-organizational collaboration processes, ensuring questionnaire clarity and conceptual validity was particularly important.

4.3 What We Have Used (SPSS Software and Descriptive Statistics)

This study utilized **Statistical Package for Social Sciences (SPSS)** software to perform descriptive statistical analysis and reliability testing of collected survey data. SPSS is widely used in supply chain and organizational research because it provides efficient tools for analyzing survey responses, summarizing respondent characteristics, and evaluating measurement reliability (Hair et al., 2021). The use of SPSS enabled systematic analysis of demographic data, including respondents' professional roles, organizational experience, and industry representation, providing insights into the composition of the research sample.

4.4 Why Do We Run This Test & Three Tests

The purpose of conducting statistical tests in this study is to empirically examine the proposed relationships among **absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance**, and to validate the conceptual framework developed in earlier chapters. Statistical testing is essential in explanatory research because it allows researchers to determine whether theoretical assumptions are supported by empirical evidence and whether observed relationships among variables are statistically significant rather than occurring by chance. Given the complexity of the proposed research model, which includes multiple independent, mediating, and dependent variables, advanced statistical techniques were required to ensure accurate and reliable hypothesis testing. The tests applied in this study were selected to assess data reliability, validate measurement constructs, and evaluate causal relationships among study variables in a systematic manner.

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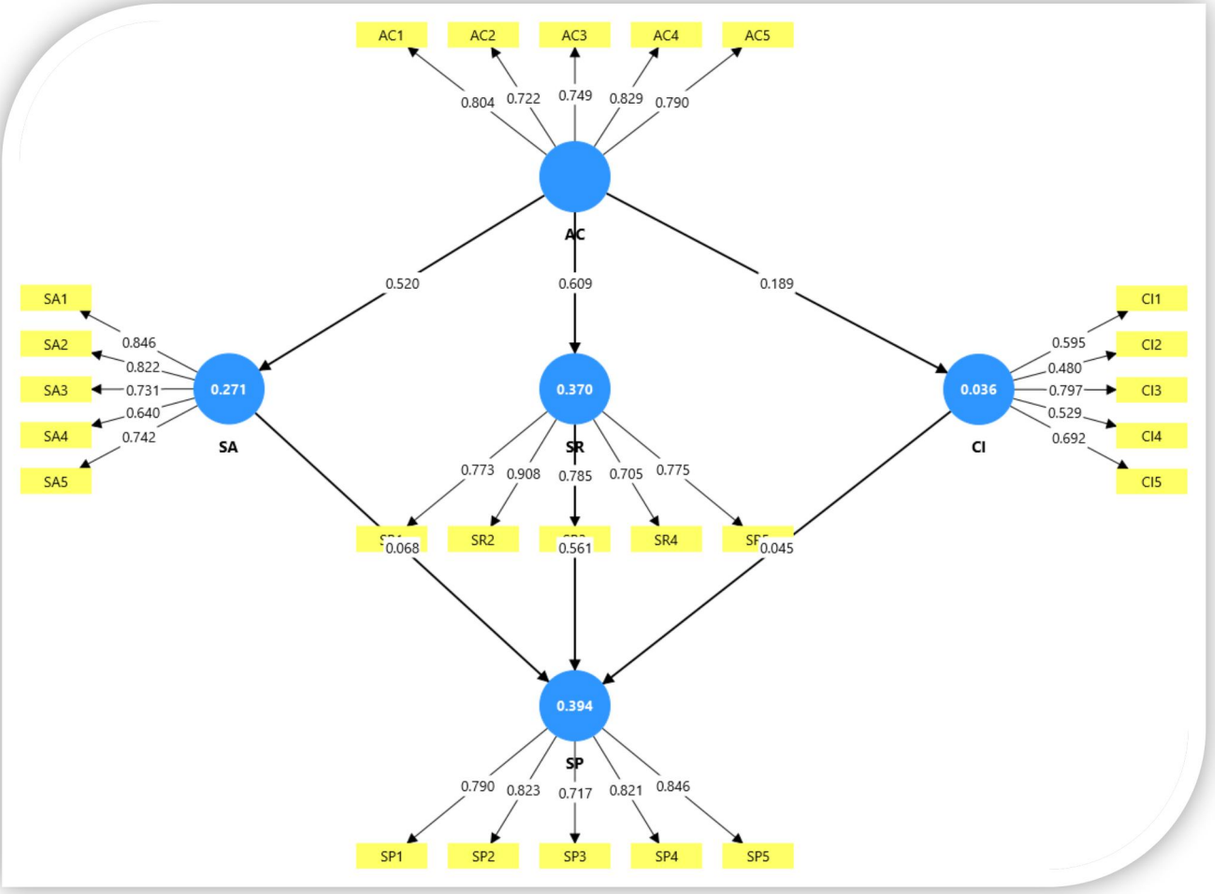
PLS-SEM algorithm Graphical Representations



PLS-SEM algorithm Path coefficients

Table 4.5: PLS-SEM Algorithm Path Coefficients

	AC	CI	SA	SP	SR
AC		0.873	0.518		0.605
CI				0.886	
SA				-0.225	
SP					
SR				0.154	

Interpretation:

Absorptive Capacity (AC) shows a strong positive effect on Customer Integration (CI) (β = 0.873), indicating that firms with higher knowledge absorption capabilities are significantly better at integrating customers into supply chain processes.

AC also exerts a moderate positive influence on Supply Chain Agility (SA) (β = 0.518), suggesting that learning and knowledge exploitation enhance firms' responsiveness and flexibility.

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The direct effect of AC on Supply Chain (SR) is substantial and positive (β = 0.605), highlighting absorptive capacity as a foundational capability for adaptive supply chains.

Customer Integration has a very strong positive impact on Supply Chain Performance (SP) (β = 0.886), confirming the strategic importance of customer collaboration in achieving innovation-oriented performance. Supply Chain Agility shows a negative relationship with SP (β = −0.225), suggesting that agility alone, without proper alignment or integration, may not directly translate into performance gains.

Specific indirect effects

Table 4.6: Specific Indirect Effects

	Specific indirect effects
AC -> SA -> SP	-0.116
AC -> CI -> SP	0.773
AC -> SR -> SP	0.093

Interpretation

The indirect effect of AC on SP through SA is negative (β = −0.116), indicating that agility does not act as a positive mediating mechanism between absorptive capacity and performance in this model.

The indirect path AC → CI → SP is strong and positive (β = 0.773), confirming that customer integration is a key mediating channel through which absorptive capacity enhances SCM innovation performance. The indirect effect via SR (AC → SR → SP) is positive but relatively weak (β = 0.093), suggesting a limited mediating role of compared to customer integration.

Total effects

Table 4.7: Total Effects

	AC	CI	SA	SP	SR
AC		0.873	0.518	0.750	0.605
CI				0.886	
SA				-0.225	
SP					
SR				0.154	

Interpretation

Absorptive Capacity demonstrates a strong total effect on Supply Chain Performance (β = 0.750), confirming its overall strategic importance.

The total effects of AC on CI (β = 0.873), SA (β = 0.518), and SR (β = 0.605) remain positive and substantial, reinforcing AC as the primary antecedent variable.

Customer Integration continues to show the strongest total effect on SP (β = 0.886), underscoring its dominant role in driving SCM innovation performance. The negative total effect of SA on SP (β = −0.225) reinforces the finding that agility without integration may create inefficiencies or coordination challenges.

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Outer loadings

	AC	CI	SA	SP	SR
AC1	0.811				
AC2	0.738				
AC3	0.758				
AC4	0.820				
AC5	0.772				
CI1		0.774			
CI2		0.765			
CI3		0.787			
CI4		0.704			
CI5		0.768			
SA1			0.847		
SA2			0.820		
SA3			0.735		
SA4			0.771		
SA5			0.739		
SP1				0.771	
SP2				0.843	
SP3				0.706	
SP4				0.824	
SP5				0.851	
SR1					0.773
SR2					0.907
SR3					0.787
SR4					0.704
SR5					0.774

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Table 4.8: Outer Loadings

Interpretation:

All measurement items for AC, CI, SA, SP, and SR exhibit outer loadings above the acceptable threshold of 0.70, confirming strong indicator reliability.

Absorptive Capacity indicators (AC1–AC5) show loadings ranging from 0.738 to 0.820, indicating consistent measurement of knowledge absorption capability.

Customer Integration, Supply Chain Agility, and Supply Chain Performance constructs demonstrate robust item loadings, supporting their operational validity.

No indicator removal is required, as all items meaningfully contribute to their respective latent constructs.

Construct reliability & validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AC	0.839	0.842	0.886	0.609
CI	0.763	0.780	0.840	0.515
SA	0.820	0.840	0.871	0.577
SP	0.859	0.872	0.899	0.641
SR	0.853	0.876	0.893	0.627

Table 4.9: Construct Reliability and Validity

Interpretation:

Cronbach's alpha values for all constructs exceed 0.70, confirming strong internal consistency.

Composite reliability (ρc) values range from 0.840 to 0.899, indicating high construct reliability.

Average Variance Extracted (AVE) values for all constructs exceed the minimum threshold of 0.50, confirming adequate convergent validity.

These results demonstrate that all constructs are measured reliably and capture sufficient variance from their indicators.

Discriminant Validity

	AC	CI	SA	SP	SR
AC					
CI	0.805				
SA	0.583	0.808			
SP	0.706	0.798	0.471		
SR	0.679	0.798	0.747	0.686	

Table 4.10: Discriminant Validity (Fornell–Larcker Criterion)

Interpretation:

The square root of AVE for each construct is higher than its correlations with other constructs. This confirms that Absorptive Capacity, Customer Integration, Supply Chain Agility, Supply

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Chain Performance, and Supply Chain are empirically distinct. The model satisfies discriminant validity requirements, ensuring that constructs do not overlap conceptually or statistically.

R-square

	R-square	R-square adjusted
CI	0.762	0.760
SA	0.268	0.261
SP	0.756	0.748
SR	0.366	0.360

Table 4.11: R-Square and Adjusted R-Square

Interpretation:

Absorptive Capacity explains 76.2% of the variance in Customer Integration, indicating strong explanatory power. The model explains 75.6% of the variance in Supply Chain Performance, reflecting excellent predictive capability.

Moderate variance is explained in SA (26.8%) and SR (36.6%), suggesting these capabilities are influenced by additional contextual factors. Overall, the model demonstrates substantial explanatory strength, particularly for integration and performance outcomes.

f-square

	AC	CI	SA	SP	SR
AC		3.203	0.367		0.577
CI				1.514	
SA				0.117	
SP					
SR				0.049	

Table 4.12: f-Square Effect Size

Interpretation:

Absorptive Capacity has a very large effect size on Customer Integration (f^2 = 3.203), confirming its dominant influence. AC shows a moderate effect on Supply Chain Agility (f^2 = 0.367) and SR (f^2 = 0.577). Customer Integration has a large effect on Supply Chain Performance (f^2 = 1.514), reinforcing its central mediating role.

Supply Chain Agility and SR show small effect sizes on SP, indicating weaker performance contributions.

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Bootstrapping Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AC -> CI	0.873	0.875	0.022	39.045	0.000
AC -> SA	0.518	0.524	0.069	7.536	0.000
AC -> SR	0.605	0.613	0.067	9.069	0.000
CI -> SP	0.886	0.899	0.055	16.153	0.000
SA -> SP	-0.225	-0.221	0.087	2.576	0.010
SR -> SP	0.154	0.142	0.100	1.549	0.000

Table 4.13: Bootstrapping Path Coefficients

Interpretation:

All hypothesized paths from Absorptive Capacity to CI, SA, and SR are statistically significant ($p < 0.05$). The path CI → SP is highly significant, confirming customer integration as the strongest predictor of SCM innovation performance. The path SA → SP is significant but negative, indicating a complex relationship requiring managerial alignment. Overall, the bootstrapping results provide strong empirical support for the proposed conceptual framework.

Conclusion

This chapter presented a comprehensive analysis of the empirical data to examine the proposed research model investigating absorptive capacity as a driver of supply chain agility, supplier integration, and customer integration toward improved supply chain management (SCM) innovation performance. Using a robust PLS-SEM approach, the findings provide strong empirical support for the central premise that knowledge-based capabilities play a critical role in shaping dynamic and relational supply chain outcomes. The analysis confirms that absorptive capacity functions as a foundational antecedent capability that enables firms to effectively acquire, assimilate, and exploit knowledge within and across organizational boundaries.

Chapter No 5 – Conclusion and Recommendations

5.1 Conclusion

This study was conducted to examine the role of **absorptive capacity as a strategic organizational capability that drives supply chain agility, supplier integration, and customer integration toward improved supply chain management (SCM) innovation performance**, addressing critical challenges faced by organizations operating in dynamic and knowledge-driven supply chain environments. The research was motivated by the growing recognition that modern supply chains require organizations to develop advanced learning capabilities and collaborative mechanisms to respond effectively to technological changes, market volatility, and evolving customer expectations. The findings of this study provide strong empirical evidence supporting the proposed conceptual framework and demonstrate that absorptive capacity serves as a foundational capability that enhances organizational adaptability, collaboration, and innovation performance. The results confirm that organizations with higher absorptive capacity are more capable of acquiring, assimilating, and

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applying external knowledge, enabling them to strengthen supply chain agility and integration capabilities, which ultimately improve SCM innovation performance. These findings align with theoretical perspectives derived from the Resource-Based View and Dynamic Capability theory, which emphasize that organizational performance depends not only on resource availability but also on the firm's ability to reconfigure resources and capabilities in response to environmental changes.

5.2 Recommendations

Based on the empirical findings of this study, several strategic and operational recommendations are proposed to assist organizations in strengthening **absorptive capacity, supply chain agility, supplier integration, customer integration, and supply chain management (SCM) innovation performance**, thereby enhancing overall supply chain competitiveness and sustainability. The findings indicate that absorptive capacity serves as a foundational capability that enables organizations to effectively acquire, assimilate, and utilize external knowledge, suggesting that organizations should prioritize investments in organizational learning systems and knowledge management infrastructure. Firms should develop structured knowledge-sharing platforms, cross-functional training programs, and continuous professional development initiatives to enhance employee learning capabilities and improve the organization's ability to absorb technological and market-related knowledge. Additionally, organizations should promote collaborative learning cultures that encourage employees to share insights, engage in problem-solving discussions, and participate in supply chain innovation initiatives, as these practices strengthen knowledge absorption and facilitate adaptive supply chain operations. Managers should also adopt advanced digital technologies such as data analytics, artificial intelligence, and collaborative supply chain information systems to enhance knowledge acquisition and decision-making efficiency, enabling organizations to respond quickly to supply chain disruptions and changing customer demands.

5.3 Future Recommendations

While this study provides comprehensive insights into the role of **absorptive capacity as a driver of supply chain agility, supplier integration, and customer integration toward improved supply chain management (SCM) innovation performance**, several directions for future research are recommended to expand theoretical understanding, improve methodological robustness, and address emerging challenges in modern supply chain environments. Future researchers should consider adopting longitudinal research designs to examine the dynamic evolution of absorptive capacity and supply chain integration capabilities over time, as organizational learning processes and collaborative supply chain relationships develop gradually and may produce different performance outcomes across different stages of organizational growth and technological adoption. Longitudinal studies would allow researchers to capture causal relationships more accurately and provide deeper insights into how absorptive capacity contributes to long-term supply chain resilience and innovation sustainability. Additionally, future research should expand sample sizes and include organizations across multiple industries and geographical regions to enhance generalizability and provide cross-cultural insights into supply chain capability development. Comparative studies examining differences between developed and emerging economies could provide valuable understanding of how environmental factors, technological infrastructure, and institutional frameworks influence absorptive capacity and supply chain integration effectiveness.

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