The Impact of Digital Transformation on Supply Chain Dynamic Capabilities and competitive advantage of the Retail Enterprises in Guangdong

Li Tong

A Thesis Submitted in Partial Fulfillment of Requirements for

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ABSTRACT

The objectives of this research are to investigate the relationship of digital transformation, supply chain dynamic capabilities (learning and absorption capability, innovation capability, optimization and integration capability), channel integration and competitive advantage. This research investigates the relationship among digital transformation, supply chain dynamic capabilities and competitive advantage. Additionally, the mediating effects of supply chain dynamic capabilities between digital transformation and competitive advantage. The moderating effects of channel integration in the relationship between digital transformation, supply chain dynamic capabilities and competitive advantage. This research applies dynamic capability and supply chain management theories to draw the conceptual model. To address these research needs, this study was conducted. First, a comprehensive framework of supply chain dynamic capabilities was applied in this study, which included three important dimensions: learning and absorptive capability, innovation capability, integration and optimization capability. Then, the framework "DT→SCDC→CA" was constructed for observation. Finally, a structural equation model was validated using questionnaire data collected from 429 respondents of Guangdong retailing companies that described this framework.

The research findings indicate that digital transformation directly influences supply chain dynamic capabilities and supply chain competitive advantage, with the three dimensions of supply chain dynamic capabilities playing a mediating role between digital transformation and competitive advantage. Furthermore, the channel integration influences the impact of digital transformation on supply chain competitive advantage. Specifically, under high channel integration, digital transformation plays a more significant role in sustaining the competitive advantage

of the supply chain. But the effect of channel integration on supply chain dynamic ability and competitive advantage is not significant.

These findings not only expand the boundaries of digital transformation theory research from within organizations to the entire supply chain but also enrich the empirical research on the antecedents of supply chain competitive advantage. This study systematically reveals the process of capability changes brought about by digital transformation, leading to enhanced competitive advantage and deepening the understanding of the theory of supply chain management and dynamic capabilities. The research results provide theoretical and practical support for the selective and gradual development of supply chain capabilities, helping companies achieve sustainable competitive advantages.

Keyword : Digital Transformation, Supply Chain Dynamic Capability, Channel Integration, Competitive Advantage, Retailing

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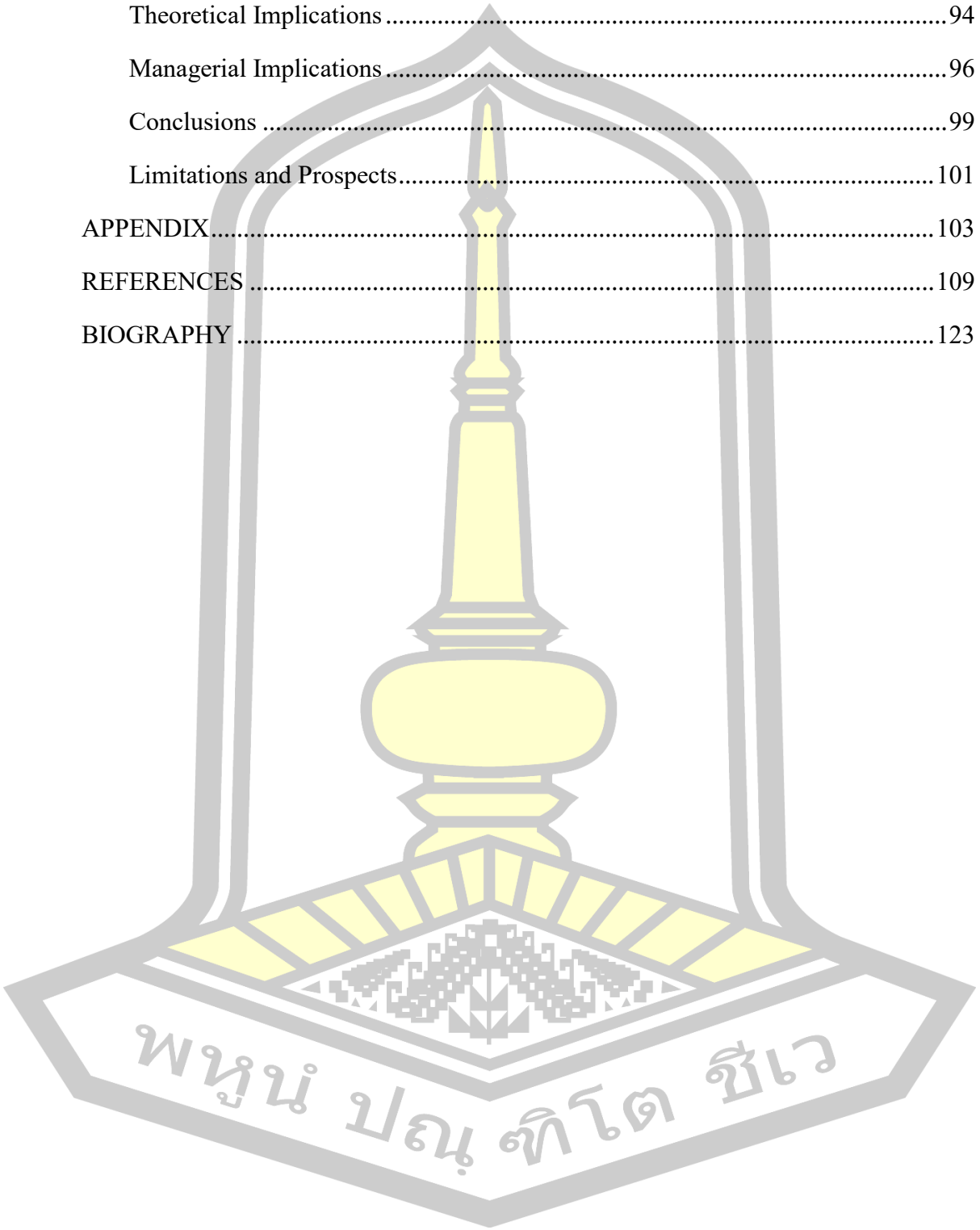

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CHAPTER I INTRODUCTION

Overview

According to the National Bureau of Statistics of China, the total retail sales of consumer goods in 2017 reached 36,626.2 billion yuan, an increase of 10.2% over the previous year, achieving double-digit growth for the 14th consecutive year. In 2020, due to the impact of the epidemic, the total retail sales of consumer goods in the year were 39,981 billion yuan, down by 3.9% from the previous year; In 2023, the total retail sales of consumer goods will reach 47,149.5 billion yuan, an increase of 7.2% over the previous year (see Figure 1). It can be seen that with the continuous increase of China's national disposable income and population, the total consumption of the retail market continues to increase, and the market scale continues to expand, but the growth rate is slowing down. How to stimulate the retail increment enterprise general concern.

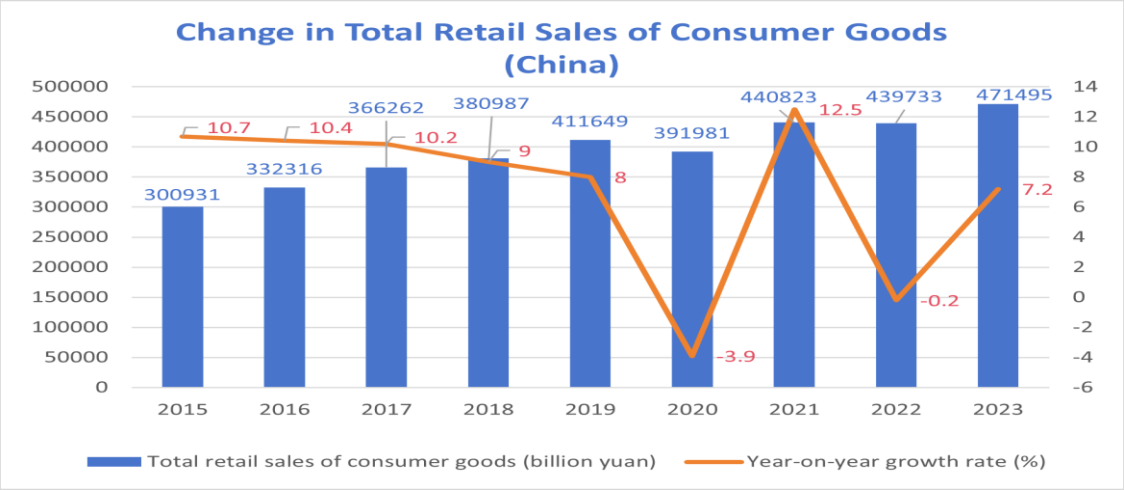


Figure 1 Total retail sales of consumer goods from 2015-2020

—— Data Source: National Bureau of Statistics

Developing the digital economy is an effective means of stimulating incremental retail sales. The digital economy is an economy that operates through digital technologies, including technical facilities and e-commerce (Miao, Z,2021). The digital economy is an important support for high-quality economic development. With the rise of the digital economy, optimizing existing business processes through digital technologies

has become a mainstream choice for many organizations to undertake digital transformation. Under the digital economy environment, the global digital retail market has also developed and grown. Global digital retail sales are expected to grow by $1.4 trillion by 2025, accounting for 50% of the retail industry's expected growth, and in 2020, 16% of goods will be purchased online (Euromonitor, 2021). Global digital retail revenues grew by 25% to $2.4 trillion in 2020, and the number of online shoppers increased by 9.5% to 3.4 billion (Skeldon, 2021). In the United States, digital retail will grow 44% in 2020, almost triple the previous year and the highest growth since the beginning of e-commerce (Ali, 2021).

Digital transformation of retail enterprises can lead to retail sales growth. This study selects retail enterprises in Guangdong Province to investigate the relationship between digital transformation, supply chain dynamic capabilities, channel integration and competitive advantage. The study is interesting from a realistic perspective.

First, scale of the Digital Economy and Policy Pioneering Advantages. Guangdong's digital economy has ranked first in China for four consecutive years (2017–2020). In 2021, the added value of its digital economy reached 5.9 trillion yuan, accounting for 47.5% of its GDP. The Regulations of Guangdong Province on the Promotion of Digital Economy (2021) pioneered a "market-oriented allocation mechanism for data production factors," providing institutional guarantees for retail enterprises in data ownership confirmation, transactions, and cross-border circulation. Selecting Guangdong as the research subject allows for an in-depth observation of the interaction between institutional environments for digital transformation in the retail sector and corporate response strategies under the release of policy dividends.

Second, typicality and Diversity of Industrial Ecosystems. Guangdong is both a major manufacturing hub for consumer goods (accounting for one-quarter of the nation's cosmetics production capacity and one-third of its apparel and footwear manufacturing capacity) and a highland for consumer markets (with total retail sales of consumer goods reaching 4.7 trillion yuan in 2023, over 10% of the national total).

This creates a natural "production-distribution-consumption" full-chain digital transformation laboratory. The research covers diverse retail formats such as beauty (Perfect Diary), home appliances (Gome), and convenience stores (Sailwan), whose differentiated digital transformation pathways reveal industry-specific patterns in supply chain capability building，for instance, Sailwan collaborates with Tencent to build a smart middle-office platform, while Gome leverages iFlyTek for AI-powered customer service. Studying such technology co-evolution cases enables the extraction of collaborative mechanisms through which platform ecosystems empower supply chain dynamic capabilities.

Third, density of Corporate Innovation Vitality. Guangdong hosts over 6.8 million small and medium-sized enterprises (SMEs), with 15.7% of China's national-level "Specialized, Refined, Distinctive, and Innovative" enterprises. It has led the country in digital economy patent grants for five consecutive years. This high-density innovation network has fostered a "symbiotic model" of retail digital transformation.

Fourth, demonstration Effects of Regional Development. Guangdong is tasked with building an international consumption hub in the Guangdong-Hong Kong-Macao Greater Bay Area. Its retail digital transformation experience can radiate nationwide through a dual-circulation pattern (linking the Greater Bay Area with inland regions). For example, Sailwan’s community retail digital transformation model has been replicated in Guangxi and Hunan, validating the cross-regional adaptability of supply chain dynamic capabilities. Research on Guangdong’s cases provides transferable digital transformation paradigms for other provinces.

Digital transformation (DT) has been recognized as an effective way for retail organizations to transform existing business processes, improve customer experience, and enhance enterprise value. For example, online mobile applications provide customers with an entirely new platform to interact with retail businesses (Ramaswamy and Ozcan, 2016). The emergence of cloud computing, big data, Internet of Things, artificial intelligence, VR and other transformation-leading new

generation of information technology, so that the digital retail market space can be expected. Therefore, with the support of digital technology, enterprises can optimize their existing business processes and achieve effective coordination between processes to create customer value through enhanced user experience (Pagani and Pardo, 2017). Digital transformation is a series of value creation activities driven by enterprise technological innovation, relying on the open sharing and efficient utilization of data resources, reconstructing business processes and business models, and aiming at improving user experience (Warner, 2019). In recent years, more and more enterprises have adopted digital transformation as an important means to build competitive advantage (Verhoef, 2021). Therefore, the study of digital transformation has been widely concerned by the academic community, and has become an important background for the study of organizational strategic change.

Supply chain competitive advantage (CA) refers to the effective coordination, collaboration and communication among different entities in the supply chain in a fast-paced business environment, which enables the organization to achieve better performance and improve customer satisfaction. Stay competitive (Barney, 1991). In order to improve the competitive advantage of retail enterprises, they must not only rely on "selling goods", but also cooperate with different entities in the supply chain, driven by customer demand, through the management of planning, procurement, production, delivery and return, to ensure its effectiveness and provide products needed in the market. The retail supply chain includes the complete process of turning raw materials into products and finally delivering products to customers, which is called the "end-consumption demand-driven supply chain" model. In this business model, the retail enterprise and the product development side of the close cooperation to supply the market needs of goods (the right product, the right consumer) can lead to increased sales; Retail enterprises can control the occurrence of out of stock (the right time, the right quantity) to reduce the sales decline caused by out of stock; At the same time, the "right amount" can optimize turnover and release financial resources.

Reasonable and efficient operation allows retail enterprises to control costs in the "appropriate range", so as to ensure that the gross profit is in the appropriate range.

In the digital era, customers browse, view, click, collect and buy goods in the virtual digital world, and every link of the supply chain serving them generates massive data, which becomes an important "production factor" of enterprise supply chain operation. How to support sales and control costs by carrying out digital supply chain management? It has become a research topic for retail enterprises. With the continuous development of digital technology, the value creation logic of the supply chain has undergone profound changes, reshaping the industrial landscape and supply chain competition dynamics, and the digital transformation of the supply chain of retail enterprises urgently needs research and practical implementation to improve the competitive advantage at the organizational level (Sun. J, 2022).

The Enterprise dynamic capability view (DCV) is designed to address the limitations of RBV and adapt to a more dynamic business environment. Teece et al. (1997) define dynamic capability as "an enterprise's ability to integrate, build, and reconfigure internal and external capabilities to respond to a rapidly changing environment." Dynamic capabilities consider the dynamic aspects of the business environment and the ability of the organization to achieve a sustained competitive advantage by strategically aligning its objectives. Singh et al. (2018) examined the use of DCV in operations and supply chain management using qualitative methods in two leading journals, the Journal of Operations Management and Management Science.

Supply chain dynamic capability (SCDC) is becoming an indispensable core organizational competence of enterprises, and supply chain collaboration, supply chain flexibility and agility are all important components of supply chain dynamics (Chun-Yan Zhu, 2022). Some scholars define supply chain dynamic capability as "the ability of an organization to consciously create, expand and modify its resource base" (Zhang, Z., 2021), which emphasizes the utilization of resources. Therefore, in the turbulent environment, it is necessary to analyze the supply chain of retail enterprises

from the perspective of dynamic capability. At present, the research on dynamic capability of supply chain mainly focuses on its relationship with supply chain performance (Hong, J., 2018).

Existing theoretical studies on channel integration (CI) emphasize that retail enterprises should integrate channel types as much as possible to meet the comprehensive experience of consumers (Li Fei,2018). The increase and integration of retail channels can improve customer satisfaction and value (Hamouda M, 2019), promote purchase intention (Li Y, et al, 2018) and customer loyalty (Zhou Fei, 2017), and improve retail efficiency (Liu Xiangdong, 2017). But one study found that: Retail channel integration will reduce the experience of original loyal customers (Berry, 2010), easily lead to opportunistic behaviors of customers, such as "searching" shopping or "showroom" behavior, reduce channel lock-in effect (Rapp A, 2015), and increase channel conflicts and business risks (Furst A, 2017). Channel "competitive eating" is generated, which ultimately leads to increased costs (Gallino S, 2017).

In retail enterprises, channel is an important index to measure customer relationship and competition pattern. Channels can directly reflect the degree of connection between customers and retail enterprises. In the process of serving customers in the market and selling goods, the level of channel integration determines how many target customers can contact with the goods. Based on the current online and offline retail formats, channel integration can be measured in terms of having physical channels, PC channels and mobile channels.

Guangdong is both a large and strong economic province in China, and is at the forefront of promoting the integration of the digital economy and the real economy. Regulations of Guangdong Province on the Promotion of Digital Economy (2021.09.01) put forward: Vigorously develop digital economy. As one of the earliest provinces in China to lay out digital economy policies, Guangdong has ranked first in the country in terms of total digital economy for four consecutive years from 2017 to 2020. At the same time, in the consumer industry, Guangdong is both a large supply

province and a large consumption province, and has strong industrial resources in many core consumer areas such as beauty, shoes and clothing, jewelry and catering, which are actively exploring digital transformation. In addition, the number of small and medium-sized enterprises and the number of patented small and medium-sized enterprises in Guangdong Province are ranked first in the country, with an active innovation atmosphere, and is the forefront of digital reform. This study focuses on: the process of exploring the impact of digital transformation on the supply chain dynamic capabilities and competitive advantage of Guangdong retail enterprises in an environment where the growth rate of total consumption in the retail market has become slower, some interesting phenomena have been identified.

In the process of communicating with retail enterprises in Guangdong province, the research found: Sailwan Times (Guangdong), established in 2012, 11 years of development time, in the case of slowing retail growth, the company's comprehensive strength has been greatly improved, the basic platform structure is gradually improved, the supply chain integration ability is comprehensively improved, and the sales end has a strong drive for the development of the company. Gome Electrical appliances is one of the earliest home appliance chain retailers in China, established in 1987, however, the latest news in October 2023 shows that Gome retail has 2 self-operated stores and 107 franchise stores in Guangdong, compared to the end of the last quarter there are 14 self-operated stores and 181 franchise stores, Gome stores in Guangdong reduced by 86 in a quarter.

From the phenomenon of Sailwan era: digital technology has indeed boosted the development of enterprises, enterprises with the innovation and technology of the industry to achieve unprecedented integration of online and offline, with the help of digital technology, accurately meet consumer demand. The comprehensive improvement of digital investment and retail supply chain integration ability of Sailwan Times has made the cost reduction and income increase of enterprises obvious. Gome Electrical Appliances is also promoting digital reform, but the

financial report shows that: in the semi-annual report released in September 2023, the revenue of Gome retail was only 414.76 million yuan, compared with the revenue of 12.1 billion yuan in the same period in 2022, down more than 96%.

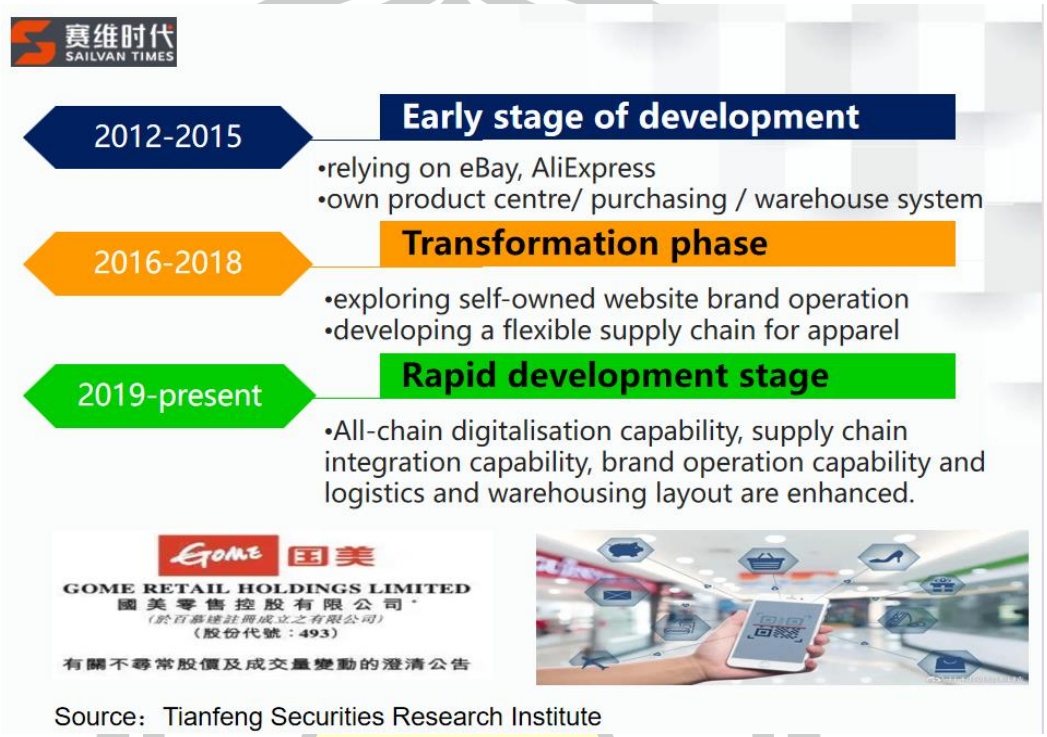


Figure 2 Comparison of the development of two retail enterprises

This phenomenon suggests that different retail enterprises in the same Guangdong Province, all of which have implemented digital reforms, have different channel integration situations, have different retail supply chain dynamic capabilities, and have different corporate competitive performance performances; it is worthwhile to study the influence relationship and the mechanism of the effects between different variables such as digital transformation, supply chain dynamic capabilities, channel integration, and competitive performance.

Purpose of the Research

This study takes the digital transformation of retail enterprises as the starting point and focuses on the theme of "The impact of digital transformation on the dynamic capability and competitive advantage of supply chain under the premise of different

channel integration levels of retail enterprises". The specific research purposes are as follows:

1. To investigate the level of digital transformation, the level of supply chain dynamic capability, the level of channel integration and the level of competitive advantage of retailing enterprises.

2. To investigate the mechanism of the role of digital transformation on the competitive advantage of retailing enterprises.

3. To investigate the mediating role of supply chain dynamic capabilities in digital transformation and competitive advantage.

4. To investigate the moderating role of channel integration levels in digital transformation and competitive advantage.

Research Questions

A key research question of this research is how the digital transformation, supply chain dynamic capability and channel integration on competitive advantage. Also, the specific research questions are presented as follows:

1. How is the level of digital transformation, the level of dynamic supply chain capabilities, the level of channel integration, and the level of competitive performance of retailing enterprises?

2. How does the digital transformation have an effect on retailing enterprises' competitive advantage?

3. How does the supply chain dynamic capabilities have the effect on digital transformation and competitive advantage?

4. How does retailing enterprises' channel integration level affect the relationship between digital transformation, supply chain dynamic capabilities and competitive advantage?

Scope of the Research

In this research, digital transformation, supply chain dynamic capability and channel integration on competitive advantage. Moreover, this research proposes the theory interaction to describe the relationships of each variable to examine and to answer the research questions and objectives. Additionally, the research questions and objectives are answered by analysis which is based on the data collected from the population used in the study were retailing enterprises in Guangdong Province, covering categories such as beauty retail, jewelry retail, shoe and apparel retail, and catering retail. Use regression analysis and structural equation models to test hypotheses and explore influencing mechanisms.

Organization of the Research

This research is structured in five chapters. Chapter one provides an overview of the research, purpose of the research, research questions, scope of the research and organization of the research. Chapter two reviews the relevant literature, explains the theoretical framework to describe the conceptual model, and develops the related hypotheses for testing. Chapter three outlines the research methods, including the population selection and data collection procedure, the variable measurements of each construct, the instrumental verification, and the statistics and equations to test the hypotheses. Chapter four demonstrates the empirical results. Finally, chapter five deals with the conclusions and discussions, theoretical and managerial contributions and implications, and limitations. The anticipation is to establish the prototype the digital transformation, supply chain dynamic capability, channel integration on competitive advantage.

CHAPTER II LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

The prior chapter described an overview of the digital transformation, supply chain dynamic capability, channel integration on competitive advantage which contains information about the purpose of the research, the research questions, and scope of the research. Accordingly, this chapter provides insights in digital transformation, supply chain dynamic capability, channel integration, and supply chain competitive advantage that consist of the theoretical foundation, relevant literature reviews, the conceptual framework, and the hypotheses development. Furthermore, the hypotheses to be proposed are expected to answer the purposes of research and the research questions.

This chapter is organized into three major sections. The first section describes some theories explaining the conceptual model in this research. The second provides relevant literature of all constructs in the conceptual framework, definitions and previous studies on the subject that are relevant to digital transformation, supply chain dynamic capability and channel integration on competitive advantage. The final section presents the summary of hypotheses the digital transformation, supply chain dynamic capability and channel integration on competitive advantage.

Theoretical Foundation

This study attempts to integrate many theoretical perspectives that support digital transformation, supply chain dynamic capabilities, and channel integration to promote competitive advantage. Theories supporting this research include supply chain management theory, dynamic capability theory, and supply chain competitive advantage theory, which are explained as follows:

Supply chain management theory

Forrester（1961） first proposed the idea of "Supply Chain" when studying the optimization of the dynamic relationship between the upstream and downstream of the industry, and the production distribution system he proposed still has an impact on the design principles of supply chains.

Subsequently, Oliver and Webber（1982） first proposed the concept of Supply

Chain Management. They defined supply chain management as the strengthening of logistics management and a management means to effectively reduce inventory occupation. During this period, supply chain management was often thought of as logistics, procurement, or equivalent to supplier management.

The Council of Logistics Management (1986) proposed that supply chain management is the logistics involving external suppliers and customers of enterprises, which was widely concerned by the industry and academia at that time. Some scholars and industry people agree with this view, they believe that the essence of supply chain management is still logistics management, but the management of materials from the source to the final customer. However, some other scholars and industry people believe that supply chain management not only includes the management of the circulation and transportation of materials from suppliers to final customers, but also includes the management of business processes such as supplier integration. Therefore, the concept of supply chain management has been divided for a long time.

Since the 1990s, due to the constant changes in the market environment and the intensification of business competition, the academic and industrial circles have gradually realized the importance of cooperation among various enterprises at the nodes of the supply chain, and the concept of supply chain management has also undergone earth-shaking changes.

Christopher (2016) believes that supply chain management focuses on cooperating with upstream suppliers and downstream customers to create as much value as possible at the lowest possible cost.

Beamon (1998) believes that supply chain management is the optimization of integrated processes of different business entities (such as suppliers, manufacturers, retailers, etc.), which is committed to transforming raw materials into final products and quickly delivering them to customers.

Carter and Narasimhan (1996) believe that supply chain management includes material flow management, information flow management and relationship management that break organizational boundaries in order to reduce costs and improve processes.

Bolstorff and Rosenbaum (2007) proposed the supply Chain Operations Reference (SCOR) model, which defined the supply chain as five processes: planning, procurement, manufacturing, transportation and return. It aims to integrate internal and external processes and information by applying enterprise resource planning and enterprise process reengineering. The application of this model has greatly promoted the development of supply chain management. As we all know, the birth of a theory will go through the repeated process of "practice-theory-practice".

In 2003, the Logistics Management Society announced the results of repeated research on the combination of theory and practice after more than ten years, that is, logistics management is a part of supply chain management.

Maersk (2003) was the first to introduce the concept of supply chain and supply chain management into China. He believes that supply chain management is the whole process from procurement to meeting the needs of final customers, including the efficient operation of workflow, information flow, capital flow and physical flow, the timely and accurate delivery of appropriate products to customers, and the optimization of supply chain operation with the least cost.

With the rapid development of economic globalization, the scope of supply chain management is no longer limited to a region or a country, but extends and extends to the global supply chain management. In the context of fierce competition in the global market and complex and changing environment, traditional supply chain management is faced with problems such as highly fragmented and untimely information transmission, which results in poor cooperation between upstream and downstream enterprises, and it is difficult for the supply chain to respond quickly and efficiently to market changes. Many enterprises have supply chain network nodes all over the world, which makes the supply chain network more complicated and increases the difficulty of supply chain management. In addition, the economic globalization, the turbulence of the market environment and the wide application of the new generation of information technology have put forward new requirements for supply chain management.

Jangga et al. (2015) proposed, in a complex and volatile business environment, enterprises are more in need of introducing new technologies and developing new

products to adapt to changing market demands. Therefore, the application of information technology is conducive to strengthening enterprises' supply chain management capabilities.

Yu et al. (2018) put forward the concept of data-driven supply chain, which refers to the introduction of big data technology into all aspects of supply chain management.

Li et al. (2020) pointed out in their research that the introduction of iot technology by enterprises can promote the visualization of supply chain, intelligent procurement and the improvement of logistics efficiency.

Based on supply chain management theory, this study combines traditional supply chain management with digital transformation to explore the impact of digital transformation of supply chain on competitive advantage of retailing enterprises.

Dynamic capability theory

It is generally believed that the Dynamic Capabilities Theory originated from the research of Teece and Eisenhardt. Teece further improved the dynamic capabilities theory in 1997. They define dynamic capability as the ability of an enterprise to build, integrate, and reconfigure its internal and external resources to respond to rapid changes in the business environment. In this definition, dynamic capability is considered a resource.

Eisenhardt and Martin explained the theory of dynamic capability from the perspective of strategy and organizational process in 2000. They believe that dynamic capability is the process of enterprise integration, reconfiguration, acquisition and release of resources to match or even create market changes, and enterprises obtain new resource allocation through these processes. This definition shows that dynamic capability is only a process and does not further explain the difference between dynamic capability and ordinary capability. After that, the academic circle began to conduct more extensive research on dynamic capability, but there are still some differences on the concept definition of dynamic capability theory. Some scholars conducted research based on Teece's capability perspective.

Pavlou and ElSawy (2011) argued that dynamic capability is a means to cope with dynamic environment, which helps managers to extend, modify and reconfigure

existing operational capabilities and reconfigure them to new capabilities that are more in line with the environment.

Wang and Ahmed (2007) define dynamic capability as the behavioral orientation of an enterprise, in which an enterprise acquires and maintains an absolute competitive advantage by continuously integrating, reconfiguring resources, updating and recreating its resources and capabilities, and most importantly, upgrading and rebuilding its core capabilities to cope with the changing environment. In this definition, they combine the ideas of Teece and Eisenhardt to show that dynamic capabilities are not just processes, but capabilities embedded in processes.

Based on researcher's views, the supply chain dynamic capabilities have three dimensions, includes supply chain learning and absorption capability, supply chain innovation capability, supply chain integration and optimization capability. The dimensions are follows, as table 1.

Table 1 Supply chain dynamic capabilities' dimensions

dimensions	sources	Operational definitions
Supply chain learning and absorptive capability	Bessant et al. (2003) Tse et al. (2016)	supply chain learning and absorptive capabilities includes external and internal learning capabilities. External learning capabilities help firms to utilize new knowledge to enhance supply chain responsiveness. Internal learning promotes market share growth and also improves financial performance.
Supply chain innovation capability	Bello et al. (2004) Lee et al. (2014)	Supply chain innovation capability is a management enhancement capability that improves the efficiency of the supply chain through collaborative work with suppliers, retailers and customers. supply chain innovation enables enterprises to quickly respond to

		uncertainties in the business environment, respond to customer demand and achieve more effective supply chain management, and supply chain innovation is not only internal innovation, but also establishes a new cooperative relationship through interaction with upstream suppliers and downstream customers.
Supply chain integration and optimization capability	Anand et al. (2009)	Supply chain integration and optimization capability is a dynamic capability that refers to a series of collaborative activities with upstream suppliers and downstream customers to improve the speed and quality of the flow of information and commodities in the supply chain. supply chain integration and optimization capability helps enterprises to better match the supply and demand at different nodes of the supply chain

Danneels et al. (2016) believe that dynamic capabilities can continuously improve ordinary capabilities, which may lead to higher efficiency. At the same time, dynamic capabilities involve the establishment of new resources or the ability to solve problems for the future, which may give enterprises competitive advantages by initiating changes in the competitive environment. Another group of scholars followed Eisenhardt's strategic and organizational process research perspective.

Zollo and Winter (2002) explored dynamic capability based on evolutionary thinking and defined dynamic capability as a stable mode achieved through collective learning activities to modify processes and improve efficiency. In their framework, learning mechanisms such as knowledge-related activities are the main drivers of dynamic ability development.

Li Dayuan et al. (2009) believe that dynamic capability is the process of creating a new resource structure through the creation, expansion, integration, reconstruction and renewal of strategic resources. According to this study, although there are differences in the academic interpretation of dynamic capability, no matter from what research perspective, scholars generally agree that a high level of dynamic capability cannot guarantee the accuracy of all strategic decisions of enterprises, but can enable enterprises to make effective responses when encountering accidents and mistakes. Dynamic capability plays a positive role in improving the competitiveness and performance of enterprises.

Anand et al. (2009) believe that dynamic capability helps enterprises effectively respond to changes in strategy and operation, thus generating improvement in operation capability. Therefore, enterprises can maintain or improve their competitiveness even in a dynamic environment.

Zahra and George (2002) argue that dynamic capabilities enable businesses to update and reconfigure their resource base in response to changing customer needs and adjustments in competitor strategies.

Barreto (2010) believes that dynamic capabilities help enterprises systematically solve problems, thus enabling enterprises to make timely and market-oriented decisions and make innovative changes to the resource base.

Weerawardena et al. (2007) believe that dynamic capability enables enterprises to develop cutting-edge knowledge-intensive products, paving the way for accelerating their entry into the market. At the same time, in the face of frequent technological changes, dynamic capability has more value, because such dynamic environment increases the opportunities for enterprises to exercise dynamic capability.

To better cover the cost of developing them. This study combines dynamic capability theory with supply chain management to explore the role of supply chain dynamic capability in the relationship between digital transformation and competitive advantage.

Relevant Literature Reviews

According to the literature, this research attempts to conceptually link digital

transformation, supply chain dynamic capabilities and channel integration on competitive advantage through five theories namely, supply chain management theory, digital transformation, supply chain competitive advantage, dynamic capability theory, and channel integration. The relationship model is separated into 5 parts as follows.

Firstly, this research focuses on digital transformation is positively related to supply chain dynamic capabilities.

Secondly, this research focuses on supply chain dynamic capabilities is positively related to competitive advantage.

Third, this research focuses on digital transformation is positively related to supply chain competitive advantage.

Fourth, this research focuses on supply chain dynamic capabilities mediate the relationship between digital transformation and supply chain competitive advantage.

Fifth, this research focuses on channel integration moderates the relationship between digital transformation and supply chain competitive advantage.

Hence, the next section mentions the literature reviews and the hypotheses digital transformation, supply chain dynamic capabilities, channel integration on competitive advantage to be discussed and proposed.

Digital Transformation and Supply Chain Dynamic Capabilities

Digital transformation

Lenka&Parida (2016) proposed that the field of digital transformation originates from the continuous development of digital technology, which is characterized by its availability, scalability and openness.

Zhou,Q (2022) proposed: Over time, a large amount of academic research has emerged around the topic of digital transformation, and 134 different definitions of digital have been found in high-quality journals.

According to recent research by Wang Hecheng et al. (2021), at the organizational level, digital transformation refers to the process in which an enterprise requires new

technology applications, ecological positioning, business models, business and organizational processes, as well as good corporate culture, leadership and risk tolerance. It aims to strengthen relationships between organizations and their employees, customers, suppliers, partners and stakeholders to enable more effective competition in the ever-changing digital economy. This definition reflects the focus of digital transformation on building deep integrated networks among industry chain participants to achieve sustainable competitive advantage.

At present, the research on digital transformation mainly falls into two categories. The first category focuses on the antecedents and consequences of digital transformation, which is also the most relevant type of research for this study. The second type of research is conducted on a different topic or entity, exploring digital transformation in a specific context or industry. The first type involves ongoing detailed research into the impact of digital transformation. The digitization of the supply chain refers to a customer-centric approach to information and data-driven management. It involves the use of digital technology to document and analyze the entire process of product procurement to delivery.

Digital transformation's impact on supply chain dynamic capabilities

Existing research shows that digital transformation can have an impact at the organizational and supply chain levels. Chen, W (2021) proposed that: at the organizational level, digital transformation has a significant effect on enhancing the supply chain capabilities of weaker members. Zhao, N (2023) proposed that: At the supply chain level, continuous application of digital technology optimizes product development, warehouse management, logistics visibility and quality traceability, thereby effectively improving supply chain networks and business processes. It also facilitates collaboration among supply chain participants, creating synergy and stability throughout the supply chain, resulting in improved financial performance (Kohtamaki, M.2020), innovation performance (Tang, H.2022), new product development performance (Chi, M., 2020), and more. The second category involves the expansion of the scope for digitally driven collaboration.

The study of digital transformation has evolved from individual organizations to broader contexts. Early studies on digital transformation mainly focused on the

sustainable development of individual organizations, exploring the driving factors of digital transformation within a single organization (Yu, D.,2021), transformation mechanism (Lu, B.,2022) and transformation effect (Truant, E.,2021; Zhao, N.,2023). With the continuous development of digital technology, digital research has penetrated into collaborative efforts within the industrial value chain. Many scholars have studied the entities that rely on digitalization for collaboration, the mode of digitalization enabling industrial value chain, and the way to integrate digital technologies to achieve industrial collaboration (Yu, F.,2022). Wang Hecheng (2021) et al. found that organizations at the forefront of digital transformation are leading the way in business and digital technology applications, which drives the construction of industry ecosystems. Scholars have also conducted research on understanding the characteristics of value co-creation in business ecosystem and its evolution under the influence of digital economy (Hu, H.,2018). While these studies enrich our understanding of the enabling factors and multifaceted benefits of digitization, most studies indicate that further empirical investigation of the antecedents and outcomes of digital transformation is needed (Salvi, A.,2021). This paper attempts to facilitate this research by elucidating the impact of digital transformation on supply chain dynamic capabilities and competitive advantage.

Wang, J (2022) demonstrated that digital transformation promotes the construction of a digitally enabled end-to-end supply chain, expands the boundaries of supply chain services, and facilitates the formation of a supply chain ecosystem, which contributes to the emergence of a responsive supply chain and drives the value expansion of supply chain optimization and integration. Therefore, it can be inferred that digital transformation enhances the ability of supply chain optimization and integration capability.

Furthermore, digital transformation enhances the visibility of the supply chain, reduces information asymmetry among supply chain members, and can be predicted to strengthen the learning and absorption capability of the supply chain.

Lastly, Lee et al. (2014) demonstrated that innovation enables enterprises to quickly respond to uncertainties in the business environment, respond to customer demand and achieve more effective supply chain management, and supply chain innovation is

not only internal innovation, but also establishes a new cooperative relationship through interaction with upstream suppliers and downstream customers. Digital transformation provides technical support and supply chain operating environment for supply chain innovation.

Therefore, the alternative hypothesis H1, H2, and H3 are proposed as per the literature review given above:

Hypothesis 1: Digital transformation is positively related to learning and absorption capability in the supply chain.

Hypothesis 2: Digital transformation is positively related to innovation capability in the supply chain.

Hypothesis 3: Digital transformation is positively related to optimization and integration capability in the supply chain.

Supply Chain Dynamic Capabilities and Competitive Advantage

Competitive advantage

The term sustainable competitive advantage (SCA) was first coined by Porter (1999), who argued that competitive advantage is the core of organizational performance in competitive markets, representing lasting performance over competitors. Building a supply chain with sustained competitive advantage is a key strategic way for organizations to survive and achieve sustainable development in a dynamic global market.

Datta, P.P. (2016) proposed that the competitive advantage of supply chain refers to the comprehensive quality of the supply chain to pass value to the market through effective allocation of resources in a highly competitive market, so as to win more development opportunities than competitors.

Hoffman (2000) further defines sustainable competitive advantage as the long-term benefits gained by implementing a unique strategy that cannot be implemented or replicated by current or potential competitors.

Yang, X. (2017) proposed that achieving supply chain competitive advantage is the ultimate goal of core enterprises leading supply chain activities.

Lei, X. (2008) proposed that supply chain competitiveness is characterized by systematicness, stability and value creation, which represents the ultimate goal of enterprise change activities.

In view of this, how to build sustainable supply chain competitiveness has attracted the attention of researchers. Supply chain management scholars have proposed various strategies to improve supply chain competitive advantage. Based on different sources of competitive advantage, three classical theories have been developed: endogenous theory, exogenous theory and integration theory. Guan, B. (2017) proposed a study on the ways to improve supply chain competition performance, which mainly follows the path of endogenic-exogenous integration, focusing on the internal management of supply chain in the early stage to realize the integration of various processes within supply chain enterprises, and gradually turning its attention to the influence of external environment on competitive advantage, and finally evolving into the integration of internal and external supply chains. To identify, explore and construct the elements of competitive advantage and the way to enhance competitive advantage.

John, T. (2020) emphasizes the endogeneity of competitive advantage based on the resource-based theory, and believes that lasting competitive advantage comes from the unique resources and capabilities formed on the basis of these resources, emphasizing the heterogeneity of resources, capabilities or knowledge. Resources and capabilities with unique attributes form the basis of organizational competitive advantage, and it is the differences in organizational resources and capabilities that lead to differences in competitive advantage (Barney, J.B., 1991). Therefore, it is necessary to use digital technologies to build an organization's digital resources and digital capabilities, thereby building an internal competitive advantage.

Porter, M.E. (1990) proposed the exogenous strategy of competitive advantage based on the SCP (Structure-Conduct performance) paradigm based on the industrial organization theory, and believed that the differences in competitive advantage of enterprises were determined by market structure and market behavior. Porter emphasizes the analysis of the influence of external market environment on competitive advantage, such as the interaction between enterprises and industries,

cooperation and competition between enterprises, the interaction between related industries, and the interaction between enterprises and suppliers, customers and peers (Ma, G., 2006). This is very consistent with the strategic practice in the digital economy environment. In this context, it is necessary to explore new strategic competitive models that are compatible with the current digital environment and to build external competitive advantages for the organization.

Supply chain dynamic capabilities 's impact on competitive advantage

Guan, B. (2017) Based on the cross-organizational and cross-functional supply chain strategy, he believes that the resources and capabilities of the entire supply chain can be integrated so as to obtain sustainable competitive advantages that individual enterprises and external enterprises cannot have. The integration perspective emphasizes the integration of internal and external resources and capabilities, as well as the accumulation of historical capabilities, as the basis for gaining competitive advantage in a dynamic market environment, explaining the sources of organizational competitive advantage (Lei, X., 2008).

To sum up, it is crucial to explore how to improve supply chain competition performance. There are three strategies to improve competition performance: internal strategy, external strategy and integration strategy.

The study of Ma Gang et al. (2006) shows that organizational competitive advantage is not only determined by high-performance practices formed by internal processes and positions, but also influenced by technological opportunities. Digital technologies, as the most advanced and evolving technologies, can play a role in these strategies. Internally, digital transformation can be used to build an organization's digital resources and capabilities to create an internal competitive advantage. Externally, digital technologies can be used to reduce transaction costs and create a more favorable external environment. Integration, which can use tools such as digital platforms to integrate resources and capabilities to achieve synergies where the sum of competitive advantages is greater than the individual parts. Therefore, this study aims to enrich this research background by examining the impact of digital transformation on supply chain competitive advantage.

This study evaluates supply chain capability from three dimensions: learning and

absorption capability, innovation capability, optimization and integration capability. These three elements are considered to assess the impact of supply chain capabilities on supply chain competitive advantage.

Shore (2003) demonstrated that learning and absorption capability promoted enterprises to share knowledge with supply chain partners in an effective and efficient manner. Learning and absorption capability is a classic organizational capability and a classic source of competitive advantage in the different age, not only digital age. Shore (2003) demonstrated that effective learning and absorption capability has been identified as one of the fundamental capabilities in supply chain processes. Omar (2010) demonstrated that efficient learning and absorption capability can enhance operational efficiency among supply chain partners, and improving information sharing strategies can enhance overall supply chain performance.

Bello et al. (2004) demonstrated that innovation capability is a management enhancement capability that improves the efficiency of the supply chain through collaborative work with suppliers, retailers and customers. Lee et al. (2014) demonstrated that innovation enables enterprises to quickly respond to uncertainties in the business environment, respond to customer demand and achieve more effective supply chain management, and supply chain innovation is not only internal innovation, but also establishes a new cooperative relationship through interaction with upstream suppliers and downstream customers.

Flynn (2010) demonstrated that optimization and integration capability is conceptualized as the degree to which a company collaborates with its supply chain partners and coordinates the management of processes within and between organizations to achieve effective integration of physical, information, and financial flows. Kumar (2017) demonstrated that optimization and integration capability is an important area that involves strategic adjustments of functions and processes within organizations and among supply chain members.

Cámara (2015) & Jian, Z. (2021) demonstrated that cross-functional boundary integration of processes and activities, including suppliers and customers within the supply chain, can reduce transaction costs, reduce information asymmetry, optimize allocation of supply chain resources, and achieve low-cost and efficient fulfillment of

customer demands, which is crucial for the development of nodal enterprises (Barney,2012).

Based on the review, strengthening supply chain capabilities can support companies in achieving higher competitive advantage on the supply chain.

Therefore, the alternative hypothesis H4, H5, and H6 are proposed as per the literature review given above:

Hypothesis 4: Learning and absorption capability in the supply chain is positively related to competitive advantage.

Hypothesis 5: Innovation capability in the supply chain is positively related to competitive advantage.

Hypothesis 6: Optimization and integration capability in the supply chain is positively related to competitive advantage.

Digital Transformation and Competitive Advantage

Belhadi et al. (2022) pointed out that digital supply chains can enhance supply chain visibility, enable flexible adjustments in structure, organization, and capabilities, improve product quality, and increase supply chain efficiency.

Xue et al. (2022) found in their research that enterprises can eliminate organizational barriers, integrity culture barriers, employee quality barriers, and management talent barriers in supply chain value management through digital transformation.

Shin and Namchul (1999) demonstrated that digital technology can enhance the coordination of economic activities and increase enterprise productivity.

Kohtamaki (2022) indicated that enterprises can significantly improve customer service performance through digital transformation.

Zeng, H et al. (2022) discovered that digital transformation can promote financial performance.

Based on the above research results, it can be seen that supply chains after digital transformation are more flexible and competitive. Therefore, it can be inferred that digital transformation undoubtedly enhances the competitive advantage of supply

chains.

Therefore, the alternative hypothesis H7 is proposed as per the literature review given above:

Hypothesis 7: Digital transformation is positively correlated with supply chain competitive advantage.

Mediating Role of Supply Chain Dynamic Capabilities

Previous research has found that supply chain dynamic capabilities supported by digital technologies are organization-specific and difficult to replicate across organizations.

Wu, F. et al. (2006) demonstrated that supply chain capabilities can serve as catalysts for transforming digital resources into higher value for companies.

Zhang, Y. et al. (2014) demonstrated that factors influencing supply chain capabilities can enhance the improvement of supply chain competitive advantage.

Therefore, it is evident that supply chain dynamic capabilities play a crucial role in the relationship between digital transformation and competitive advantage.

Based on the above, this study concludes that digital transformation can enhance the capabilities of supply chain learning and absorption, innovation, optimization and integration, thereby contributing to supply chain competitive advantage.

Therefore, there have the mediating role of supply chain dynamic capabilities. We proposed the view as per the literature review given above.

Hypothesis 8: Learning and absorption capability in the supply chain mediates the relationship between digital transformation and supply chain competitive advantage.

Hypothesis 9: Innovation capability in the supply chain mediates the relationship between digital transformation and supply chain competitive advantage.

Hypothesis 10: Optimization and integration capability in the supply chain mediates the relationship between digital transformation and supply chain competitive advantage.

Moderating Role of Channel Integration

Channel integration

Channel integration means that enterprises coordinate the goals, design and deployment of various channels to a certain extent, provide convenience for consumers, and ultimately achieve synergies between channels.

Sousa and Voss (2006) first proposed the channel integration quality model and divided it into two parts: channel service configuration and channel integration interaction.

Lee & Chen et al. (2019) defined channel service configuration as a broad and flexible combination of cross-channel services to facilitate consumers to freely switch purchase paths among alternative channels according to their preferences. Channel integration interactions describe the consistency of content and processes provided by different channels. Specifically, channel service configuration includes the breadth and transparency of channel services, and interactive integration includes content consistency and process consistency.

Hossain et al. (2020) combined the theory of channel integrated quality with the dynamic capability theory, and incorporate the measurement dimension of quality assurance into the model of channel integrated quality.

Lee and Kim (2010) constructed a cross-channel integration index system from the perspective of consumer perception, which was divided into five measurement dimensions: freedom of channel choice, consistency of channel information, online operation effect, channel complementarity and offline service experience.

Zhuang Guijun (2019) summarized the measurement dimensions of cross-channel integration as consistency, sharing, collaboration and complementarity.

From the perspective of customers, Frasquet and Miquel (2017) propose that channel integration is the combination and management of various channel types by retailers in order to provide customers with seamless experience of different channels. Cross-channel integration is seen as an effective way to enhance the customer shopping experience, allowing customers to have a seamless cross-channel

experience, which in turn increases satisfaction and value.

Based on an enterprise perspective, Oh & Teo et al. (2012) proposed that channel integration is regarded as a channel management method that coordinates multiple interaction forms, with the goal of utilizing the advantages of each channel to obtain more sales opportunities and achieve economies of scale, thus improving enterprise performance. They put forward that the evaluation system of channel integration can be divided into information acquisition integration, promotion information integration, retail commodity and price information integration, transaction information integration, order fulfillment integration and customer service integration according to the retail process of goods.

Cui Xingwen(2021) believes that cross-channel integration is a management process for retailers to design, configure and combine various available channel types based on information technology in order to provide consumers with seamless cross-channel shopping experience and optimize their own performance.

In addition to defining the concept and connotation of cross-channel integration, scholars pay more attention to its impact on relationship or market performance [Li Y (2018), Wang Xuhui (2017)]. A few studies have also focused on cost and efficiency [Gallino (2017), Liu Xiangdong (2017)].

Channel integration's moderating effect

Zhang et al. (2018) & Saghiri et al. (2017) proposed that when channel integration level is high, customers can query consistent commodity information, price information or promotion information in different channels in a wider range, higher frequency and more conveniently, which is conducive to accelerating the process of customer purchase and improving customer satisfaction.

Zhou et al. (2017) proposed that at a high level of channel integration, different channels can share common infrastructure (logistics distribution system, warehousing system, etc.), common operations, and common customer groups to achieve economies of scale.

Cao & Li (2018) proposed that due to the difference in resource endowment and management ability, different enterprises have different channel integration degrees.

The higher the degree of channel integration, the stronger the learning and absorption ability, innovation ability, optimization and integration ability are required to maintain supply chain competitive advantage.

Digital transformation can achieve higher data collection, processing, analysis and dissemination, and it is easier to meet the information processing, analysis and precision mining needs of supply chains with higher channel integration.

Therefore, as the degree of enterprise channel integration increases, the digitally transformed supply chain shows more significant advantages in maintaining and improving competitive advantage.

Based on these assertions, the study concludes that digital transformation enhances the supply chain's ability to maintain competitive advantage in an environment of increased channel integration.

Therefore, there have the moderating role of channel integration. We proposed the view as per the literature review given above.

Hypothesis 11: Channel integration moderates the relationship between digital transformation and competitive advantage.

Hypothesis 12: Channel integration moderates the relationship between Learning and absorption capability and competitive advantage.

Hypothesis 13: Channel integration moderates the relationship between innovation capability and competitive advantage.

Hypothesis 14: Channel integration moderates the relationship between optimization and integration capability and competitive advantage.

Conceptual Framework

Digital transformation, supply chain dynamic capabilities, channel integration on competitive advantage.

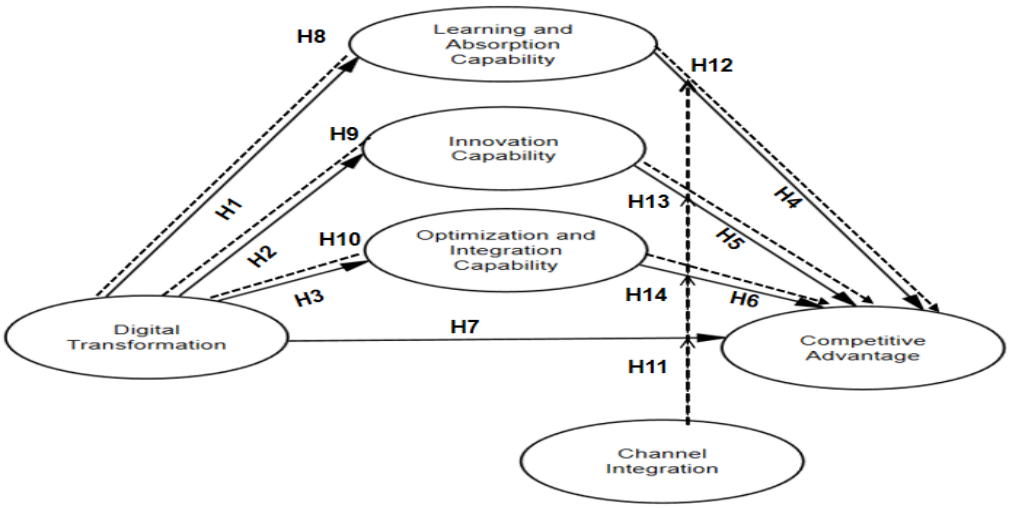


Figure 3 Conceptual Framework

CHAPTER III RESEARCH METHODS

Chapter III summarizes the research method by which the methods are described in detail. Chapter II discusses the literature review and conceptual framework to provide a theoretical and research background to the proposed research built digital transformation, supply chain dynamic capabilities, channel integration on competitive advantage.

This chapter presents the research methods which are organized as follows: Firstly, the sample selection and data collection procedure part which include the population and sample and the data collection. Secondly, the variable measurements are confirmed. Finally, the methods and the statistical techniques.

Sample Selection and Data Collection Procedure

Population and Sample

Research related to the digital transformation, supply chain dynamic capability, channel integration and competitive advantage of the Guangdong retail enterprises. We should choose the retail trades data of Guangdong to test our hypotheses. For this reason, this research found that according to the Guangdong Statistical Yearbook, there were 1201165 retail trades by the end of 2022. At the same time, according to Taro Yamane Table, 95 percent confidence level (Yamane,1973). the sample size was 400. Data will be collected from 400 organizations of Guangdong retail trades.

$$n=\frac{N}{1+N(e^2)} \qquad n=\frac{1201165}{1+1201165(0.05^2)}=400$$

Notes: n=sample size; N=population size; e=level of precision

Data Collection

In this research, the key informants are managers at middle management level and above with a clear understanding of the specific operations of the retail enterprises in

Guangdong. These are considered appropriate key respondents.

The questionnaires were sent to participants through two methods. One method is online, and the other method is collecting the data through the retailer's meeting which many suitable participants attended. It is appropriate because online questionnaire is a widely-used method for large data collection in a geographical area, and on the retailer`s meeting, questionnaires is effective.

In this study, the questionnaire consists of four parts. The first part is the introduction. The second part presents evaluations of digital transformation, supply chain dynamic capabilities, channel integration, and competitive advantages. The third part asks for personal information. The fourth part is the acknowledgement. Additionally, the second part is related to each structure in the evaluation concept model, and the items measured by this model are anchored by a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree. According to Nunnally (1978) and Neuman (2006).

In the pretest stage, data was collected at the annual meeting of the Guangdong Chain Operation Association and within the member stores of the Store Manager Vocational Education Group to ensure the reliability and validity of the measurement scale to the greatest extent. During the stage of verifying the reliability and validity of the questionnaire, when I was collecting data through sending the questionnaire to the people face to face, I could conveniently grasp the understanding level of the respondents towards each item. In the pretest stage, I delivered 300 questionnaires through the retailer's meeting. 201 responses were received. Of the surveys completed and returned, only 151 were usable.

I tested the reliability and validity of the measurement questionnaire through the 151 valid data collected onsite. After confirming that the questionnaire has good reliability and validity, I began to collect data online and on-site. 685 responses were received. Of the surveys completed and returned, 429 valid questionnaires were returned in this study due to the presence of short response time, apparently random responses, incomplete answers, and non-target sample population. The total effective response rate was approximately 62.63 %.

Table 2 shows the results of the questionnaire sending that used is for analysis in this

research.

Table 2 The Details of Questionnaire Sending

Details of questionnaire sending	
Details	**numbers**
Online questionnaire	564
Received	564
Unusable	209
Usable	355
response rate	62.94%
on-site questionnaire	121
Received	100
Unusable	21
Usable	74
Response Rate	61.16%
Total delivered	685
Total usable	429
Total effective response rate	62.63%

Variable Measurements

Digital transformation, supply chain dynamic capability, channel integration and competitive advantages are all measured from mature scales.

Digital transformation was measured by five items that rated the companies' ability to use digitalize in their operation. Digital transformation was identified by the following items: “In our company, we aim to digitalize everything that can be digitized,” “In our company, we collect massive volumes of data from different sources,” “In our

company, we aim to create stronger networking between the different business processes with digital technologies," "In our company, we aim to enhance an efficient customer interface with digitality," and "In our company, we aim at achieving information exchange with digitality." This construct was built based on prior literature (Berman, 2012; Frank et al., 2019; Hagberg et al., 2016; Leviäkangas, 2016; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019).

Learning and absorption capability was measured by three dimensions.There are totally 15 items that related supplier learning, customer learning and internal learning.This construct was built by the study of Baofeng Huo et,al(2020). Based on prior literature that supplier and customer learning from Kale, Singh, and Perlmutter (2000), Simonin (1999), and Zhou, Yim, and Tse (2005). Similarly, internal learning measures were adapted from Sánchez, Vijande, and Gutiérrez (2011) and López Sánchez, María Leticia Santos, and Juan Antonio Trespalacios (2010).

The innovation capability, which has likely two dimensions; technology management and R&D management is measured by four items for each of them. This construct was built by the study of Tharwa Najar (2022). Based on the prior research of Prajogo and Ahmed (2006).

There are three priority aspects of supply chain integration, namely: supplier integration, customer integration, and internal integration (Frohlich & Westbrook, 2001; Zhao et al., 2011). The measurements from a prior study by Jajja et al. (2018) were used to measure the Supply Chain Integration, including Supplier Integration (4 items), Internal Integration (4 items) and Customer Integration (4 items).

The Competitive advantage is measured by four items. This construct was built by the study of Lianju Ning and Dan Yao (2023). Based on the prior research of Yang, X. (2017)， Jiao, H. （2008） and Zhou, S. (2016).

The Channel integration is measured by eight items. This construct was built by the study of Zhao xinyu and Zhuang guijun (2021). Based on the prior research of zhou. F (2017） and Sousa Voss. (2006).

All the indicators were measured with a five-point Liker scale from 1= strongly disagree to 5 = strongly agree.

The measurement constructs and items are shown in the following list.

The List of Constructs and Items

Constructs	Items
Digital Transformation (DT) [Berman, 2012; Frank et al., 2019; Hagberg et al., 2016 et.al]	DT1: We aim to digitalize everything that can be digitalized.
	DT2: We collect large amounts of data from different sources.
	DT3: We aim to create stronger networking between the different business processes with digital technologies.
	DT4: We aim to enhance an efficient customer interface with digitality.
	DT5: We aim at achieving information exchange with digitality.
Learning and Absorption Capability (LAAC) [Baofeng Huo et,al(2020), Kale, Singh, and Perlmutter (2000) Zhou, Yim, and Tse (2005), S ánchez, Vijande, and	SL1: Our company acquires substantial production information from our major supplier.
	SL2: Our major supplier provides us critical and useful information for product innovation.
	SL3: As a part of product development, our company learns a great deal from our major supplier.
	SL4: Our company applies the knowledge learned from our major supplier in new technology adoption.
	SL5: Our company has systematic checks to ensure that the knowledge from our major supplier is utilized.

Gutiérrez (2011)]	CL1: Our company acquires substantial production information from our major customer.
	CL2: Our major customer provides us critical information for product innovation.
	CL3: As a part of product development, our company learns a great deal from our major customer.
	CL4: Our company applies the knowledge learned from our major customer in new technology adoption.
	CL5: Our company has systematic checks to ensure that the knowledge from our major customer is utilized.
	IL1: Internal functions communicate a lot of product information with each other.
	IL2: Internal functions communicate a lot of innovation information with each other.
	IL3: Internal functions learn a lot of useful things from each other.
	IL4: Knowledge communication among internal functions promotes the adoption of new technology.
	IL5: Internal functions evaluate whether they have applied product knowledge from other functions.
Innovation Capability (IC) [Tharwa Najar (2022) &	TM1: Our company always attempts to stay on the leading edge of new technology in our industry.
	TM2: We make an effort to anticipate the full potential of new practices and technologies.

Prajogo and Ahmed (2006)]	TM3: We pursue long-range programs in order to acquire technological capabilities in advance of our needs.
	TM4: We are constantly thinking of the next generation of technology.
	RDM1: We have excellent communication processes between R&D and other departments.
	RDM2: Our R&D pursues truly innovative and leading-edge research.
	RDM3: Our R&D strategy is mainly characterized by high-risk projects with chance of high return.
	RDM4: R & D plays a major part in our business strategy.
Optimization and Integration Capability (OAIC) [Jajja et al. (2018) Frohlich & Westbrook, 2001; Zhao et al., 2011]	ISP1: We have a high degree of information exchange with our primary supplier through information networks.
	ISP2: We share our procurement or production plans with our major suppliers-farmers, farmer cooperatives, etc.
	ISP3: We share our demand forecasts with our major suppliers.
	ISP4: We have a high degree of a strategic partnership with our major suppliers.
	ICU1: We have a high degree of information sharing with major customers about market information.
	ICU2: We have a high degree of joint planning and forecasting with major customers to anticipate

	demand visibility.
	ICU3: We share our production plan with our major customers.
	ICU4: We have a high degree of strategic partnership with our major customers.
	INTE1: We realize data integration among all internal functions.
	INTE2: We can real-time search the information of supply, production, and demand.
	INTE3: We use cross-functional teams in the procurement process of agricultural products.
	INTE4: We use cross-functional teams in new product development, e.g., developing new brands or introducing new product lines.
competitive advantage (CA) [Yang, X (2017), Jiao, H (2008) and Zhou, S (2016)]	CA1: Lower communication costs, order management costs, warehouse management costs, logistics management costs, etc.
	CA2: Customers are highly satisfied with our service.
	CA3: Our company performs well in terms of sales revenue growth compared to key competitors.
	CA4: Our company performs well in terms of market share compared to key competitors.
Channel Integration (CI) [Zhou fei	CI1: The product information provided by all channels of the company is consistent.
	CI2: The price information provided by all channels of the company is consistent.

(2017), Sousa & Voss (2006)]	CI3: The inventory information provided by the company's various channels is consistent.
	CI4: The company's operating system can provide after-sales service for the goods ordered by users on various channels.
	CI5: Each channel of the company supports and helps each other.
	CI6: The service image provided by each channel of the company is consistent.
	CI7: The company maintains the same level of service to online customers as offline customers.
	CI8: The company's service to customers across different channels is consistent in terms of timeliness.

The control variables were firm age, firm size, the company's annual sales, total assets and retail field.

Firm age includes four options, namely 1-3 years, 3-8 years, 8-15 years and over 15 years. It is possible that companies with longer age may have more resources and experience, and thus their digital transformation may be more mature, or conversely, they may be more conservative. This variable needs to be controlled to avoid it interfering with the analysis of the main effect.

Firm size includes five options, namely 0-50, 51-100, 101-300, 301-500 and over 500. Large companies usually have more funds and manpower to invest in digital transformation, while small companies may have limited resources. Therefore, the number of employees may affect the effectiveness of the transformation, and it needs to be controlled.

The company's annual sales include five options, namely less than 5 million yuan, 5-30 million yuan, 30-100 million yuan, 100-300 million yuan and over 300 million yuan.

Total assets include five options, namely less than 5 million yuan, 5-50 million yuan, 50-150 million yuan, 150-500 million yuan, and over 500 million yuan. Annual sales and total assets are both indicators for measuring the scale of an enterprise, and they may affect the enterprise's resource acquisition capabilities and market influence. For example, enterprises with high sales may have more funds for technology investment, which in turn affects the dynamic capabilities of the supply chain and competitive performance.

Retail field includes ten options, namely beauty, jewelry, shoes and clothing, catering, daily chemical, electrical appliances, communication equipment, home furnishing, automobile and other. Retail field as a control variable, because different retail field have different digitalization demands and supply chain characteristics, controlling this variable can eliminate the interference caused by industry differences.

Methodology

This study used a combination of qualitative and quantitative scientific research methods. The details are as follows:

Literature research method

Literature research method is a method to collect and organize the existing literature, summaries and conclude the research status at home and abroad, so as to obtain a comprehensive and scientific understanding and knowledge of the research problem.

Literature research method is a necessary prerequisite for conducting research and the basis for conceptual model construction. This study analyses domestic and international literature and industry perspectives on key variables such as digital transformation, supply chain dynamic capabilities, channel integration and competitive advantage, summarizes the results and shortcomings of existing research, and lays the literature foundation for subsequent case studies and theoretical assumptions.

Theoretical Analysis Method

Theoretical analysis method is a method of researching and analyzing problems based on certain theories, so as to come up with judgments and action plans. This study relies on supply chain management theory, dynamic capability theory, 4R marketing theory, etc., to explore in depth the relationship between the interaction of digital transformation, supply chain dynamic capabilities, channel integration and competitive advantage, and to draw conclusions.

Questionnaire Survey Method

Questionnaire survey method is a scientific research method to collect data in the form of written questions, the problem to be researched is compiled into a questionnaire, and the theme part is scored using a five-level LIKERT scale, which is used to understand the respondent's point of view on the specific issue. The first step of the questionnaire survey method is to design the questionnaire, according to the questions of our research, according to allowable error of 5% at 95% confidence level, 400 companies were selected as a sample of respondents to issue and collect the questionnaire, the respondents of this study are not ordinary employees, can be the managers at middle management level and above with a clear understanding of the specific operations of the retail enterprises in Guangdong. Finally, the results are analyzed based on the data obtained from the questionnaires and the corresponding conclusions are drawn.

Empirical Analysis Method

Empirical analysis method is a method based on objective and real data, which is processed and analyzed through mathematical methods to verify the research ideas theoretically. This study uses Spss27.0 and Amos 26.0 software to analyze the data of the study, and the sample data are tested for reliability and validity, descriptive statistical analysis, and validation factor analysis to test the quality of the sample. Correlation analysis and regression analysis were used to verify the main, mediating and moderating effects of the research hypotheses and to derive the results of the empirical analysis. Through empirical research, this study explores the mechanism of digital transformation on the competitive advantage, verifies the mediating effect of supply chain dynamic capabilities in digital transformation and competitive

advantage, and verifies the moderating effect of channel integration in digital transformation and competitive advantage.

Statistical Techniques

Data analysis of the study was carried out using Spss27.0 and Amos 26.0 software to test the sample data for reliability and validity, descriptive statistical analysis, and validation factor analysis to test the quality of the sample. Correlation analysis and regression analysis were used to verify the main, mediating and moderating effects of the research hypotheses, and to derive the results of the empirical analysis.

After collecting the data through a combination of onsite and online questionnaire, the statistical analysis is carried out according to the following steps.

First: Reliability and validity analysis of the questionnaire.

Second: Demographic analysis of the sample.

Third: Confirmatory factor analysis and Common variance deviation test

Fourth: Descriptive statistics and Correlation analysis.

Fifth: Structural equation model fit test and test the research hypotheses.

Sixth: Draw results.

CHAPTER IV RESULTS

The previous chapter describes the research methods involving sample selection and data collection processes, including overall and sample, data collection, methods, control variables, measurement models, and analyses. Therefore, the research method helps to verify the main, mediating and moderating effects of the research hypothesis and to derive empirical analysis results to answer the research objectives and research questions. This chapter validates the reliability and validity of the measurement questionnaire and analyzes the pretest results. After determining the reliability and validity of the measurement questionnaire, this chapter also conducted descriptive statistical analysis to understand the characteristics of the respondents, at the same time using Amos26.0 to verify the scale factor analysis, convergent validity and differentiation validity test, structural equation path analysis to verify the main effect, mediation effect and regulatory effect of the hypothesis. The chapter is organized as follows. First, SPSS27.0 was used to analyze the pretest results. Secondly, SPSS27.0 and AMOS26.0 were comprehensively used to analyze the survey results, including descriptive statistical analysis, to verify the main effects, mediation effects and moderation effects of the study hypothesis.

Pretest Results

In the pretest stage, the questionnaire data collection was collected on-site, and 151 valid questionnaires were collected for the managers familiar with the digital transformation of enterprises in the retail industry in Guangdong Province.

Reliability Analysis

In the pretest of the questionnaire, Churchill (1979) specifically stated in its study that the initial questionnaire should screen and purify the initial measurement items through factor analysis. Unpurified items are prone to multi-dimensional situations during factor analysis, which is not conducive to the analysis of the relationship between observed variables and latent variables. Generally, it is beneficial for CIC to calculate the correlation coefficient between each project. If the CIC is less than 0.5, the project needs to be deleted. Li Huizu (2004) believes that the project should be deleted when the CIC is less than 0.35. At the same time, the reliability of the scale should be determined according to the value of the reliability coefficient Cronbach α.

Generally, it is believed that if the Cronbach α value is greater than 0.7, the reliability of the latent variable meets the requirements. If it is between 0.5 and 0.7, the scale of the latent variable needs to be corrected; if it is lower than 0.5, the questionnaire needs to be redesigned. At the same time, if the reliability coefficient Cronbach α value of the latent variable is greater than the Cronbach α value of all the latent variables, the item needs to be deleted.

In conclusion, three main criteria are used for the purification and modification of the scale. If CITC is <0.5, delete the item; delete the Cronbach α value of the item; if the reliability coefficient of the latent variable is above 0.7, the questionnaire should be redesigned. In this paper, we conduct CITC analysis and reliability analysis on 151 samples using spss27.0. Table 3, Table 4, Table 5, Table 6, Table 7, Table 8 represent the results of CITC analysis and reliability analysis of six variables, including digital transformation, learning and absorption, innovation, optimization and integration, competitive advantage, and channel integration.

Table 3 CITC & Reliability Analysis of Digital Transformation

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Digital Transformation	DT1	0.679	0.843	0.868
	DT2	0.609	0.859	
	DT3	0.746	0.827	
	DT4	0.660	0.848	
	DT5	0.771	0.821	

Table 4 CITC & Reliability Analysis of Learning and Absorptive Capability

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Supplier Learning	SL1	0.770	0.882	0.905
	SL2	0.765	0.883	
	SL3	0.704	0.896	
	SL4	0.749	0.887	
	SL5	0.821	0.870	
Customer Learning	CL1	0.691	0.776	0.829
	CL2	0.636	0.792	
	CL3	0.594	0.805	
	CL4	0.586	0.806	
	CL5	0.630	0.794	
Internal Learning	IL1	0.756	0.874	0.898
	IL2	0.710	0.884	
	IL3	0.749	0.876	
	IL4	0.806	0.863	
	IL5	0.721	0.882	

Table 5 CITC & Reliability Analysis of Innovation Capability

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Technology Management	TM1	0.741	0.799	0.856
	TM2	0.676	0.826	
	TM3	0.642	0.840	
	TM4	0.739	0.800	
R&D Management	RDM1	0.773	0.837	0.882
	RDM2	0.705	0.864	
	RDM3	0.670	0.876	
	RDM4	0.831	0.814	

Table 6 CITC & Reliability Analysis of Integration and Optimization Capability

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Integration Supplier	ISP1	0.687	0.780	0.834
	ISP2	0.651	0.796	
	ISP3	0.605	0.815	
	ISP4	0.716	0.766	
Integration Customer	ICU1	0.733	0.779	0.844
	ICU2	0.646	0.817	
	ICU3	0.666	0.810	
	ICU4	0.679	0.803	

Integration Internal	INTE1	0.744	0.721	0.818
	INTE2	0.618	0.781	
	INTE3	0.570	0.806	
	INTE4	0.634	0.773	

Table 7 CITC & Reliability Analysis of Competitive Advantage

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Competitive Advantage	CA1	0.715	0.841	0.872
	CA2	0.694	0.851	
	CA3	0.782	0.813	
	CA4	0.722	0.837	

Table8 CITC & Reliability Analysis of Channel Integration

Latent variables	Item	Corrected Item-Total Correlation (CITC)	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Channel Integration	CI1	0.811	0.912	0.926
	CI2	0.738	0.917	
	CI3	0.705	0.920	
	CI4	0.826	0.910	
	CI5	0.730	0.918	
	CI6	0.763	0.915	
	CI7	0.682	0.921	
	CI8	0.737	0.917	

The results are shown in the table, The digital transformation variable contains 5 question items, The Cronbach's α coefficient is 0.868; The supplier learning variable contains 5 question items, The Cronbach's α coefficient is 0.905; The customer learning variable contains 5 question items, The Cronbach's α coefficient is 0.829; Internal learning variables contain 5 problem items, The Cronbach's α coefficient is 0.898; The technical management capability variable contains 4 question items, The Cronbach's α coefficient is 0.856; The R & D management capability variable includes 4 items, The Cronbach's α coefficient is 0.882; The supplier integration variable contains 4 question items, The Cronbach's α coefficient is 0.834; The customer integration variable contains 4 question items, The Cronbach's α coefficient is 0.844; The customer integration a variable contains 4 question items, The Cronbach's α coefficient is 0.818; The competitive advantage variable contains four question items, The Cronbach's α coefficient is 0.872; The channel integration variable contains 8 question items, The Cronbach's α coefficient is 0.926; No Cronbach's α coefficient was greater than the Cronbach's α coefficient of each variable, besides, Most majority between the observed variables and their latent variables mostly between 0.6 and 0.9, Meet the requirements of greater than 0.5, This indicates that the correlation coefficient of each observed variable and its latent variable exceeds 0.5, And most of them are between 0.6-0.9, This indicates that the latent variable setting of each asking item is better, It indicates that the overall reliability of the questionnaire is very high.52All the items have passed the tests and will not be deleted. The Cronbach's α coefficient greater than 0.8 indicates that the reliability level of the questionnaire reaches the standard and the scale has good internal consistency and stability.

Analysis of Validity

Exploratory factor analysis

Exploration factor analysis is to measure the structural validity of the scale, to judge whether the measured variable of each latent variable has stable consistency and structure, and is the most commonly used index when evaluating the scale validity. This paper applies SPSS27.0 software to test the composition of each dimension.

When using factor analysis for validity analysis, it is necessary to judge whether the conditions are satisfied. Generally, two conditions are met, one is the KMO value greater than 0.7; the other is that the significance of Bartlett sphericity test is less than 0.05. If these two conditions are met, there is strong correlation between the observed variables, which is suitable for factor analysis. Table 9 shows the KMO values and the Bartlett-test results for each measured variable.

Table 9 KMO and Bartlett's Test

KMO		0.902
Bartlett's Test of Sphericity	Approx. Chi-Square	13274.342
	df	1326
	Sig.	0

The test results show that the KMO test value of the survey data is greater than 0.70, indicating that the questionnaire is suitable for factor analysis. The results of Bartlett sphericity test show that the approximate chi-square value is greater than zero, and the probability of significance is 0.000 (P <0.01). Therefore, the empty hypothesis of Bartlett sphericity test is rejected, and the scale is suitable for factor analysis, so the validity structure is good.

The test results show that using the principal component analysis method in table 10. 11 componens are extracted, and the cumulative sum of rotation is 68.905%, more than 60%.

Table 10 Total Variance Explained

Component	Initial Eigenvalues			Sum of squares of the extracting loading			Sum of squares of rotational loading		
		% of Variance	Cumulative %		% of Variance	Cumulative %		% of Variance	Cumulative %
1	12.673	24.371	24.371	12.673	24.371	24.371	5.81	11.173	11.173
2	4.503	8.66	33.031	4.503	8.66	33.031	3.466	6.666	17.838

3	3.831	7.368	40.4	3.831	7.368	40.4	3.312	6.368	24.207
4	3.349	6.441	46.84	3.349	6.441	46.84	3.3	6.346	30.552
5	2.874	5.527	52.368	2.874	5.527	52.368	3.055	5.876	36.428
6	1.967	3.783	56.151	1.967	3.783	56.151	2.983	5.737	42.165
7	1.551	2.983	59.134	1.551	2.983	59.134	2.905	5.586	47.751
8	1.526	2.935	62.069	1.526	2.935	62.069	2.861	5.501	53.252
9	1.284	2.47	64.539	1.284	2.47	64.539	2.807	5.398	58.65
10	1.166	2.243	66.781	1.166	2.243	66.781	2.719	5.229	63.879
11	1.105	2.124	68.905	1.105	2.124	68.905	2.614	5.027	68.905
12	0.821	1.579	70.485						
13	0.752	1.446	71.93						
14	0.688	1.323	73.254						
15	0.653	1.256	74.51						
16	0.623	1.199	75.709						
17	0.613	1.179	76.888						
18	0.592	1.139	78.026						
19	0.569	1.095	79.121						
20	0.546	1.05	80.171						
21	0.51	0.981	81.152						
22	0.501	0.963	82.115						
23	0.496	0.954	83.069						
24	0.473	0.91	83.979						
25	0.445	0.857	84.836						
26	0.44	0.845	85.681						
27	0.422	0.811	86.492						

28	0.411	0.79	87.282
29	0.403	0.775	88.057
30	0.392	0.754	88.811
31	0.382	0.735	89.546
32	0.371	0.713	90.259
33	0.362	0.696	90.955
34	0.357	0.687	91.642
35	0.329	0.633	92.275
36	0.326	0.626	92.902
37	0.318	0.611	93.513
38	0.299	0.575	94.088
39	0.294	0.566	94.654
40	0.279	0.537	95.191
41	0.268	0.515	95.706
42	0.247	0.476	96.182
43	0.241	0.463	96.645
44	0.23	0.442	97.087
45	0.225	0.432	97.52
46	0.222	0.427	97.947
47	0.21	0.404	98.351
48	0.207	0.399	98.749
49	0.182	0.351	99.1
50	0.169	0.325	99.425
51	0.152	0.292	99.718
52	0.147	0.282	100

Extraction method: Principal Component Analysis (PCA).

Next, an exploratory factor analysis was done for all variables. Table 11 represents the exploratory factor analysis results of six variables including digital transformation, learning and absorption, innovation, optimization and integration, competitive advantage, and channel integration.

Table 11 Factor Rotation Component Matrix

Item	Component										
	1	2	3	4	5	6	7	8	9	10	11
DT1			0.768								
DT2			0.785								
DT3			0.758								
DT4			0.805								
DT5			0.824								
SL1				0.798							
SL2				0.654							
SL3				0.627							
SL4				0.723							
SL5				0.778							
CL1		0.768									
CL2		0.71									
CL3		0.705									
CL4		0.763									
CL5		0.781									
IL1						0.7					
IL2						0.646					

IL3	0.755				
IL4	0.577				
IL5	0.746				
TM1	0.792				
TM2	0.726				
TM3	0.776				
TM4	0.798				
RDM1		0.786			
RDM2		0.753			
RDM3		0.815			
RDM4		0.684			
ISP1					0.812
ISP2					0.798
ISP3					0.635
ISP4					0.66
ICU1				0.784	
ICU2				0.699	
ICU3				0.761	
ICU4				0.724	
INTE1			0.766		
INTE2			0.684		
INTE3			0.767		
INTE4			0.766		
CA1				0.788	
CA2				0.733	

CA3		0.745
CA4		0.777
CI1	0.847	
CI2	0.767	
CI3	0.767	
CI4	0.831	
CI5	0.786	
CI6	0.781	
CI7	0.761	
CI8	0.849	

Extraction method: Principal Component Analysis (PCA).

Rotation method: Cauchy Normalization Maximum Variance Method.

Rotation converged after 8 iterations.

Table 11 of exploratory factor analysis results shows that the principal component analysis method above. After rotation by Cauchy Normalization Maximum Variance Method, 11 factors were classified out. The load of each item is higher than 0.5, indicating that the information of the extracted 11 factors is comprehensive, and there is no high double factor load. Each observed variable is aggregated into each dimension according to the theoretical preset. Considering the analysis above shows that the scale selected in this paper has good structural validity.

Hypothesis Testing and Results Analysis

After testing the reliability and validity of 151 samples collected in the pretest stage and using SPSS27.0, it is found that the selected scale has good internal consistency and stability, as well as good structural validity. And then the questionnaire data was collected by online and onsite, and a total of 429 valid questionnaires were collected.

Demographic Analysis

Through the 429 valid questionnaires data, the sample characteristics are shown as

table 12.

Table 12 The description of characteristics in sample

Item	Indicators	Frequency	Percent
time	1-3years	6	1.4
	3-8years	80	18.6
	8-15years	188	43.8
	More than 15 years	155	36.1
employee	0-50	40	9.3
	51-100	100	23.3
	101-300	133	31
	301-500	87	20.3
	500 or more	69	16.1
sales	Less than 5	5	1.2
(million yuan)	5-30	29	6.8
	30-100	59	13.8
	100-300	113	26.3
	More than 300	223	52
assets	Less than 5	2	0.5
(million yuan)	5-50	21	4.9
	50-150	51	11.9
	150-500	99	23.1
	500 and more	256	59.7
field	beauty	37	8.6
	jewelry	24	5.6
	Shoes and clothing	89	20.7

catering	41	9.6
Daily chemical	75	17.5
Electrical appliance	60	14
Communication equipment	46	10.7
Home furnishing	42	9.8
automobile	11	2.6
other	4	0.9
Total	429	100

Table 12 shows the results of demographic analysis. The demographic characteristics of the respondents include the time of operation of the company, the number of employees of the company, the annual sales of the company, total assets, retail field, etc. Basic information frequency statistics table shows the 4 29 to participate in the research object, distribution in Guangdong province beauty makeup, jewelry, shoes, clothing, catering, cosmetic, electrical appliances, communication equipment, household, automobile, other retail areas, including shoes (20.7%), cosmetic (17.5%) in the field of the top two, the shoes and Guangdong province with deep industry foundation, daily chemical retail enterprises present a highly concentrated trend of the phenomenon. In the questionnaire characteristics of the participants, the results showed that about 43.8% of the respondents had worked in the company for 8-15 years, and only 1.4% of the respondents had worked for less than 3 years, indicating that the respondents had long enough working experience in the unit and had sufficient understanding of the internal reform, resource ability and competition status of the enterprise. The surveyed enterprises with less than 300 employees accounted for 63.6%. This phenomenon clearly reflects the structural characteristics of retail enterprises in Guangdong Province. They focus on a certain market segment, such as featured shoes and clothing products and niche daily chemical categories, and are active in the market with precise control of the needs of the niche. Annual sales revenue is more than 300million yuan Retail enterprises accounted for 52%, and retail enterprises with total assets of more than 500 million yuan accounted for 59.7%. Such a high proportion of large-scale retail enterprises highlights the solid and thick

industrial foundation of Guangdong retail industry. On the one hand, at the level of asset accumulation, the total asset enterprises with a high proportion of more than 500 million yuan mean that a large amount of capital, property, equipment and other high-quality resources have been deposited in the industry. These have laid a solid foundation for continued expansion, risk resistance and diversification. On the other hand, combined with the bright sales revenue data, it shows the excellent market realization ability of Guangdong retail enterprises.

Reliability Test

The reliability test of the questionnaire is the test of the reliability and credibility of the questionnaire. It is mainly an indicator that reflects the authenticity of the measured data according to the consistency or stability of the results of the test tools. Reliability is divided into intrinsic reliability and extrinsic reliability. The internal reliability test is to test whether a group of questions measure the internal consistency of the various questions of the same concept and composition scale. The higher the internal consistency of the questionnaire is, the higher the credibility of the questionnaire is. In this study, the intrinsic reliability of the questionnaire was measured by the Cronbach's Alpha. A higher coefficient in the Cronbach's Alpha measure indicates a higher internal consistency of the questionnaire. The internal consistency of the questionnaire was tested by examining the reliability of each part of the scale separately, and the test results are shown in the table. According to the table, the Cronbach's Alpha of the scale is above 0.7, indicating that the internal consistency of the questionnaire is relatively high, and the questionnaire can be used as a research tool for this study.

Table 13 Reliability Analysis

Latent variables	Cronbach's Alpha	N of Items
Digital Transformation	0.859	5
Supplier Learning	0.845	5
Customer Learning	0.877	5
Internal Learning	0.838	5
Technology Management	0.893	4

R&D Management	0.884	4
Integration Supplier	0.836	4
Integration Customer	0.82	4
Integration Internal	0.824	4
Competitive Advantage	0.878	4
Channel Integration	0.934	8
Learning and Absorptive Capability	0.909	15
Innovation Capability	0.912	8
Integration and Optimization Capability	0.884	12

The results are shown in Table 13, The digital transformation variable contains 5 question items, The Cronbach's α coefficient is 0.859; The supplier learning variable contains 5 question items, The Cronbach's α coefficient is 0.845; The customer learning variable contains 5 question items, The Cronbach's α coefficient is 0.877; Internal learning variables contain 5 problem items, The Cronbach's α coefficient is 0.838; The technical management capability variable contains 4 question items, The Cronbach's α coefficient is 0.893; The R & D management capability variable includes 4 items, The Cronbach's α coefficient is 0.884; The supplier integration variable contains 4 question items, The Cronbach's α coefficient is 0.836; The customer integration variable contains 4 question items, The Cronbach's α coefficient is 0.820; The internal integration variable contains 4 problem items, The Cronbach's α coefficient is 0.824; The competitive advantage variable contains four question items, The Cronbach's α coefficient is 0.878; The channel integration variable contains 8 question items, The Cronbach's α coefficient is 0.934; The learning and absorption ability variable contains 15 question items, The Cronbach's α coefficient is 0.909; The innovation ability variable contains 8 question items, The Cronbach's α coefficient is 0.912; The optimization and integration ability variable contains 12 question items, The Cronbach's α coefficient is 0.884; A Cronbach's α coefficient greater than 0.8, Explain that the reliability level of the questionnaire, The scale has good internal consistency and stability.

Analysis of Validity

Factor analysis is to measure the structural validity of the scale, to judge whether the measured variable of each latent variable has stable consistency and structure, and is the most commonly used index when evaluating the scale validity. In this paper, SPSS27.0 software is applied to test the composition of each dimension. When using factor analysis for validity analysis, it is necessary to judge whether the conditions are satisfied. Generally, two conditions are met, one is the KMO value greater than 0.7; the other is that the significance of Bartlett sphericity test is less than 0.05. If these two conditions are met, there is strong correlation between the observed variables, which is suitable for factor analysis.

Table 14 KMO and Bartlett's Test

Latent variables	KMO	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Digital Transformation	0.853	904.757	10	0.000
Learning and Absorptive Capability	0.906	3188.24	105	0.000
Innovation Capability	0.905	2171.588	28	0.000
Integration and Optimization Capability	0.887	2220.256	66	0.000
Competitive Advantage	0.834	869.034	6	0.000
Channel Integration	0.945	2437.998	28	0.000

Table 14 indicates that the KMO test value of the survey data is greater than 0.70, indicating that the questionnaire is suitable for factor analysis. The results of Bartlett sphericity test show that the approximate chi-square value is greater than zero, and the probability of significance is 0.000 (P <0.01). Therefore, the empty hypothesis of Bartlett sphericity test is rejected, and the scale is suitable for factor analysis, so the validity structure is good.

Confirmatory Factor Analysis

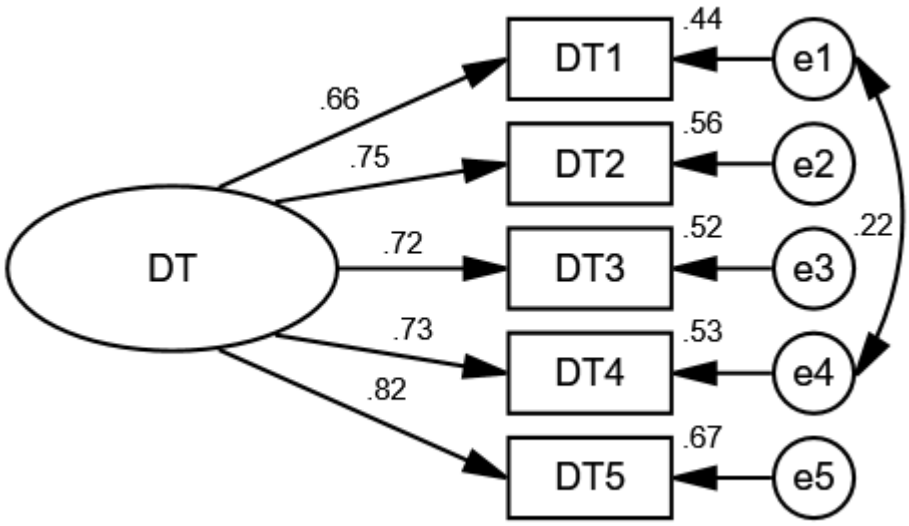
Validation factor analysis is a statistical analysis of survey data. This method is used to test whether the relationship between a factor and the corresponding observed variable complies with the theoretical relationship preset by the researcher. Swedish statisticians first systematically put forward the theories and methods of confirmatory factor analysis, whose basic ideas are expressed as follows table 18. Researchers first put forward assumptions and reasoning based on their own theories and knowledge, and gradually build a model about the relationship between a set of variables. The purpose of the research is to test the consistency between theory and data from the theoretical hypothesis, so as to test and finally develop the theory.

Table 15 Main Evaluation Indexes and Evaluation Criteria of The Overall Fitness

Statistical inspection quantity	Adaptation standard or critical value
Chi-square ratio of degrees of freedom (NC value)	1 < NC < 3, good adaptation
GFI	>0.8
AGFI	>0.8
IFI	>0.9
CFI	>0.9
TLI	>0.9
NFI	>0.9
RMSEA	< 0.08, reasonable adaptation

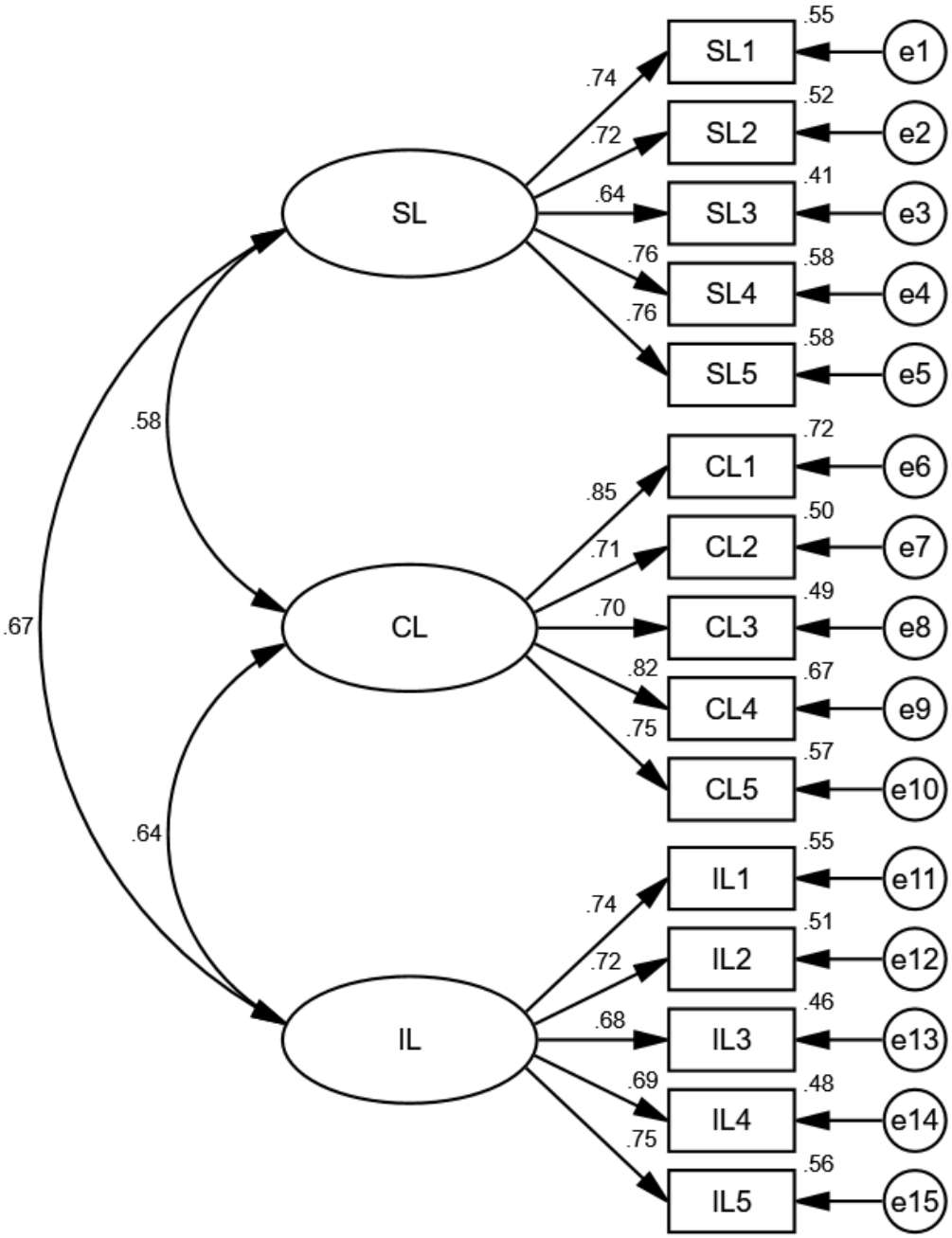
For confirmatory factor analysis (CFA) using AMOS26.0, a validation factor model is established based on the results of exploratory factor analysis and determined by determining the validation factor model fit. If the criteria are met as shown in Table 15, it indicates that the model built in this paper can effectively measure relevant latent variables. Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9 show the validation factor model results of six variables, including digital transformation, learning and absorption ability, innovation ability, optimization and integration ability, competitive advantage, and channel integration (the lower left corner of the figure is

the specific explanation of the code of each variable respectively). The model fit indicators for each variable are shown in Table 16.



Notes: Digital Transformation (DT)

Figure 4 Validation Factor Model for Digital Transformation

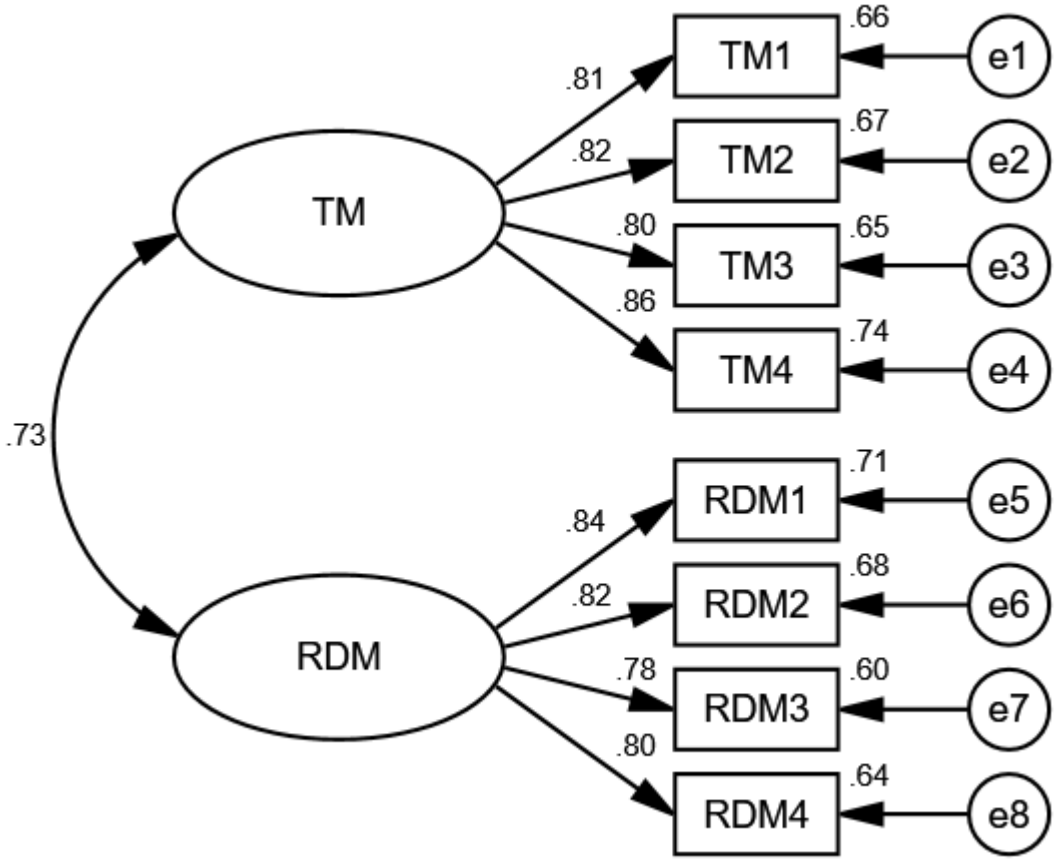


Notes: Supplier Learning (SL)

Customer Learning (CL)

Internal Learning (IL)

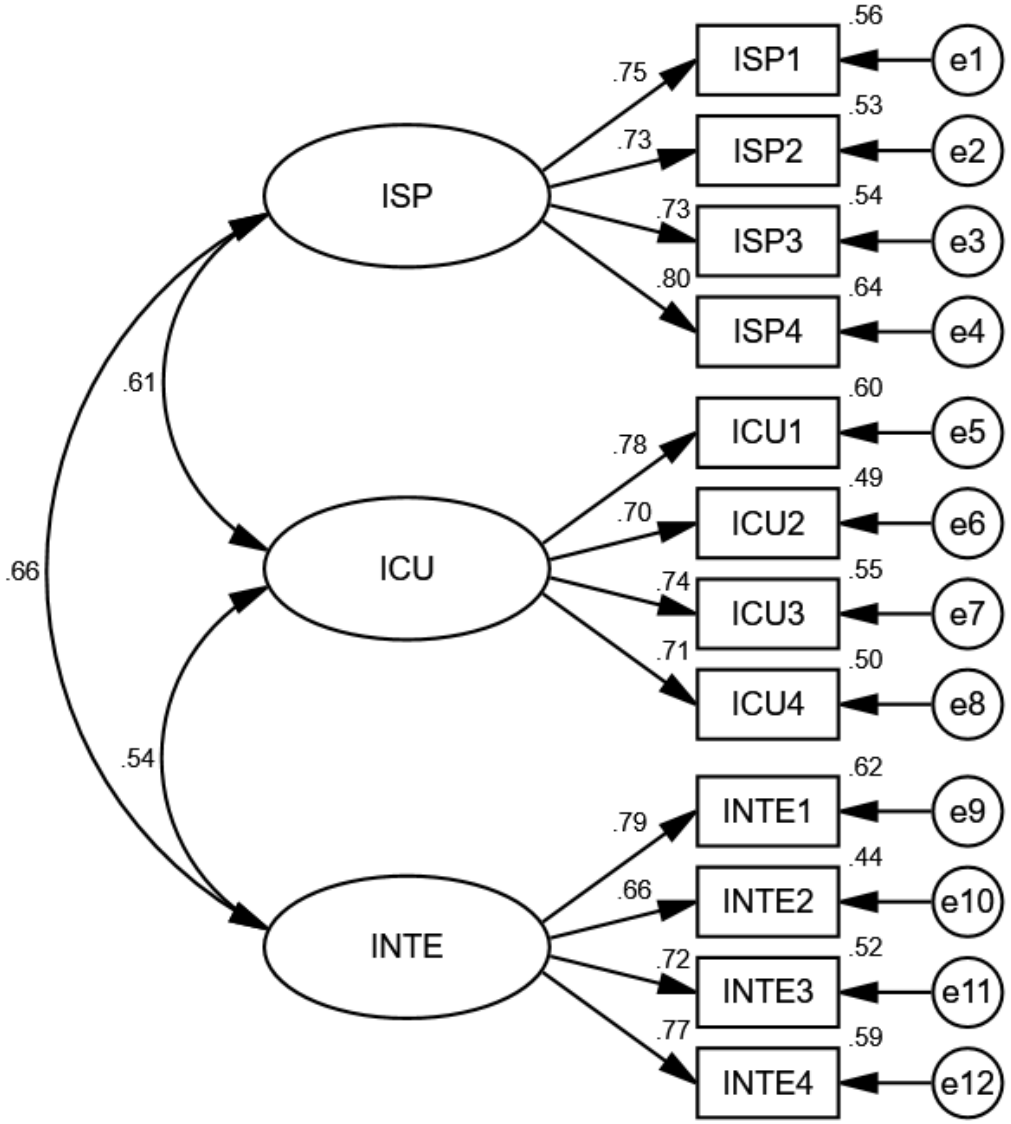
Figure 5 Validation Factor Model for Learning and Absorptive Capability



Notes: Technology Management (TM)

R&D Management (RDM)

Figure 6 Validation Factor Model for Innovation Capability

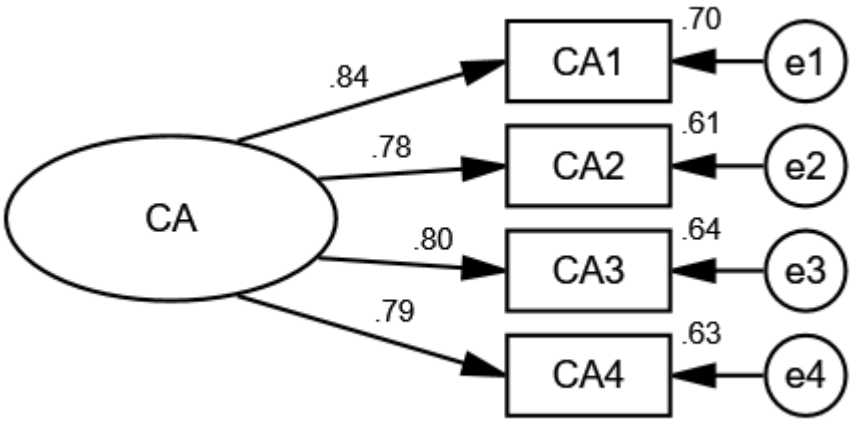


Notes: Integration Supplier (ISP)

Integration Customer (ICU)

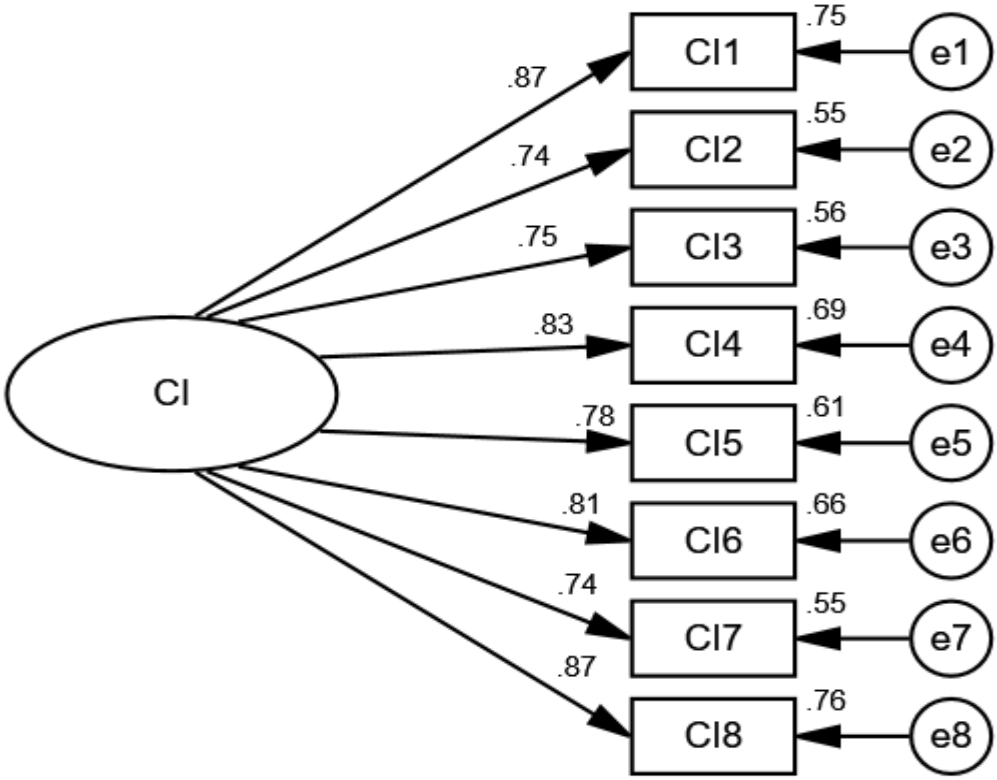
Integration Internal (INTE)

Figure 7 Validation Factor Model for Integration and Optimization Capability



Notes: Competitive Advantage (CA)

Figure 8 Validation Factor Model for Competitive Advantage



Notes: Channel Integration (CI)

Figure 9 Validation Factor Model for Channel Integration

Table 16 Fitting index of the Model

Reference index	X^2/df	GFI	AGFI	NFI	TLI	CFI	RMSEA
Digital Transformation	2.808	0.990	0.963	0.988	0.980	0.992	0.065
Learning and Absorptive Capability	3.383	0.919	0.888	0.909	0.920	0.934	0.075
Innovation Capability	3.200	0.967	0.937	0.972	0.972	0.981	0.072
Integration and Optimization Capability	2.388	0.956	0.933	0.946	0.958	0.968	0.057
Competitive Advantage	2.008	0.996	0.978	0.995	0.993	0.998	0.049
Channel Integration	2.534	0.973	0.951	0.979	0.982	0.987	0.060
Reference value	<5	>0.8	>0.8	>0.9	>0.9	>0.9	<0.08
Conclusion	Qualified	Qualified	Qualified	Qualified	Qualified	Qualified	Qualified

From Table 16, X^2 / df is 2.808,3.383,3.200,2.388,2.008,2.534, Less than 5, GFI is, 0.990,0.919,0.967,0.956,0.996,0.973, AGFI was 0.963,0.888,0.937,0.933,0.978,0.951, Greater than 0.8, The NFI of 0.988,0.909,0.972,0.946,0.995, and 0.979, Greater than 0.9, Both the CFI and TLI were greater than 0.9, The RMSEA is 0.065,0.075,0.072,0.057,0.049,0.060, Less than 0.08, According to the criteria of the model fitting indicators, The fitting indicators of the model all meet the requirements, So the path of the model is analyzed.

Convergent Validity and Discriminative Validity Tests

Convergent validity test

Convergent validity (Convergent Validity) means that the classification obtained when two different measurement tools are used to measure the same concept is highly correlated (Geng Xianfeng, 2008). This study tested the convergence validity by the combined reliability (CR) and the mean variance extraction value (AVE) according to Rong (2009, P.145). Construction reliability is usually> 0.7 and AVE> 0.5 to meet the standard. Table 17, Table 18, Table 19, Table 20, Table 21, and Table 22 respectively show the results of the six variables, including digital transformation, learning and absorption, innovation, optimization and integration, competitive advantage, and channel integration.

Table 17 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Digital Transformation	DT1	0.664				0.855	0.543
	DT2	0.746	0.088	12.663	***		
	DT3	0.720	0.075	12.337	***		
	DT4	0.726	0.077	14.366	***		
	DT5	0.819	0.087	13.392	***		

Table 18 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Supplier Learning	SL1	0.739				0.847	0.526
	SL2	0.721	0.065	14.041	***		
	SL3	0.641	0.060	12.465	***		
	SL4	0.760	0.067	14.771	***		
	SL5	0.759	0.063	14.760	***		

Customer Learning	CL1	0.847				0.878	0.590
	CL2	0.710	0.043	16.194	***		
	CL3	0.703	0.043	15.987	***		
	CL4	0.818	0.043	19.664	***		
	CL5	0.753	0.043	17.527	***		
Internal Learning	IL1	0.738				0.839	0.511
	IL2	0.716	0.062	13.859	***		
	IL3	0.675	0.064	13.078	***		
	IL4	0.691	0.067	13.382	***		
	IL5	0.750	0.064	14.482	***		

Table 19 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Technology Management	TM1	0.812				0.894	0.677
	TM2	0.816	0.058	18.886	***		
	TM3	0.804	0.055	18.523	***		
	TM4	0.859	0.055	20.153	***		
R&D Management	RDM1	0.840				0.885	0.658
	RDM2	0.823	0.049	19.666	***		
	RDM3	0.778	0.054	18.213	***		

	RDM4	0.802	0.053	19.009	***		

Table 20 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Integration Supplier	ISP1	0.748				0.839	0.566
	ISP2	0.729	0.066	14.228	***		
	ISP3	0.734	0.081	14.325	***		
	ISP4	0.797	0.079	15.471	***		
Integration Customer	ICU1	0.777				0.821	0.535
	ICU2	0.697	0.060	13.589	***		
	ICU3	0.743	0.062	14.439	***		
	ICU4	0.706	0.061	13.771	***		
Integration Internal	INTE1	0.786				0.825	0.542
	INTE2	0.663	0.053	13.209	***		
	INTE3	0.722	0.061	14.437	***		
	INTE4	0.768	0.059	15.312	***		

Table 21 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Competitive Advantage	CA1	0.836				0.879	0.644
	CA2	0.779	0.052	17.582	***		
	CA3	0.801	0.053	18.200	***		
	CA4	0.794	0.049	18.006	***		

Table 22 Confirmatory factor analysis results

Latent variables	Observation variable	Standard factor load coefficient	S.E.	C.R.	P	CR	AVE
Channel Integration	CI1	0.867				0.934	0.641
	CI2	0.740	0.039	18.507	***		
	CI3	0.746	0.038	18.741	***		
	CI4	0.831	0.040	22.436	***		
	CI5	0.782	0.040	20.175	***		
	CI6	0.815	0.038	21.641	***		
	CI7	0.741	0.039	18.536	***		
	CI8	0.872	0.038	24.508	***		

The observed value factor load, combined reliability (CR), and mean variance extraction value (AVE) of each variable are shown in the table. The load value of each item factor is between 0.6-0.9, indicating that the convergence validity is high, the combined reliability (CR) of each dimension is greater than 0.7 to the standard, AVE

is greater than 0.5, and the probability of significance P <0.001, indicating that 11 latent variables have significant relationships with the measurement index variables, and the convergence of the scale structure model is very good.

Distinguish validity

It can be seen from Table 23 that the AVE of each dimension is greater than 0.5, and the square root of the AVE is greater than the correlation coefficient between the dimensions, so it shows that the scale has good discriminatory validity.

Table23 Discriminant validity analysis

	1	2	3	4	5	6	7	8	9	10	11
Digital Transformation	0.737										
Supplier Learning	.138**	0.725									
Customer Learning	.096*	.505**	0.768								
Internal Learning	.137**	.571**	.550**	0.715							
Technology Management	.196**	.277**	.175**	.234**	0.823						
R&D Management	.153**	.250**	.173**	.230**	.651**	0.811					
Integration Supplier	.124*	.171**	.243**	.295**	.255**	.224**	0.753				
Integration	.177**	.216**	.222**	.280**	.278**	.192**	.511**	0.731			

Customer Integration	.135**	.279**	.228**	.259**	.225**	.183**	.547**	.451**	0.736	
Internal Channel Integration	.130**	.216**	.305**	.289**	.365**	.407**	.256**	.245**	.229**	0.803
Competitive Advantage	.316**	.319**	.437**	.350**	.403**	.383**	.329**	.359**	.292**	.349**	0.801

** Correlation is significant at the 0.01 level (2-tailed).

Note: The square root of the AVE value is bolded in the upper right corner

Common Variance Deviation Test

Duing the process of data collection, the artificial covariation between the predictor variable and the effect standard variable caused by the same data source or scorer, the same measurement environment, the project context, and the characteristics of the project itself is a common method deviation. The questionnaire measurement error includes systematic error and random error. This common method bias generated by data homology will seriously confuse and mislead the statistical analysis results, which belongs to the systematic error. At present, the methods to test the common method deviation include: Harman one factor test, partial correlation method, potential error variable method, error uniqueness correlation model, and direct product model. In order to ensure the accuracy of statistical analysis results, using the most common Harman univariate method to test the data, the exploratory factor analysis, extract the eigenvalue greater than 1, the test results are shown in Table 24, 11 eigenvalue greater than 1, the cumulative variance interpretation rate is 68.905%, and the interpretation amount of the first factor is 24.371%. Below 40%, there is not a common factor explaining the majority of the variation. It can indicate that there is no serious common method bias problem in this paper. Empirical results can be analyzed.

Table 24 Common Method Deviation Test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.673	24.371	24.371	12.673	24.371	24.371
2	4.503	8.66	33.031	4.503	8.66	33.031
3	3.831	7.368	40.4	3.831	7.368	40.4
4	3.349	6.441	46.84	3.349	6.441	46.84
5	2.874	5.527	52.368	2.874	5.527	52.368
6	1.967	3.783	56.151	1.967	3.783	56.151
7	1.551	2.983	59.134	1.551	2.983	59.134
8	1.526	2.935	62.069	1.526	2.935	62.069
9	1.284	2.47	64.539	1.284	2.47	64.539
10	1.166	2.243	66.781	1.166	2.243	66.781
11	1.105	2.124	68.905	1.105	2.124	68.905

Descriptive Statistical Analysis

For the six variables proposed in this study, all scales used the Likert scale, and all scales had higher scores and higher corresponding evaluation level. The descriptive statistics results of the six variables are shown in Table 4.24. The skewness and kurtosis in the following table are the normal distribution tests of the formal survey data. It is usually considered that when the absolute value of skewness is less than 5 and the absolute value of kurtosis is less than 7, it indicates that the sample basically conforms to the normal distribution. As can be seen from Table 25, the absolute value of skewness of all survey items is less than 5, and the absolute value of kurtosis is less than 7. Therefore, the large sample survey data of each survey item in this study basically meet the above threshold requirements, and further analysis can be conducted.

Table 25 Describes the statistical results

Observation variable	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Digital Transformation	429	1	5	3.478	0.746	-0.128	-0.133
Supplier Learning	429	1	5	3.491	0.854	-0.421	-0.811
Customer Learning	429	1	5	3.486	0.946	-0.581	-0.852
Internal Learning	429	1	5	3.502	0.860	-0.681	-0.482
Learning and Absorptive Capability	429	2	5	3.493	0.739	-0.733	-0.427
Technology Management	429	1	5	3.628	0.895	-0.654	-0.315
R&D Management	429	1	5	3.510	0.930	-0.549	-0.532
Innovation Capability	429	1	5	3.569	0.829	-0.840	-0.265
Integration Supplier	429	2	5	3.453	0.861	-0.506	-0.596
Integration Customer	429	1	5	3.360	0.827	-0.277	-0.460
Integration Internal	429	1	5	3.402	0.851	-0.452	-0.256
Integration and Optimization Capability	429	2	5	3.405	0.692	-0.634	-0.167
Competitive Advantage	429	1	5	3.692	0.926	-0.829	-0.195

Channel Integration	429	1	5	3.640	0.932	-0.961	-0.107

Correlation Analysis

When there is a connection between things, but it cannot directly explain the causal relationship, the relationship between things is called a related relationship. This paper uses the Pearson correlation to first analyze the relationship between the variables in this study.

Table 26 Correlation analysis

	Digital Transformation	Learning and Absorptive Capability	Innovation Capability	Integration and Optimization Capability	Channel Integration	Competitive Advantage
Digital Transformation	1					
Learning and Absorptive Capability	.147**	1				
Innovation Capability	.192**	.292**	1			
Integration and Optimization Capability	.177**	.357**	.304**	1		
Channel Integration	.130**	.325**	.426**	.298**	1	
Competitive Advantage	.316**	.445**	.432**	.399**	.349**	1

** Correlation is significant at the 0.01 level (2-tailed).

Related analysis table 26 results show: digital transformation, learning and absorption ability, innovation ability, optimization and integration ability, channel integration, channel integration and competitive advantage correlation coefficient respectively 0.316,0.445,0.432,0.399,0.349, the corresponding P value is less than 0.01, has significant statistical significance, that the digital transformation, learning and absorption ability, innovation ability, optimization and integration ability, channel integration, channel integration and competitive advantage have significant correlation.

Structural Equation Model Fit Test

Main model pathway results are shown in Figure 10, According to the structural equation model adaptation test index: the ratio NC of chi-square degree of freedom should be between 1-3; The progressive residual mean square and square root RMSEA (Residual mean square error of approximation) value should be between 0.05-0.08, If it is lower than 0.05, the adaptation is very good; Adapter index GFI value is generally considered to be greater than 0.9, If the value is above 0.8, it is acceptable; The CFI value of the value-added suitability index should be greater than 0.9; The TLI value of the unregulated adaptation index should be above 0.9; It is generally believed that the sample number should be greater than 200 (Hou, Wen Zhonglin, 2005; Wu Minglong, 2012)

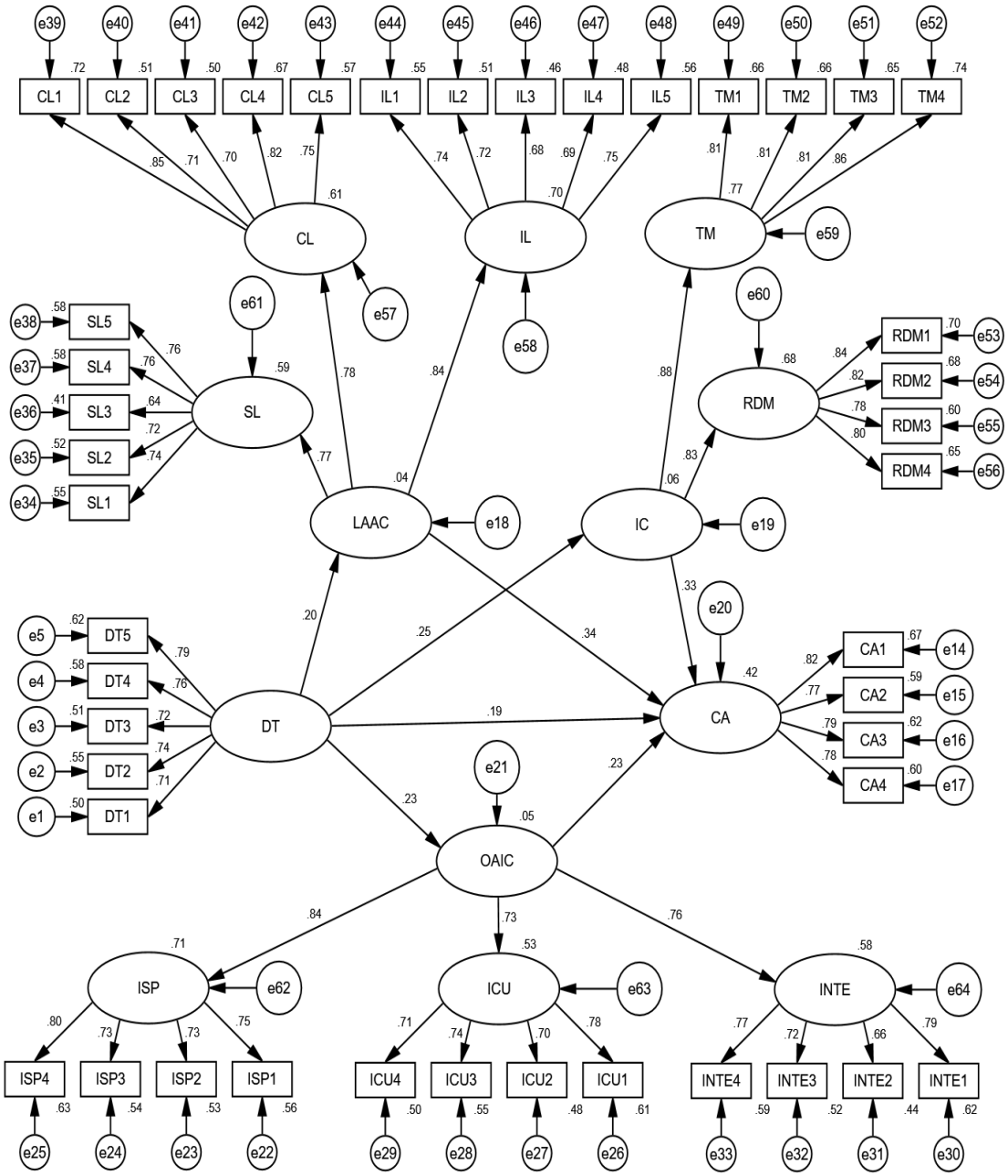


Figure 10 **Standardized Path Estimation of Structural Equation Model**

The fitting index of the model operation is shown in Table 27. The fitting index is: x^2 / df = 1.89, less than 3. GFI=0.856, AGFI=0.839, greater than 0.8, IFI = 0.921, TLI = 0.915, CFI = 0.92, greater than 0.9, RMSEA = 0.046, the fitting criteria of the model all met the requirements, so the path of the model was analyzed.

Table 27 Model Goodness-of-Fit Index

Reference index	X^2/df	GFI	AGFI	IFI	TLI	CFI	RMSEA
Statistical value	1.89	0.856	0.839	0.921	0.915	0.92	0.046
Reference value	<3	>0.8	>0.8	>0.9	>0.9	>0.9	<0.08
Conclusion	Qualified	Qualified	Qualified	Qualified	Qualified	Qualified	Qualified

Path Analysis

In this study, AMOS26.0 software was used to analyze the structural equation model path, so as to obtain the path value and C.R. value of the structural equation model. The path coefficient reflects the influence between variables, the critical ratio C.R. (Critical Ratio) can judge whether the regression coefficient is significant or not, and it is generally considered that C.R. value is greater than or equal to 1.96, which has a significant influence at 0.05 significant level (Hou, Wen Zhonglin, 2005). The standardized regression coefficients and variance parameter estimates for the structural equation model in this study are shown in Table 28.

Table 28 Path coefficient test of structural equation model

Path relationship			Standard path coefficient	S.E.	C.R.	P
Learning and Absorptive Capability	<---	Digital Transformation	0.192	0.058	3.31	***
Innovation Capability	<---	Digital Transformation	0.255	0.062	4.106	***
Integration	<---	Digital Transformation	0.23	0.061	3.769	***

and Optimization Capability						
Competitive Advantage	<---	Learning and Absorptive Capability	0.443	0.075	5.918	***
Competitive Advantage	<---	Innovation Capability	0.409	0.072	5.646	***
Competitive Advantage	<---	Integration and Optimization Capability	0.294	0.07	4.205	***
Competitive Advantage	<---	Digital Transformation	0.244	0.068	3.593	***

Notes：***Means P<0.001。

Relationship Hypothesis Testing

1. Hypothesis validation of the relationship between digital transformation and learning and absorption ability

The path coefficient of digital transformation on learning and absorption ability is 0.192, The value of C.R. is 3.31, corresponding to the significance of P <0.001. Therefore, digital transformation has a significant positive impact on learning and absorption ability, so the assumption is true, Support Hypothesis 1.

2. Hypothesis verification of the relationship between digital transformation and innovation ability

The path coefficient of digital transformation on innovation ability is 0.255, The value of C.R. is 4.106, corresponding significance P <0.001. Therefore, digital transformation has a significant positive impact on innovation ability, so the assumption is true, Support Hypothesis 2.

3. Hypothesis verification of the relationship between digital transformation and optimization and integration capabilities

The path coefficient of the digital transformation on the optimization and integration ability is 0.23, The value of C.R. is 3.769, corresponding to the significance of P

<0.001. Therefore, the digital transformation has a significant positive impact on the optimization and integration ability, so the hypothesis is true, Support Hypothesis 3.

4. Hypothesis validation of the relationship between learning and absorption ability and competitive advantage

The path coefficient of learning and absorption ability on competitive advantage is 0.443, The value of C.R. is 5.918, corresponding to P <0.001 significance, therefore, learning and absorption ability has a significant positive impact on competitive advantage, so the hypothesis is true, Support Hypothesis 4.

5. Hypothesis verification of the relationship between innovation ability and competitive advantage

The path coefficient of innovation ability on learning and competitive advantage is 0.409, The value of C.R. is 5.646, corresponding to the significance of P <0.001. Therefore, innovation ability has a significant positive impact on learning and competitive advantage, so the assumption is true, Support Hypothesis 5.

6. The hypothesis verification of the relationship between optimization and integration ability and competitive advantage

The path coefficient of optimization and integration ability on learning and competitive advantage is 0.294, The value of C.R. is 4.205, corresponding to the significance P <0.001. Therefore, optimization and integration ability have a significant positive impact on learning and competitive advantage, so the assumption is true, Support Hypothesis 6.

7. hypothesis verification of the relationship between digital transformation and competitive advantage

The path coefficient of digital transformation on learning and competitive advantage is 0.244, The value of C.R. is 3.593, corresponding to the significance of P <0.001. Therefore, digital transformation has a significant positive impact on learning and competitive advantage, so the assumption is true, Support Hypothesis 7.

Mediating Effect Test

According to the results of the path analysis, the hypothesis test is established. In

order to explore whether these significant paths have mediation effects, we ran the Bootstrap method in AMOS26.0 and repeated it 5000 times, and the confidence interval standard was 95%. Therefore, we used the syntax of AMOS software to assign all relevant paths and calculate the specific mediation effect of standardization. The results are shown in Table 29.

Table 29 Intermediary Effect Test

Parameter	Effect value	Lower	Upper	P
DI→Learning Capability→CA (Indirect Effect)	0.067	0.026	0.116	0.002
DT→Innovation Capability→CA (Indirect Effect)	0.082	0.042	0.126	0.001
DT→Integration Capability→CA (Indirect Effect)	0.053	0.021	0.096	0.000
DT→CA (Direct Effect)	0.192	0.101	0.279	0.001
DT→CA (Total Effect)	0.395	0.295	0.485	0.000

1. The mediating role of learning and absorption ability between digital transformation and competitive advantage

The mediating effect of competitive advantage of digital transformation learning and absorption ability is 0.067, and the corresponding 95% confidence interval is [0.026,0.116], excluding 0, indicating that the mediating effect of learning and absorption ability is significant between digital transformation and competitive advantage, so the hypothesis 8 is true.

2. The mediating role of innovation ability between digital transformation and competitive advantage

The mediating effect of competitive advantage of digital transformation innovation ability is 0.082, and the corresponding 95% confidence interval is [0.042,0.126], excluding 0, indicating that the mediating effect of innovation ability between digital transformation and competitive advantage is significant, so the hypothesis 9 is true.

3. The mediating role of optimization and integration capabilities between digital transformation and competitive advantage

The mediating effect of competitive advantage of digital transformation optimization and integration ability is 0.053, and the corresponding 95% confidence interval is [0.021,0.096], excluding 0, indicating that the mediating effect of optimization and integration ability is significant between digital transformation and competitive advantage, so the hypothesis 10 is true.

Moderating Effect Test

The regulatory effect test mainly uses multivariate hierarchical regression. Because the independent variables and regulatory variables are easy to produce collinearity problems, it is usually necessary to centralize the independent variables and regulatory variables to prevent the occurrence of collinearity, as shown in Figure 11. Three multiple regression models were mainly established according to the regulatory effect of the relevant literature. The first model is the introduction of the control variables, Mainly due to the more sensitive role of the regulatory variables, To prevent the emergence of pseudo-regression, the independent variables, regulatory variables and interaction terms should be controlled; The second model introduces control, independent, and regulatory variables, The model is designed for whether the independent and regulatory variables will affect the dependent variables, Determine the explanatory power of the model, That is, to judge the size of the model R^2; The third model is the introduction of control variables, independent variables, regulatory variables, and independent variables and regulatory variables interaction terms, If the regression coefficient of the interaction term is significant, And the R^2 was significantly improved, It indicates that the adjustment variables have a significant regulatory effect on the relationship between the independent variables and the dependent variables. Showed as figure 11.

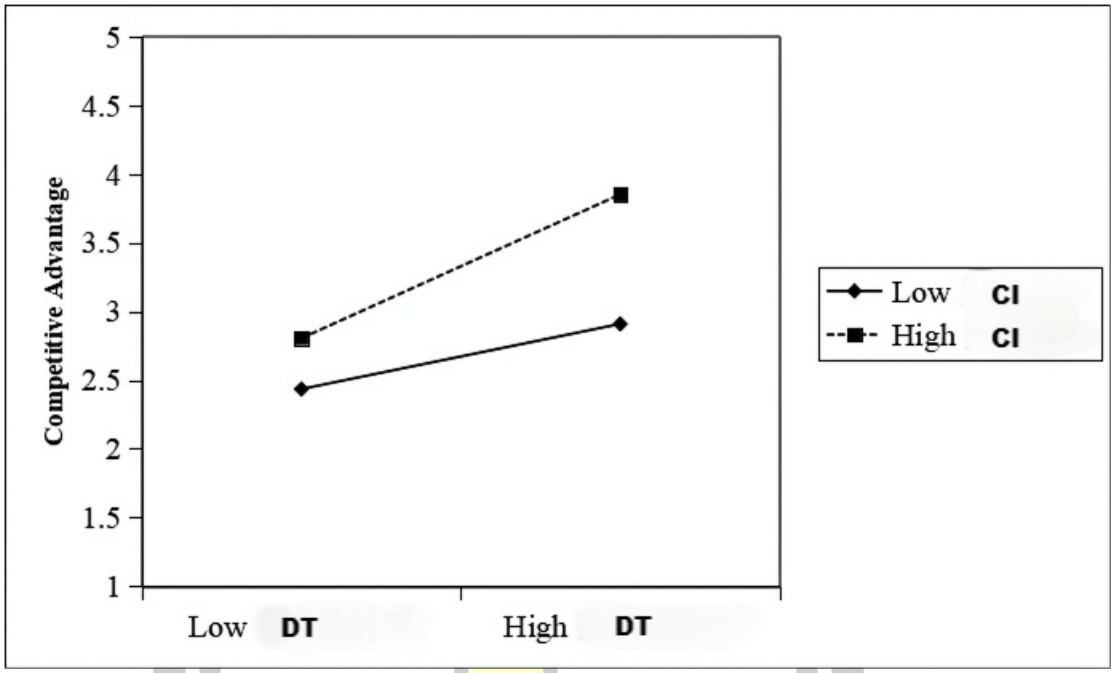


Figure 11 Moderating Slope Chart

1. The moderating role of channel integration between digital transformation and competitive advantage

Table 30 Moderating effect test (CI, DT and CA)

	Dependent Variable: CA					
	Model1		Model2		Model3	
	β	t	β	t	β	t
time	-0.006	-0.122	-0.026	-0.571	-0.023	-0.492
employee	0.006	0.103	0.027	0.517	0.021	0.402
sales	0.157	2.055*	0.098	1.415	0.101	1.480
assets	-0.122	-1.534	-0.101	-1.414	-0.103	-1.449
field	0.037	0.770	0.057	1.310	0.048	1.111
Digital Transformation			0.277	6.301***	0.306	6.820***

(DT)				
Channel Integration (CI)		0.312	7.088***	0.330	7.467***
CI				0.124	2.722**
R Square	0.012	0.205		0.219	
Adjusted R Square	0.010	0.192		0.204	
F	1.018	15.553***		14.742***	

Notes: *P < 0.05, **P < 0.01, ***P < 0.001

As shown in Table 30, Model 1 with time, employee, sales, assets, and field as independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model 2 takes time, employee, sales, assets, field, digital transformation, and channel integration as the independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model 3 with time, employee, sales, assets, field, digital transformation, channel integration; And the interaction of the digital transformation channel integration into independent variables, Competitive advantage builds multiple regression models for the dependent variables. The regression coefficient of the control variable sales in model 1 is significant, indicating that sales have a significant control effect on the competitive advantage; the regression coefficient of the interaction term of the digital transformation channel integration in model 3 is (β =0.124, P <0.01); indicating that the interaction term has a significant influence on the competitive advantage, and the R^2 of model 2 is 0.205 and the R^2 of model 3 is 0.219, indicating that the model interpretation ability is enhanced.

Therefore, it is proved that the channel integration of regulatory variables has a significant enhancement effect on digital transformation and competitive advantage, so the hypothesis 11 is true.

2. The moderating role of channel integration between learning and absorption capability and competitive advantage

Table 31 Moderating effect test (CI，Learning Capability and CA)

	Dependent Variable: CA

	Model1		Model2		Model3	
	β	t	β	t	β	t
time	-0.006	-0.122	-0.003	-0.064	-0.001	-0.023
employee	0.006	0.103	-0.019	-0.376	-0.02	-0.39
sales	0.157	2.055*	0.13	1.945	0.126	1.885
assets	-0.122	-1.534	-0.124	-1.797	-0.119	-1.715
field	0.037	0.77	0.013	0.301	0.014	0.338
Learning Capability			0.374	8.295***	0.361	7.778***
CI			0.222	4.945***	0.21	4.549***
Learning Capability×CI					-0.052	-1.138
R Square	0.012		0.253		0.255	
Adjusted R Square	0.010		0.240		0.241	
F	1.018		20.334***		17.967***	

Notes: *P < 0.05, **P < 0.01, ***P < 0.001

As shown in Table 31, Model 1 with time, employee, sales, assets, and field as independent variables, Competitive advantage establishes multiple regression model for dependent variables; Model 2 with time, employee, sales, assets, field, learning and absorption ability, and channel integration as independent variables, Competitive advantage establishes multiple regression model for dependent variables; Model 3 with time, employee, sales, assets, field, learning and absorption ability, channel integration; And the integration of interaction item learning and absorption capacity channels into independent variables, Competitive advantage builds multiple regression models for the dependent variables. The regression coefficient of the control variable sales in model 1 is significant, indicating that sales have a significant control effect on the competitive advantage; the regression coefficient of the interaction term of learning and absorption capacity channel integration in Model 3 is (β = -0.052, P> 0.05); indicating that the interaction term has no significant effect on the competitive advantage, and the R^2 of model 2 is 0.253, and the R^2 of model 3 is

0.255, indicating that the explanatory ability of the model has not changed.

Therefore, it is proved that the channel integration of regulatory variables has no significant effect on the learning and absorption capability and competitive advantage, so the hypothesis 12 is not true.

3. The moderating role of channel integration between innovation capability and competitive advantage

Table32 Moderating effect test (CI，Innovation Capability and CA)

	Dependent Variable: CA					
	Model1		Model2		Model3	
	β	t	β	t	β	t
time	-0.006	-0.122	-0.039	-0.855	-0.039	-0.848
employee	0.006	0.103	0.036	0.694	0.036	0.687
sales	0.157	2.055*	0.122	1.798	0.122	1.798
assets	-0.122	-1.534	-0.138	-1.972*	-0.139	-1.971*
field	0.037	0.77	0.039	0.903	0.039	0.897
Innovation Capability			0.352	7.421***	0.353	7.043***
CI			0.198	4.178***	0.199	4.069***
Innovation Capability×CI					0.004	0.088
R Square	0.012		0.231		0.231	
Adjusted R Square	0.01		0.218		0.216	
F	1.018		18.076***		15.780***	

Notes: *P < 0.05, **P < 0.01, ***P < 0.001

As shown in Table 32, Model 1 with time, employee, sales, assets, and field as independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model 2 takes time, employee, sales, assets, field, innovation ability, and channel integration as the independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model

3 with time, employee, sales, assets, field, innovation ability and channel integration; And the integration of interactive item innovation ability channels into independent variables, Competitive advantage builds multiple regression models for the dependent variables. The regression coefficient of the control variable sales in model 1 is significant, indicating that the sales has a significant control effect on the competitive advantage; the regression coefficient of the interaction term of innovation ability channel integration in model 3 is (β =0.004, P> 0.05); it indicates that the interaction term has no significant influence on the competitive advantage, and the R^2 of model 2 is 0.231 and the R^2 of model 3 is 0.231, which has not been significantly improved, indicating that the model interpretation ability has not changed.

Therefore, it is proved that the channel integration of regulatory variables has no significant effect on the innovation capability and competitive advantage, so the hypothesis 13 is not true.

4. The moderating role of channel integration between optimization and integration capability and competitive advantage

Table 33 Moderating effect test (CI, Integration Capability and CA)

	Dependent Variable: CA					
	Model1		Model2		Model3	
	β	t	β	t	β	t
time	-0.006	-0.122	-0.01	-0.212	-0.013	-0.285
employee	0.006	0.103	-0.009	-0.175	-0.001	-0.026
sales	0.157	2.055*	0.119	1.742	0.115	1.696
assets	-0.122	-1.534	-0.106	-1.51	-0.111	-1.579
field	0.037	0.77	0.04	0.916	0.043	0.985
Integration Capability			0.323	7.163***	0.307	6.641***
CI			0.249	5.505***	0.235	5.122***
Integration Capability×CI					-0.074	-1.607
R Square	0.012		0.225		0.23	

Adjusted R Square	0.01	0.212	0.215
F	1.018	17.458***	15.656***

Notes: *P < 0.05, **P < 0.01, ***P < 0.001

As shown in Table 33, Model 1 with time, employee, sales, assets, and field as independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model 2 takes time, employee, sales, assets, field, optimization and integration capability, and channel integration as the independent variables, Competitive advantage: Establish a multiple regression model for the dependent variables; Model 3 with time, employee, sales, assets, field, optimization and integration ability, channel integration; And interaction terms optimization and integration capability channel integration into independent variables, Competitive advantage builds multiple regression models for the dependent variables. The regression coefficient of the control variable sales in model 1 is significant, indicating that sales have a significant control effect on the competitive advantage; the regression coefficient of the interaction term of optimization and integration ability channels in model 3 is (β = -0.074, P> 0.05); indicating that the interaction term has no significant influence on the competitive advantage, and the R^2 of model 2 is 0.225, and the R^2 of model 3 is 0.230, which is not significantly improved, indicating that the explanatory ability of the model has not changed.

Therefore, it is proved that the channel integration of regulatory variables has no significant effect on the optimization and integration capability and competitive advantage, so the hypothesis 14 is not true.

The Results of Hypothesis Testing

This chapter verifies the theoretical model and research hypothesis proposed above, and uses empirical research methods to explore the interaction between the variables of digital transformation, supply chain dynamic capability, channel integration and competitive advantage of retail enterprises in Guangdong Province. The comprehensive application of SPSS27.0 and AMOS26.0 to analyze and test the results show that digital transformation has a positive impact on competitive advantage, digital transformation has a positive impact on the three dimensions of supply chain

dynamic capability, and the three dimensions of supply chain dynamic capability have a positive impact on competitive advantage. The dynamic capability of supply chain plays a complete mediating role between digital transformation and competitive advantage. The moderating effect of channel integration is significant between digital transformation and competitive advantage, but the moderating effect of channel integration is not significant between supply chain dynamic capability and competitive advantage. According to data analysis, the results of hypothesis testing are shown in the table 33.

Table 34 The Results of Hypothesis Testing

Hypothesis	The statements	Results
H1	Digital transformation is positively related to learning and absorption capability.	Supported
H2	Digital transformation is positively related to innovation capability.	Supported
H3	Digital transformation is positively related to optimization and integration capability.	Supported
H4	Learning and absorption capability is positively related to competitive advantage.	Supported
H5	Innovation capability is positively related to competitive advantage.	Supported
H6	Optimization and integration capability is positively related to competitive advantage.	Supported
H7	Digital transformation is positively related to competitive advantage.	Supported
H8	Learning and absorption capability mediates the relationship between digital transformation and competitive advantage.	Supported
H9	Innovation capability mediates the relationship between digital transformation and competitive advantage.	Supported
H10	Optimization and integration capability mediates the relationship between digital transformation and co	Supported

	mpetitive advantage.	
H11	Channel integration moderates the relationship between digital transformation and competitive advantage.	Supported
H12	Channel integration moderates the relationship between learning and absorption capability and competitive advantage.	Not supported
H13	Channel integration moderates the relationship between innovation capability and competitive advantage.	Not supported
H14	Channel integration moderates the relationship between optimization and integration capability and competitive advantage.	Not supported

The 14 research hypotheses proposed in this study, after empirical research, 11 hypotheses were finally verified, thus revealing the relationship between digital transformation, supply chain dynamic capability, channel integration and competitive advantage of Guangdong retail enterprises. Based on the results of hypothesis testing, the theoretical model was revised as shown in Figure 12.

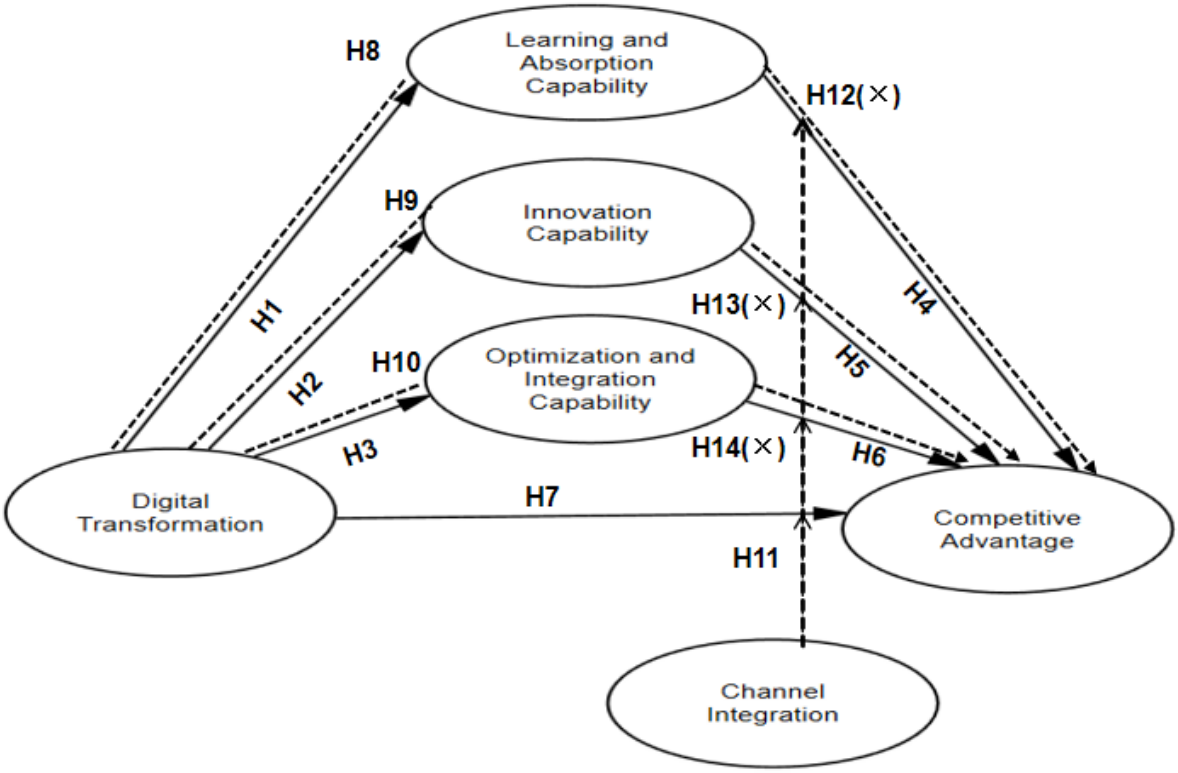


Figure 12 Revised Conceptual Model

CHAPTER V CONCLUSIONS

This chapter includes all findings in this research. It involves the summary of the findings and hypotheses testing, conclusions and discussions, theoretical implications, managerial implications, limitations and prospects.

Discussion

This study combines the theory of dynamic capabilities with supply chain management theory to explore the relationships among digital transformation, supply chain dynamic capabilities, channel integration and competitive advantage. Through the utilization of the survey data collected from 400 respondents of retail enterprises in Guangdong Province, China, the theoretical model was verified.

First, digital transformation can lead the supply chain in new directions of competition as a current research focus of significant interest. Nevertheless, when it comes to the integration of digital transformation and supply chain management, theoretical research lags considerably behind practical advancements. The digital transformation of the supply chain covers a comprehensive digital revolution , including technology, business models, organizational structures, processes, services, and operations. Analyzing the antecedents and consequences of digital transformation facilitates the revelation of the process through which the supply chain undergoes reconstruction in order to survive, evolve, and adapt to the digital environment. This study also provides theoretical support for how digital transformation can continue to improve supply chain dynamic capabilities and thus lead to supply chain competitive advantage in an environment of increasing channel integration.

Second, this study explores the mediating effect of supply chain dynamic capabilities between digital transformation and supply chain competitive advantage, revealing the mechanism of influence between them. Previous studies have discussed the relationship between supply chain dynamic capabilities and competitive advantage or organizational performance, but tend to treat supply chain dynamic capabilities as

independent variables and ignore their sources. While delving into the impact of digital transformation on supply chain competitive advantage, this study finds that digital transformation indirectly affects competitive advantage through the three dimensions of supply chain dynamic capabilities, elucidating the causal path of digital transformation in supply chain competitive advantage. The results of this study validate the behavioral logical starting point and micro-level origins of supply chain dynamic capabilities constituted by digital transformation, expand the prior research on supply chain dynamic capabilities, and provide a theoretical foundation for the construction of supply chain dynamic capabilities in the digital economy. Therefore, based on the principles of supply chain management and the theory of dynamic capabilities, this study links digital transformation to competitive advantage, through three dimensions of supply chain dynamic capabilities, including learning and absorptive capabilities, innovation capabilities, optimization and integration capabilities. The findings of this study not only fill the theoretical gap in understanding digital transformation mechanisms and supply chain competitive performance, but also provide a reference for future research on supply chain capabilities from the perspective of the digital economy.

Third, channel integration moderate digital transformation and supply chain competitive advantage. Specifically, supply chains with higher levels of digital transformation have better competitive performance with higher levels of channel integration. However, the relationship between channel integration regulating supply chain dynamic capabilities and competitive advantage is not significant. From a theoretical perspective, although channel integration is theoretically believed to promote the synergy of information, resources, and processes in a supply chain, its role may be limited by a number of constraints in the actual business environment. For example, there may be deep-rooted cultural differences and conflicts of interest among different channels, which in turn affect the difficulties of supply chain synergy and thus fail to effectively regulate the relationship between supply chain dynamic

capabilities and competitive advantage. Some studies have shown that the complex relationships and interest trade-offs between different channels, and different subjects in the supply chain may be caught in a "prisoner's dilemma", with conflicts of interest, affecting the overall operation and decision-making of the supply chain (Lei Chen, Qiuyu Huang, Jingwen Xu, 2024). The interest relationship and game situation between different subjects reflect, to some extent, the impact of conflict of interest on supply chain competitive advantage that may arise from power structure and information differences among partners in cross-channel supply chains (Ma, XL; Mao, JY, 2024). Partners' conflict of interest prevents the supply chain from forming an effective collaborative learning and knowledge sharing mechanism, which leads to the difficulty of transforming the supply chain's dynamic capabilities into actual competitive advantages, thus making the moderating effect of cross-channel integration insignificant. Meanwhile knowledge management is a key prerequisite for developing dynamic capabilities, and it is crucial to develop dynamic capabilities through knowledge management practices to build supply chain resilience (Pal, T; Ganguly, K; Chaudhuri, A, 2024). The lack of effective knowledge management mechanism in channel integration prevents the deep excavation and effective utilization of such knowledge, which makes supply chain enterprises unable to timely adjust their strategies and innovate their products and services in the face of market changes and customer demands, thus leading to the insignificant moderating effect of channel integration on the relationship between supply chain dynamic capabilities and competitive advantages.

Theoretical Implications

This research systematically introduces the dynamic capabilities theory into the field of retail supply chain management, clarifying the full mediating role of the three dimensions of supply chain dynamic capabilities (learning and absorptive capacity, innovation capability, and optimization and integration capability) between digital

transformation and competitive advantage. This finding fills the theoretical gap in the research on the mechanisms of digital transformation.

First, the integration of digital transformation and supply chain management is still lagging behind practical developments in terms of theoretical research. This study attempts to empirically investigate the impact of digital transformation on competitive advantage of enterprises in the retail industry. On the one hand, there is limited empirical research on how digital transformation affects supply chain competitive advantage. On the other hand, Elisa Truant et al. argue that there is a need to enrich the understanding of the consequences of digital transformation from multiple perspectives. This study empirically enriches the understanding of the relationship between digital transformation and supply chain competitive advantage. It also provides theoretical support for the continuous development of supply chain dynamic capabilities based on digital transformation.

Second, this study enriches the understanding of the relationship between digital transformation and supply chain competitive advantage by introducing supply chain dynamic capabilities as a mediating variable. This study also elucidates the causal path of digital transformation in supply chain competitive advantage by identifying the positive impact of digital transformation on supply chain dynamic capabilities and that digital transformation indirectly affects competitive advantage through the three dimensions of supply chain dynamic capabilities. This study validates the behavioral logical starting point of supply chain dynamic capabilities constituted by digital transformation and extends the previous research on supply chain dynamic capabilities. In addition, while previous studies linking digital transformation to supply chain capabilities have focused only on general and broad capabilities, this study reveals the impact of digital transformation on more granular aspects of supply chain capabilities, such as learning and absorption capability, innovation capability, optimization and integration capability.

Third, with the development of information technology and the increasing diversification of channels, more and more retailers are gaining competitive advantages by coordinating and managing different channels and implementing cross-channel integration strategies. This study collects rich primary data to provide empirical evidence to explain the relationship between digital transformation, supply chain dynamic capability and supply chain competitive advantage under different degrees of cross-channel integration. It further deepens the understanding of the relationship between digital transformation, supply chain dynamic capabilities and competitive advantage by revealing the moderating role of channel integration, and extends supply chain management theory and supply chain dynamic capability theory by emphasizing the importance of digital transformation, partner conflict of interest during channel integration, and lack of knowledge management mechanism.

Managerial Implications

This study provides valuable managerial insights to improve supply chain dynamics, offers practical value to Guangdong firms, and enriches the understanding of cross-channel supply chains.

First, Learning and Absorptive Capacity: Knowledge Sharing and Ecosystem Collaboration. As a pioneer in China's digital economy development, Guangdong Province, with its policy innovations and industrial practices, provides retail enterprises with unique opportunities to enhance their learning and absorptive capacity through knowledge sharing and ecosystem collaboration. This study, through empirical analysis, finds that the learning and absorptive capacity within supply chain dynamic capabilities is a key mediating mechanism through which digital transformation empowers competitive advantage. Combined with policy orientations such as the Guangdong Province Data Element Market-oriented Allocation Reform Plan, the value of this capacity for enterprises in Guangdong is mainly reflected in the following three aspects: Data Resourcefulness: Transforming fragmented consumer

behavior and supply chain operation data into standardized knowledge assets to achieve value mining and integration of data. Knowledge Capability: Making tacit knowledge explicit through industry-university-research cooperation and the application of digital tools (such as artificial intelligence and knowledge graphs), thereby enhancing corporate knowledge management and innovation capabilities. Capability Ecosystem: Relying on open platforms to upgrade enterprise-level capabilities to industry-level public services, forming a positive cycle of "capability co-construction—value sharing" to promote the collaborative development of the industrial ecosystem. In summary, Guangdong's policies and industrial practices provide a solid foundation for the digital transformation of retail enterprises. As a key mediating mechanism, the learning and absorptive capacity, through data resourcefulness, knowledge capability, and capability ecosystem, helps enterprises build competitive advantages and drives the high-quality development of the regional digital economy.

Second, Innovation Capability: Policy Empowerment and Technological Integration. Guangdong Province has constructed a "policy-technology-ecosystem" trinity framework for the leap in innovation capability of retail enterprises, through the deep integration of policy tool innovation and digital technology. This framework provides a practical paradigm for the digital transformation of traditional industries. The empirical results of this study indicate that this model significantly enhances the innovation dimension of supply chain dynamic capabilities, with its specific value reflected in the following two aspects: Reduction of Institutional Costs: Through mandatory technology openness and socialized risk-sharing, Guangdong has successfully reduced the marginal innovation costs of small and medium-sized enterprises (SMEs) by 60%-80%. This effectively alleviates the innovation cost pressures faced by SMEs, enhancing their innovation enthusiasm and capabilities. Ecosystem-Level Value Network: Upgrading from single-point innovation to

full-chain capability co-construction, a positive cycle of ″innovation contribution—benefit feedback″ has been formed. This promotes the diffusion and value maximization of innovation outcomes within the industrial chain, enhancing the collaborative innovation capability of the entire industrial ecosystem.

Third, Optimization and Integration Capability: End-to-End Agile Response. Guangdong Province has constructed a leapfrogging path for the optimization and integration capabilities of retail supply chains by integrating top-level policy design with digital technology. This provides a replicable practical model for the agile transformation of supply chains nationwide. The empirical results of this study indicate that this model has restructured the supply chain response mechanism through data integration and intelligent decision-making, with its specific value reflected in the following aspects: Full Lifecycle Traceability: By assigning unique digital identifiers to products such as electronics and home appliances, end-to-end data integration is achieved from raw material procurement to after-sales service. Cross-Chain Collaborative Efficiency: The establishment of a unified identification and resolution node in the Greater Bay Area supports data interconnection between enterprises in Guangdong and Hong Kong, significantly compressing market feedback cycles. Source Data Integration: Integration of multi-dimensional data streams, including ERP (order data), IoT (equipment status), GIS (logistics trajectories), and social media (demand sentiment).

Finally, managers should recognize that the impact of digital transformation on enhancing the competitive advantage of the supply chain is affected by channel consolidation. The higher the level of channel integration, the greater the need for digital transformation to enhance supply chain competitive advantage. However, channel integration adjusts the relationship between supply chain dynamic capabilities and competitive advantage not significantly. In cross-channel supply chains, there are substantial differences in the benefit needs of different partners due to different

channel locations and business models. For example, partners in online channels are more inclined to focus on short-term traffic and sales growth, while partners in offline channels are more focused on long-term brand image and customer loyalty maintenance. This conflict of interest manifests itself in the process of cross-channel integration, making it difficult for partners to reach consensus and coordination. As a result, it adversely affects the dynamic capacity of the supply chain, limiting the ultimate advantage of the moderating effect of cross-channel integration on forcing. Meanwhile, in the process of cross-channel integration, many enterprises lack a systematic knowledge management mechanism to effectively integrate, share, and apply knowledge obtained from different channels. As a result, knowledge becomes dispersed and isolated within the supply chain and fails to exert its due impact, further hindering the improvement of supply chain dynamic capabilities and the positive impact on competitive advantage. Therefore, industry associations and key enterprises within the industry chain should establish more favorable partnerships and more effective knowledge management mechanisms to promote the sustainable and healthy development of the supply chain. This will ensure the building of supply chain dynamic capabilities and promote supply chain competitive advantage in the process of cross-channel integration.

Conclusions

The present research within the field of supply chain capabilities has identified the effect of digitization on the enhancement of supply chain competitive advantage across various dimensions. However, this influence necessitates empirical analysis and validation to be more conclusive and reliable. Additionally, the multi-faceted mediating role that supply chain dynamic capabilities (SCDC) play between digital transformation (DT) and competitive advantages (CA) demands further in-depth investigation and exploration. Moreover, the moderating impact of channel integration on the connection between digital transformation and supply chain competitive

advantage remains indistinct and lacks clear understanding. To tackle these research requirements and fill the existing gaps, this particular study was initiated and carried out. Firstly, in this study, a comprehensive and all-encompassing framework of supply chain dynamic capabilities was adopted and applied. This framework encompassed three highly significant dimensions: namely, the learning and absorptive capability, the innovation capability, and the integration and optimization capability. Then, the framework labeled as "DT→SCDC→CA" was meticulously constructed for the purpose of close observation and analysis. Finally, a structural equation model was verified and confirmed using the questionnaire data that were collected from Guangdong retailing companies and which precisely described this framework.

The research findings clearly demonstrate that digital transformation has a direct and substantial influence on both supply chain dynamic capabilities and supply chain competitive advantage. The three dimensions of supply chain dynamic capabilities act as a mediating factor between digital transformation and competitive advantage. Furthermore, the channel integration has an impact on the influence that digital transformation exerts on supply chain competitive advantage. Specifically, in situations where the level of channel integration is high, digital transformation assumes a more pronounced and crucial role in maintaining and sustaining the competitive advantage of the supply chain. But it is notable that the effect of channel integration on supply chain dynamic ability and competitive advantage is not substantial or significant.

These findings not only broaden and extend the boundaries of digital transformation theory research from the internal aspects of organizations to the entire supply chain landscape, but also enrich and enhance the empirical research on the precursors and antecedents of supply chain competitive advantage. This study systematically and comprehensively reveals the process of capability alterations and changes that are brought about by digital transformation, resulting in an enhanced competitive advantage and a deeper and more profound understanding of the theory of supply

chain management and dynamic capabilities. The research results offer valuable theoretical and practical support for the selective and gradual advancement and development of supply chain capabilities. They provide useful guidance and assistance to companies, helping them achieve and maintain sustainable competitive advantages in the highly competitive market environment.

Limitations and Prospects

Based on supply chain management theory and dynamic capability theory, this study uses quantitative research methods to deeply explore the mechanism of digital transformation, supply chain dynamic capability, channel integration and competitive advantage, and analyzes the mediating role of supply chain dynamic capability between digital transformation and competitive advantage. It also reveals the regulating effect of channel integration on the relationship between digital transformation and competitive advantage, and the relationship between supply chain dynamic capability and competitive advantage, which has certain theoretical and practical guiding significance for retail enterprises in Guangdong Province to carry out supply chain digital transformation. However, there are still certain deficiencies in the research process, which need to be further deepened and improved in future research.

First, this study combines theoretical research with empirical research to reveal the relationship between digital transformation and competitive advantage. However, due to the limitation of scientific research capacity and time, only retail enterprises in Guangdong Province are studied, and the industries and regions involved are relatively limited. Insufficient sample size may limit the interpretation and generality of the results. Future studies should aim to expand the sample size, collect more data from a wider range of regions and industries, and further validate the results of this study to improve the generalization of the results.

Second, this research directly adopted mature scales for data collection. Data were collected onsite in the pretest stage which can clarify the description of the scale, and then the questionnaire expressions were optimized to ensure the reliability and validity of the questionnaire after changing the environment in the research process. However, because of the questionnaire design contains organizational behavior and psychological cognitive variables, there are inevitably subjective cognitive biases in the process of questionnaire recovery. For example, in the measurement of competitive advantage, this study takes the subjective impression of managers as the evaluation basis, which will inevitably lead to evaluation bias. In the future, more objective evaluation indicators can be added or other public data in specific situations can be used, such as corporate financial statements.

Third, since digital transformation is a long-term and dynamic process, different enterprises may have certain differences in the digital transformation of the supply chain. For example, the core enterprises in the supply chain have more autonomy in the digital transformation of the supply chain, while the non-core enterprises can only passively transform, which also means that the digital transformation of the supply chain may have different impacts due to the different status or development stage of the enterprise in the industry. Therefore, future research can try the differential mechanism of digital transformation between core enterprises and non-core enterprises in the supply chain. Therefore, more effective and accurate management suggestions and optimization strategies are proposed for the digital transformation of supply chains of different enterprises.

APPENDIX

Questionnaire on Retail supply chain transformation

Dear
We are an academic research team on retail supply chain transformation. Thank you for taking time out of your busy schedule to complete this questionnaire. The purpose of this survey is to delve into the digital transformation and competitive advantage of the retail supply chain. Please be assured that anonymity is guaranteed for this survey in accordance with the academic research protocol, ensuring that your responses are confidential. Please provide your honest feedback when filling out the questionnaire.
Thank you for your valuable participation!

Part I Main Questions

Digital Transformation

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards the right, the greater your agreement is understood to be. Your responses should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				**Strongly Agree**
We aim to digitalize everything that can be digitalized.	1	2	3	4	5
We collect large amounts of data from different sources.	1	2	3	4	5
We aim to create stronger networking between the different business processes with digital technologies.	1	2	3	4	5
We aim to enhance an efficient customer interface with digitality.	1	2	3	4	5
We aim at achieving information exchange with digitality.	1	2	3	4	5

Supply chain dynamic capability-- Learning

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards

the right, the greater your agreement is understood to be. Your responses should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				Strongly Agree
Our company acquires substantial production information from our major supplier.	1	2	3	4	5
Our major supplier provides us critical and useful information for product innovation.	1	2	3	4	5
As a part of product development, our company learns a great deal from our major supplier.	1	2	3	4	5
Our company applies the knowledge learned from our major supplier in new technology adoption.	1	2	3	4	5
Our company has systematic checks to ensure that the knowledge from our major supplier is utilized.	1	2	3	4	5
Our company acquires substantial production information from our major customer.	1	2	3	4	5
Our major customer provides us critical information for product innovation.	1	2	3	4	5
As a part of product development, our company learns a great deal from our major customer.	1	2	3	4	5
Our company applies the knowledge learned from our major customer in new technology adoption.	1	2	3	4	5
Our company has systematic checks to ensure that the knowledge from our major customer is utilized.	1	2	3	4	5
Internal functions communicate a lot of product information with each other.	1	2	3	4	5
Internal functions communicate a lot of innovation information with each other.	1	2	3	4	5
Internal functions learn a lot of useful things from each other.	1	2	3	4	5
Knowledge communication among internal functions promotes the adoption of new technology.	1	2	3	4	5
Internal functions evaluate whether they have applied product knowledge from other functions.	1	2	3	4	5

Supply chain dynamic capability-- Innovation

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards the right, the greater your agreement is understood to be. Your responses

should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				Strongly Agree
Our company always attempts to stay on the leading edge of new technology in our industry.	1	2	3	4	5
We make an effort to anticipate the full potential of new practices and technologies.	1	2	3	4	5
We pursue long-range programs in order to acquire technological capabilities in advance of our needs.	1	2	3	4	5
We are constantly thinking of the next generation of technology.	1	2	3	4	5
We have excellent communication processes between R&D and other departments.	1	2	3	4	5
Our R&D pursues truly innovative and leading-edge research.	1	2	3	4	5
Our R&D strategy is mainly characterized by high-risk projects with chance of high return.	1	2	3	4	5
R&D plays a major part in our business strategy.	1	2	3	4	5

Supply chain dynamic capability--Integration

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards the right, the greater your agreement is understood to be. Your responses should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				Strongly Agree
We have a high degree of information exchange with our primary supplier through information networks.	1	2	3	4	5
We share our procurement or production plans with our major suppliers-farmers, farmer cooperatives, etc.	1	2	3	4	5
We share our demand forecasts with our major suppliers.	1	2	3	4	5
We have a high degree of a strategic partnership with our major suppliers.	1	2	3	4	5
We have a high degree of information sharing with major customers about market information.	1	2	3	4	5

We have a high degree of joint planning and forecasting with major customers to anticipate demand visibility.	1	2	3	4	5
We share our production plan with our major customers.	1	2	3	4	5
We have a high degree of strategic partnership with our major customers.	1	2	3	4	5
We realize data integration among all internal functions.	1	2	3	4	5
We can real-time search the information of supply, production, and demand.	1	2	3	4	5
We use cross-functional teams in the procurement process of agricultural products.	1	2	3	4	5
We use cross-functional teams in new product development, e.g., developing new brands or introducing new product lines.	1	2	3	4	5

Channel Integration

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards the right, the greater your agreement is understood to be. Your responses should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				**Strongly Agree**
The product information provided by all channels of the company is consistent.	1	2	3	4	5
The price information provided by all channels of the company is consistent.	1	2	3	4	5
The inventory information provided by the company's various channels is consistent.	1	2	3	4	5
The company's operating system can provide after-sales service for the goods ordered by users on various channels.	1	2	3	4	5
Each channel of the company supports and helps each other.	1	2	3	4	5
The service image provided by each channel of the company is consistent.	1	2	3	4	5

The company maintains the same level of service to online customers as offline customers.	1	2	3	4	5
The company's service to customers across different channels is consistent in terms of timeliness.	1	2	3	4	5

Competitive Advantage

Please indicate your level of agreement with the following statements, reflecting your sincere thoughts and feelings. The more you move towards the right, the greater your agreement is understood to be. Your responses should be based solely on your own perspectives, without the need to consult or consider the opinions of others.

	Strongly Disagree				Strongly Agree
Lower communication costs, order management costs, inventory costs, warehouse management costs, transportation costs, logistics management costs, etc.	1	2	3	4	5
Customers are highly satisfied with our services.	1	2	3	4	5
Our company performs well in terms of sales revenue growth compared to key competitors.	1	2	3	4	5
Our company performs well in terms of market share compared to key competitor.	1	2	3	4	5

Part II Basic Information

53. Company operating period

1-3 years, 2) 3-8 years, 3) 8-15 years, 4) more than 15 years

54. The number of employees of the company

1) 0-50; 2) 51-100, 3) 101-300, 4) 301-500, 5) 500 or more

55. The company's annual sales (million yuan)

1) less than 5, 2) 5-30, 3) 30-100, 4) 100-300, 5) more than 300

56. Total assets (million yuan)

1) less than 5, 2) 5-50, 3) 50-150, 4) 150-500, 5) 500 and more

57. Retail field

1)beauty, 2)jewelry, 3)shoes and clothing, 4)catering, 5)daily chemical, 6) electrical appliances, 7) communication equipment, 8) home furnishing, 9) automobile, 10) other

THANK YOU VERY MUCH FOR YOUR VALUABLE TIME AND PARTICATION!

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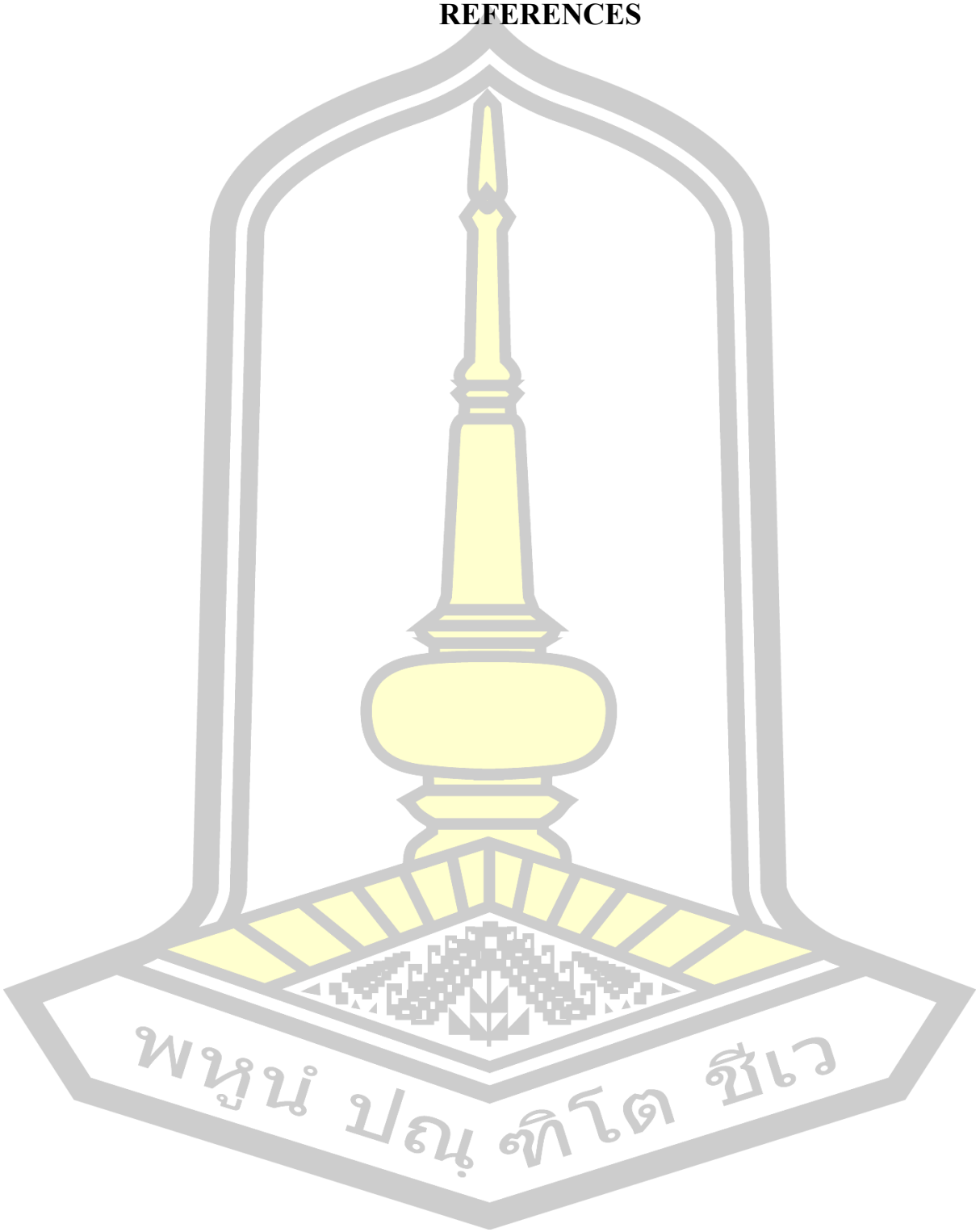

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