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A Study on Factors Influencing Technology Innovation of Logistics of China from a Perspective of Knowledge

by

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Management of Technology

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A Study on Factors Influencing Technology Innovation of Logistics of China from a Perspective of Knowledge
(지식관점에서의 중국 물류기술 혁신 영향요인에 관한 연구)

Advisor: Prof. Wonchul Seo

by

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A dissertation

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지식관점에서의 중국 물류기술 혁신 영향요인에 관한 연구

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개요

지식경제시대에 지식은 기업의 기술혁신 역량을 강화하기 위한 효과적인 수단으로서 인식되고 있다. 물류산업에서의 새로운 기술 및 제품의 개발과 서비스 역량의 향상은 물류기업들이 경쟁우위를 확보할 수 있도록 하는 기본적인 근간이 되고 있다. 이에 본 연구는 지식의 관점에서 물류기업의 기술혁신 역량에 영향을 미치는 요인들을 분석한다. 지식혁신 및 지식경영을 시작점으로 하여 물류기업의 내·외부 환경 및 추진 메커니즘과 기술혁신 역량 간 영향관계를 체계적으로 파악하고 이들 간 영향관계가 작용하는 경로를 구체화한다. 논문은 베이징, 상하이, 광저우를 주요 지역으로 하여 중국의 50 개 중소물류기업에서 설문지 조사를 진행한다. 우선, 기술혁신, 기업의 다이내믹 역량 및 지식과 관련한 기존 문헌에 대한 탐색을 바탕으로 지식 관점에서의 물류기술 혁신에 대한 영향요인을 설명할 수 있는 14 가지 연구가설을 제시한다. 기업 내·외부의 다양한 요인들이 지식혁신 및 지식관리를 통해 물류기업의 기술혁신 역량에 영향을 미치는 메커니즘을 구체화한다. 기존 문헌에서 활용된 다양한 설문문항들을 기반으로 물류산업의 특징을 반영할 수 있도록 변수 측정항목을 새롭게

설계한다. 설문은 지식관점에서의 물류기술 혁신 영향요인과 관련된 항목 28 가지와 응답자 개인정보와 관련된 항목 4 가지로 구성된다. SPSS22.0 과 AMOS23.0 을 활용하여 회수된 응답 데이터의 기술 통계량을 파악하고 신뢰도 및 유효성에 대한 검증을 시행한다. 그리고 물류기업의 기술혁신 역량에 대한 영향요인을 체계적으로 파악할 수 있도록 구조방정식 모델을 구축한 후, 모델 적합성 평가를 통해 모델을 개선한다. 분석결과 총 14 개의 연구가설 중 12 개의 가설이 지지되었다. 물류기업 내부 환경에서의 학습능력, 조직구조, 기술인력 및 기업규모는 지식혁신과 지식관리를 통해 물류기술 혁신에 긍정적인 영향을 미치는 것으로 파악되었다. 외부 환경에서의 정보시설은 지식관리를 거쳐 물류기술 혁신에 긍정적인 영향을 미치는 반면, 정책 환경은 지식혁신을 거쳐 물류기술 혁신에 긍정적인 영향을 미치는 것으로 나타났다. 정보 시설이 지식혁신에 미치는 긍정적인 영향과 정책 환경이 지식관리에 미치는 긍정적인 영향은 유의하지 않은 것으로 판단되었다. 이러한 분석결과를 토대로 본 연구는 물류기업의 기술혁신 역량을 증진하기 위한 전략적 시사점을 제시할 수 있다는 점에서 강한 의의를 지니고 나아가 물류산업의 지속 가능한 성장을 위한 기반을 마련하는데 기여할 것으로 기대된다.

키워드: 물류, 영향 요인, 지식 혁신, 지식 관리, 기술 혁신

A Study on Factors Influencing Technology Innovation of Logistics of China from a Perspective of Knowledge

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Abstract

In the era of knowledge economy, knowledge is undoubtedly an effective tool to build and enhance the technological innovation ability of enterprises.Logistics enterprises bear the vital responsibility of promoting the transformation and upgrading of logistics industry. The sustainable development of new technologies and new products and the improvement of service capability has become essential means for logistics enterprises to obtain competitive advantages. Therefore, this paper studies the factors influencing the technological innovation capability of logistics enterprises from the perspective of knowledge. By taking knowledge innovation and knowledge management as the entry point, we systematically analyzes the interaction between the internal environment, external environment and the technological innovation capability of logistics enterprises. The progressive influence mechanism model between internal and external driving force mechanism and technological innovation capability is constructed, and the

influence path between the three is found through the investigation of the influence relationship among the relevant dimensions.

The dissertation takes Beijing, Shanghai and Guangzhou as main area to carry on questionnaire investigation in China's 50 small and medium-sized logistics enterprises. First,compiled the theoretical foundations related to technological innovation, enterprise dynamic capability and knowledge; sorted out the relevant literature at home and abroad,and put forward 14 research hypotheses for the study of factors influencing logistics technological innovation from the perspective of knowledge. Then, we constructed a conceptual model to explore the operational mechanism of internal and external factors influencing the technological innovation capability of enterprises through knowledge innovation and knowledge management.

Besides, some existing scales in the domestic and international literature were used to design variable measurement items by combining the characteristics of logistics industry. The formal questionnaire was determined through pre-research and consultation discussions, which contained 28 questions related to factors influencing logistics technology innovation from the knowledge perspective and four questions related to personal information. SPSS22.0 and AMOS23.0 were used to analyze the descriptive statistical information, reliability and validity of the collected sample data, and to verify the reliability and validity of the questionnaire measurement items and sample data.It is also used to construct a structural equation model for the influencing factors of logistics technology innovation, to assess the model fit, and to make model corrections.

The results show that 12 out of 14 hypotheses pass the test and two hypotheses fail the test. The learning ability, organizational structure, technical talents and company size in the internal environment of logistics enterprises will positively influence logistics technology innovation through positively influencing knowledge innovation and knowledge management. The information facilities in the external environment positively influence logistics technology innovation through positively influencing knowledge management, and the policy environment positively influences logistics technology innovation through positively influencing knowledge innovation. The positive influence of information facilities on knowledge innovation and the positive influence of policy environment on knowledge management are not significant.

Based on the analysis results, this paper concludes with countermeasure suggestions to enhance the technological innovation capability of logistics enterprises and promote the sustainable and healthy development of logistics enterprises.

Keywords: logistics, influencing factors, knowledge innovation, knowledge management, technological innovation

I. INTRODUCTION

1.1 Research Background

1.1.1 Time background

The World Economic Cooperation Organization defines the knowledge economy as an economy based on the creation, storage, use, and consumption of knowledge and information, the core of which is modern science and technology. In the era of knowledge economy, the sustainable growth of economy and society directly depends on the accumulation, dissemination, use and creation of knowledge resources. Drucker (1993) proposed that in the era of knowledge economy, knowledge is the only meaningful resource for enterprises. As a new type of resource, knowledge plays a more important role in enterprises than before, and has become the core for enterprises to obtain competitive advantages and cultivate. The decisive factor of competitiveness[1]. Spender & Grant (1996) believes that as a heterogeneous body of knowledge, the enhancement of its capabilities is essentially a process of knowledge integration[2]. Nelson & Rosenberg (1993) believes that the knowledge accumulated through organizational learning is untradeable and difficult to imitate. Knowledge application and knowledge innovation capabilities are the most important sources for companies to obtain sustainable competitive advantages[3]. New knowledge mobilizes the

resources and capabilities of all aspects of the enterprise to transform the new knowledge resources into the actual production technology system of the enterprise to obtain high-efficiency production and operation and promote the process of sustainable development of the enterprise. Kogut & Zander (1992) proposed that the competitive advantage of enterprises stems from the creation, storage and application of knowledge[4]. Eisenhardt & Martin (2000) proposed that the dynamic capabilities of enterprises exist in a series of management processes such as the acquisition, absorption, creation, integration, and reconstruction of knowledge[5]. Leonard Barton (1995) believes that the skills rooted in the enterprise and knowledge in daily work have strong experience and potential. It is designed for the special needs of the enterprise. The core competence of the enterprise is a dynamic knowledge evolution development system[6]. Prahalad & Hamel (1990) believe that the core competence of an enterprise is composed of knowledge, which is used to integrate and coordinate the accumulated knowledge of different production skills and technical expertise[7].

1.1.2 Theoretical background

Foreign scholars have conducted research on logistics innovation mainly based on grounded theory, resource advantage theory, and network theory. Flint et al.[8] used grounded theory to study logistics innovation and how to be more innovative while providing logistics services to customers. They believed that related improvements in

logistics were mainly driven by the customers of logistics service providers; Richey) Et al.[9] used the theory of resource advantage to explain the important role of innovation in the field of reverse logistics; Dhanaraj et al.[10] based on network theory, constructed a logistics innovation that includes variables such as status, power, and embeddedness. Framework, studied the role of each company in the network and its impact on innovation.

In addition, innovation-driven is a multi-faceted and multi-level comprehensive innovation. It is a method of rational and efficient allocation of resources with innovative elements such as knowledge and technology as the main driving force of economic development. It is a strategic choice that is different from traditional element-driven[11] With the introduction of policies related to innovation-driven development strategies, scholars have carried out a large number of researches on innovation-driven development. At the national and regional levels, Liang Zheng[12] emphasized the expansion of the connotation and extension of innovation, and focused on the "recombination" of the efficient use of policy tools to promote innovation. Sheng Nan et al.[13] pointed out that the implementation of the background of the innovation-driven strategy stems from the emphasis on enhancing social independent innovation capabilities and strengthening the integration of technology and economy. Wu Weihong et al.[14] based on the research on the efficiency level of innovation-driven development in 30 provinces in my country and found that the efficiency of innovation-driven

knowledge development is greater than that of innovation-driven economic environmental development.

At present, the research on innovation in the logistics industry mostly focuses on service innovation management and influencing factors of logistics innovation. For example, Wang Zhitai[15] pointed out that logistics industry innovation should not only pay attention to technological innovation, but also to system and management innovation. Both Shen Jing[16] and Busse[17] found that basic elements such as resource endowment and the environment in which the industry is located are important driving forces supporting the development of the logistics industry. Lin et al.[18] summarized the factors affecting logistics innovation into technical factors, organizational factors, and environmental factors. It has laid a good theoretical foundation for the further systematic research of this article.

1.1.3 Current research perspective

Research on logistics innovation by foreign scholars mainly follows the following clues: Panayides[19] customer-oriented perspective believes that an organization centered on maintaining customer relationships is often more innovative, Autry (Autry)[20] The knowledge perspective believes that there is a close connection between knowledge (supply chain knowledge development) and logistics innovation. Panayitis et al.[21] The organizational learning perspective believes that organizational learning

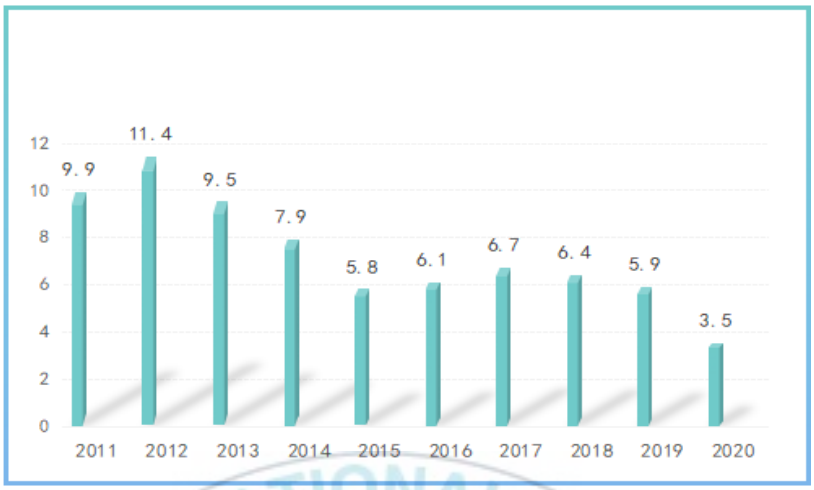
orientation has a great impact on corporate innovation, especially in technology. In terms of process innovation, it can further improve the efficiency of logistics services. (Lichtenthaler)[22] the absorptive capacity perspective believes that absorptive capacity not only affects innovation, but also has an indirect impact on R&D, that is, through better learning and understanding of external knowledge, to make up for the first The possible inhibitory effect of tripartite knowledge spillovers on innovation.

1.1.4 Research necessity

（1） Development status of logistics

Logistics is a basic industry to support social and economic development.Since 2011, China's total express logistics has been expanding. In 2012, the year-on-year growth rate of China's total social logistics reached the peak. From 2013 to 2015, it has been decreasing. From 2016 to 2019, it slowed down and gradually leveled off. Under the condition of national capacity reduction, structural adjustment and improving economic operation efficiency, it is imperative to "reduce cost and increase efficiency" in China's logistics. At the same time, with the joint efforts of government and enterprises, the growth rate of logistics expenses in China has slowed down as a whole, and the proportion in GDP has been declining.So, it is a necessary path to accelerate the transformation and upgrading of logistics under the new economic normal by enhancing the level of logistics innovation through an innovation-driven approach.

<Figure 1.1-1> China's total social logistics year-on-year growth rate



（2）Development trend of Logistics

China's logistics industry has low operational efficiency, weak service supply capacity, incomplete infrastructure connectivity and lack of technical input, resulting in insufficient logistics innovation capacity, and has yet to form an innovation-driven collaborative sharing intelligent logistics system. In the new stage of smart logistics development, the logistics industry relies on the Internet and big data to implement collaborative sharing innovation mode to reshape the logistics industry structure and form a new logistics ecology. The core of smart logistics is collaborative sharing, which breaks the boundary of traditional enterprises by sharing the right to use logistics resources, deepens the division of labor and cooperation among enterprises, and maximizes the value of idle resources in the society. The improvement of logistics enterprises' technological innovation ability is conducive to realizing the docking of

enterprise information and social information, accelerating the integration of technology and logistics, and playing an important role in improving the smart logistics ecosystem and the optimization and upgrading of smart supply chain.

(3) The urgency of logistics innovation

Zinn[23] is an earlier scholar who pointed out the urgency of logistics innovation. He believes that the intensified competition between enterprises and the shortage of capital make logistics innovation urgent. In addition, some scholars have analyzed from different angles and believe that some new environmental development trends have exacerbated the urgency of innovation for logistics service providers. Langley et al.[24] believe that with the globalization of integration, the pressure on logistics enterprises to innovate is increasing; Langley et al.[25] further researched and pointed out that more logistics service providers hope to extend their The types and scope of services have shifted to more complex services, so innovation is necessary; Chieh-Yu Lin et al.[26] studied the influencing factors of technological innovation of logistics service providers in Taiwan, and believe that more and more Many logistics service providers will start to carry out logistics innovation in accordance with the changes in the market environment and the adjustment of policy orientation; Jensen et al.[27] believe that the increasing relaxation of control also makes innovation more urgent; Lian guang Cui) Et al.[28] studied the cases of logistics innovation carried out by third-party logistics companies in Taiwan, Hong Kong and the mainland, and believed that customer

demand, environmental factors, service expansion and differentiation have made innovation more urgent.

1.2 Research Purpose and Significance

1.2.1 Research Purpose

Technological innovation is the source of enterprise vitality, and innovation is the primary driving force to lead development. China is in the strategic opportunity period of technological innovation. Focusing on the national innovation strategy, promoting the construction of scientific research and technological innovation bases, strengthening the construction of open sharing and service platform of scientific and technological resources for logistics enterprises, accelerating the cultivation of innovative talents and developing innovation space are the important means to seize the innovation opportunities. Logistics enterprises should establish the awareness of "knowledge first" as early as possible and form the competitive advantage of knowledge in order to seize the market share quickly. The main objectives of studying the influencing factors of enterprise technology innovation capability from the perspective of knowledge are as follows：

One is to sort out the condition and trends of relevant theoretical development at home and abroad, to conduct research on the relevance of knowledge and technological innovation, and to construct a conceptual model of the impact of technological

innovation capability of logistics enterprises from both internal and external environment of enterprises.

The other is that, through qualitative description, quantitative analysis and empirical research, we study the influencing factors and improvement measures of technological innovation capability of logistics enterprises under the perspective of knowledge, and reveal the ways and laws of each influencing factor acting on technological innovation capability of logistics enterprises.

1.2.2 Research Significance

（1）Theoretical significance

Most domestic and foreign scholars' researches on technological innovation capability focus on capability evaluation and capability enhancement, but there are not many literature that study the influencing factors of enterprise technological innovation capability from the perspective of knowledge. This study tries to construct a conceptual model of the influencing factors of enterprise technological innovation capability based on knowledge. Grasping the connotation and essence of technological innovation capability, introducing enterprise dynamic capability theory to construct internal and external dynamic mechanism, and dividing knowledge into knowledge innovation and knowledge management, this study tries to enrich the theoretical research system from the above aspects.

（2）Practical significance

China’s logistics industry started late, and enterprises are in a state of growth. There are more problems and questions about the future development, especially in relation to what factors really play a role in the growth of enterprises, and how these factors affect the growth of enterprises, about which many enterprises are also unclear. In order to enable small and medium-sized logistics enterprises to develop continuously, healthily and steadily in the future, it is necessary to help them find out what factors are crucial to the development of enterprises, explore their influence mechanisms, and hope that the conclusions obtained will help logistics enterprises to solve this practical problem, accelerate the process of knowledge for China’s logistics enterprises, better provide services to customers, and thus provide logistics enterprises with some lessons in the process of technological innovation. We hope that these findings will help logistics enterprises to solve this practical problem, to speed up the process of their own knowledge, to provide better services to customers, and to provide some reference for logistics enterprises in the process of technological innovation.

1.3 Thesis Outline

With the research topic of influencing factors of logistics technology innovation ability under the knowledge perspective, the research object is identified by combing the literature review to discover the problems of existing research. Then we organize

relevant theories, construct a conceptual model and propose hypotheses on this basis, and conduct empirical analysis. Finally, countermeasures are proposed to improve the technology innovation capability of logistics enterprises under the knowledge perspective, and the specific contents are divided into five chapters.

Chapter I: Introduction

It describes the background, purpose and significance of the study on the factors influencing logistics technology innovation from the perspective of knowledge, thesis outline, the methodology and research approach, the formulation of the technical route, and the possible innovations of the study.

Chapter II: Theoretical Foundation and Literature Review

The literature related to knowledge, logistics technology innovation and enterprise dynamic capability at home and abroad is collated to understand the current condition of research. Theories related to technological innovation capability, enterprise dynamic capability and knowledge are systematically elaborated to provide theoretical support for the subsequent conceptual model construction.

Chapter III: Research Hypothesis and Model Construction

The research hypothesis of the influencing factors of logistics technology innovation capability under the knowledge perspective is proposed on the basis of theoretical research.The influencing factors are proposed from two dimensions of internal and external environment of enterprises respectively,and the conceptual model

is constructed.

Chapter IV: Empirical Analysis

This chapter first briefly introduces the analysis methods of the empirical study, briefly explains the process of the large sample research and the descriptive statistics of the research data, and uses SPSS22.0 to analyze the reliability and validity of the obtained research data. Then it conducts preliminary tests of the research hypotheses with the help of correlation analysis and uses AMOS23.0 to conduct in-depth analysis of the sample data to determine the specific path-action relationships among the variables and to do the final verification of the research hypotheses. Finally, the empirical research results are discussed and analyzed.

Chapter V: Conclusion and Prospect

Through the results of the empirical analysis, the factors that affect the technological innovation capability of logistics enterprises are found. Based on the actual situation, targeted solutions are proposed, while the shortcomings of this study are inventoried and a brief prospect is made on the future research that can be continued in depth.

1.4 Methodology and Research Approach

1.4.1 Methodology

Adhering to the principle of combining qualitative and quantitative research, the

nature of the research problem is determined through qualitative research, the problem is quantified through quantitative research. The following research methods are mainly used to measure sample data, and describe the relationship of variables.

（1）Literature research

Through collating the literature to form a scientific understanding of the issue under study, we studied the literature related to knowledge and technological innovation capability at home and abroad, sorted out the current status of research on the influencing factors of technological innovation capability based on knowledge, and summarized the contributions and shortcomings of existing literature research. Besides, we built a conceptual model of the influencing factors of technological innovation capability of logistics enterprises under the perspective of knowledge based on the research gap.

（2）Questionnaire

The literature was compiled and analyzed to collect more reliable existing scales and to measure the issues under study by means of controlled measurement items. The knowledge perspective of logistics technology innovation ability influence factor measurement questions were designed, and the initial measurement questions were refined in the pre-exist process, and the formal questionnaire survey was conducted mainly through electronic questionnaire distribution.

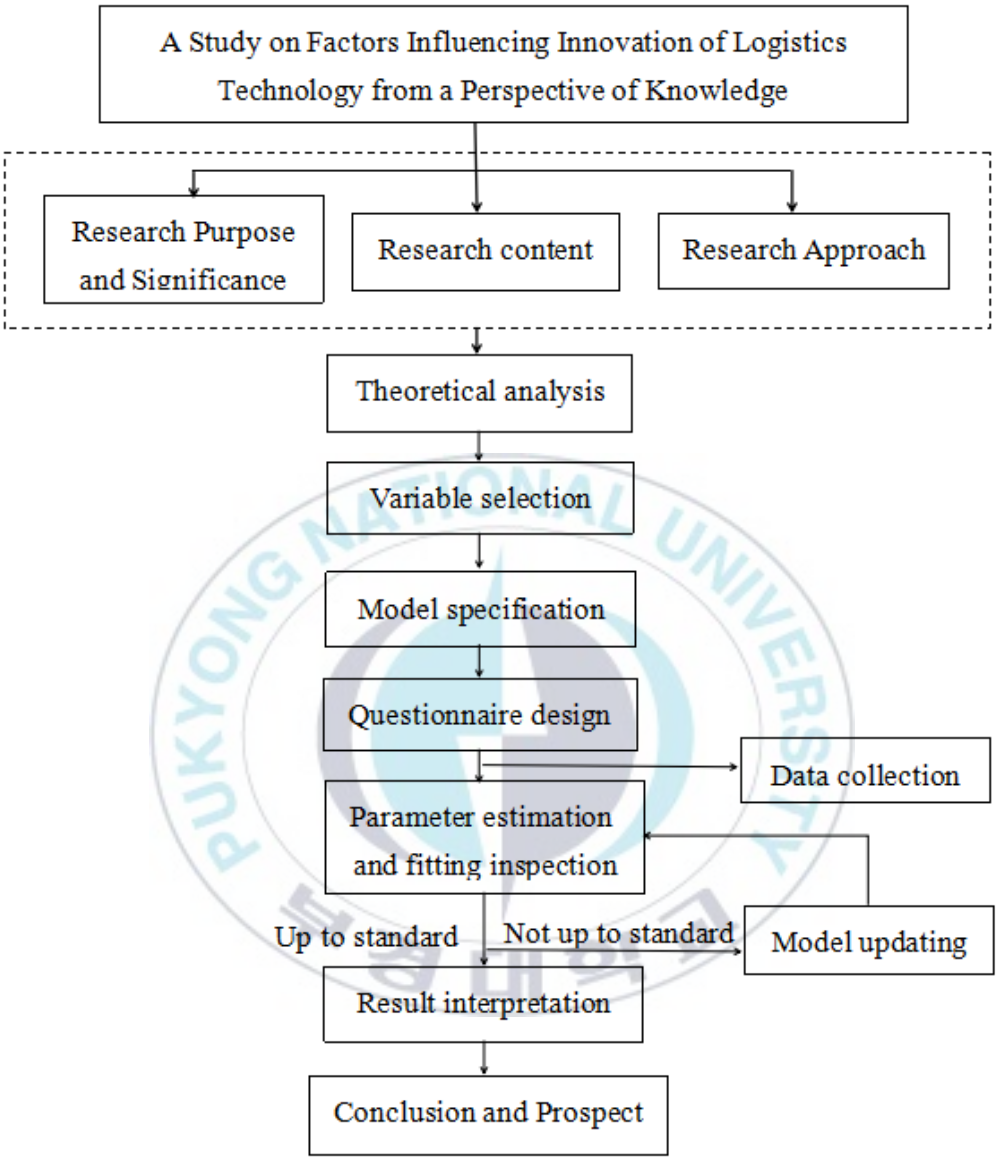
（3）Statistical analysis

Descriptive statistical analysis of sample and variable characteristics was performed using SPSS22.0, and the reliability and validity of the questionnaire items and questionnaire data were analyzed by exploratory and validation factor analysis for the technological innovation capability dimensions. Structural equation models were constructed using AMOS 23.0 to measure the internal consistency of indicators and the fit of variables. Besides, structural equation model testing, path analysis and model revision were conducted.

1.4.2 Research approach

The research approach of this paper is to clarify the research purpose and research significance of the study of technological innovation influencing factors of logistics enterprises from the perspective of knowledge, organize relevant theories, sort out the current situation of domestic and foreign research, propose research hypotheses based on existing research gaps, construct conceptual models and design questionnaires, collect sample data for empirical testing, and draw research conclusions. The research route studied in this paper is as follows:

<Figure 1.4-1> Research route



1.5 Innovative Points

The innovations of this paper are mainly in the following aspects：

Firstly, logistics enterprises are an important carrier and intermediate force for implementing industrial restructuring and technological innovation in China, but there is a relative lack of research on how to enhance the technological innovation capability of logistics enterprises through effective knowledge management and knowledge innovation. This study introduces the theory of dynamic capability of enterprises according to the development characteristics of logistics, and summarizes the factors affecting the technological innovation capability of logistics into two aspects of internal environmental factors and external environmental factors according to the internal and external dynamic mechanisms in the theory of dynamic capability. From the perspective of synergistic development of six factors such as learning ability, technical talents, company size, organization, Information facility, policy environment, it establishes a model of the influence mechanism of logistics technology innovation capability from the perspectives of internal driver construction and dynamic capability development of knowledge management and knowledge innovation. It finds the intrinsic catalysts for logistics industry to realize technological innovation, and realizes the innovative application of knowledge management and knowledge innovation in the development practice of China’s logistics industry while enriching the existing theoretical research results of technological innovation.

Secondly, technological innovation capability of logistics is the sum of the vector of innovation capabilities of logistics enterprises in each stage of technological innovation process. This study takes knowledge as the core concern, and then constructs a model of the influencing factors of technological innovation capability in logistics industry based on knowledge perspective. The research conclusion shows that the internal and external driving forces of technological innovation indirectly promote the improvement of logistics technological innovation capability through acting on knowledge management and knowledge innovation, and the organic integration of this direct role and indirect influence forms the dynamic development mechanism of technological innovation capability of logistics enterprises, and determines the mode, speed, process and effectiveness of enterprise technology innovation. Knowledge innovation and management are influenced by many factors in the internal and external environment of enterprises, and they in turn act on logistics technology innovation capability, and there is little research on the mechanism of action among the three by domestic scholars.

Thirdly, this study uses SPSS22.0 and AMOS23.0 tools for empirical analysis on the basis of questionnaire survey to break through the limitation that most current studies focus only on theoretical analysis and case study analysis, and find out the internal driving forces of knowledge management and innovation of logistics enterprises as well as the role relationship and influence paths among various

dimensions of technological innovation capability. The results of the empirical validation help analyze the key paths and concerns of the dynamic development process of enterprise knowledge management and innovation in the accumulation and enhancement of technological innovation capability of enterprises, and provide a more reliable theoretical basis for logistics enterprises to cultivate and develop the dynamic capability of knowledge management and knowledge innovation and thus promote the development of technological innovation capability.

II. Theoretical Foundations and Literature Review

2.1 Theory of Technological Innovation

2.1.1 Technological Innovation

Joseph Schumpeter (1912) considered innovation as the recombination and configuration of factors of production, where a factor of production and corresponding production conditions that first appeared are configured in a completely new ratio, resulting in a dramatic change in production methods and an increase in production capacity[29]. Technological innovation refers to the activities of enterprises that put new technologies into practice by adopting new production methods and business models to enhance product quality and efficiency or develop new products in order to occupy the market and obtain economic benefits. Technological innovation theory is divided into the following schools of thought.

（1）New classical School

The new classical school believes that the market mechanism usually cannot guarantee the optimal allocation of social resources in economic activities, and there are “market failures” in the process of technological innovation. The market failure needs government intervention and regulation to compensate for it, so as to ensure the efficiency and level of technological innovation and maximize the overall benefit of

society. Robert Solow, a representative of the neoclassical school, used Solow's residual method to calculate and found that more than 80% of the total output value of the U.S. manufacturing industry between 1909 and 1949 was the result of technological progress, and this algorithm was later widely used to measure the performance of technological innovation[30]. The neoclassical school is concerned with the failure of market regulation in the allocation of resources for technological innovation and the role of technological innovation on economic growth, and believes that the market mechanism can make the operational effect of technological innovation in the market reach an economically rational and good state.

（2）Neo-Schumpeterian School

The neo-Schumpeterian School considers technological innovation as a complex process in which market factors interact and act in an integrated manner, and studies the application of new technologies in depth from the perspective of the technological innovation process. Edwin Mansfield, a representative of the neo-Schumpeterian school, studied the application of new technologies in depth, analyzed the economic factors that affect the degree of application of new technologies within enterprises, and established a model for the diffusion of new technologies[31]. Morton Kamien and Nancy Schwartz studied the relationship between technological innovation and market structure from the perspective of monopoly and competition, trying to establish an optimal market structure model to promote technological innovation[32][33]. The neo-

Schumpeterian school focuses on the source of innovation, the process of innovation and the operation of innovation methods, and constructs a primary theoretical framework of technological innovation.

（3）School system innovation

The school system innovation believes that a system that effectively motivates individuals is the key to promoting technological innovation, and that such a system represents a mechanism that can govern the ownership of a certain amount of social resources, in which the social and private rates of return for each activity are close to equal; that changes in the scope of property rights definition can lead to institutional changes, so that the emergence and development of new technologies must be accompanied by the birth of a systematic property rights system; and that, with each individual's proprietary rights are clearly defined and effectively protected by the entire social ownership system, the risks of innovation will be reduced and the interests of inventors ensured[34]. The school of institutional innovation applies institutional theory to innovation theory and deeply studies the influence of social institutions on economic growth, which is an enrichment and development of the original innovation ideas.

（4） The national innovation system theory schools

The national innovation system school believes that the state is the most important force in promoting technological innovation, and that the various innovation agents in society interact in the national institutional system to promote the introduction, transfer

and application of knowledge and enhance the overall level of national innovation. Richard Nelson believes that the national innovation system includes various factors and involves various social agents, emphasizing that technological change should be adapted to the institutional structural context and that the institutional arrangements in national innovation system should be flexible and elastic[35]. The national innovation system theory is a guide for how the government can stimulate the interaction of social innovation agents such as enterprises, universities, and research institutes through policies to accelerate the development and application of technological innovation.

2.1.2 Technology innovation capability

Technological innovation capability is the ability of a company to reassemble and effectively integrate information and knowledge using communication, management, and information technologies, and in the process gain technology, knowledge, and practical experience[36].

Foreign scholars' research on technological innovation capability mainly focuses on the research and empirical analysis process of factors influencing technological innovation. Burgelaman (1998), based on the organizational behavior viewpoint, argues that the technological innovation capability of an enterprise is expressed as the ability of the enterprise to demonstrate in strategic planning, structural adjustment, resource allocation, and corporate culture shaping[37]. Barton (1995) argues that the

work quality and professional skills of employees are crucial to the enhancement of technological innovation capability of enterprises; in addition, the strategic layout, learning ability, and technological awareness of enterprises are also important[38]. Mulherin, Boone (2000) found through empirical research that enterprise size and technological innovation capability do not always vary positively, and that larger enterprises are often inferior to small enterprises in terms of innovative incentive systems, information transfer speed and enforcement[39]. Heimonen (2012) used intellectual property data to study the relationship between R&D investment and enterprises' technological innovation capability and found that the increase in R&D investment strength has a significant effect on enterprises' technological innovation capability[40].

Domestic scholars mainly focus on the construction and improvement of the evaluation index system and the countermeasures to improve technological innovation capability. Wu Fuxiang and Zhou Shaodong (2006) classified industrial enterprises and analyzed the different performance of different types of enterprises in technological innovation and product innovation, and found that either too fierce or lax market competition would hinder the enhancement of technological innovation capability of enterprises[41]. According to Zhang Gang and Bo Qiushi (2009), the content and nature of technological innovation differ in different environments and organizational structures, and the role between corporate culture and technological innovation

capability is significant, and the development of corporate culture adapted to technological innovation is what can drive enterprises to improve their innovation capability[42]. Sun Yutao and Li Miao (2013) analyzed data from a sample of listed companies in China's emerging industries and found that excellent geographic location can help regional emerging industry enterprises improve their technological innovation capabilities, while foreign investment in the region can inhibit local enterprises from fostering technological innovation capabilities[43]. Li Yue, Zhang Yuting and Guo Hang et al. (2017) systematically analyzed the factors affecting the technological innovation capability of enterprises and constructed an evaluation index system for technological innovation capability considering R&D investment, main body synergy, R&D output and innovation environment[44].

2.1.3 Logistics technology innovation capability

Studies on the influencing factors of logistics innovation have mainly stated their respective views in a listing manner. Lin Jieyu[45] (2006), when studying the influencing factors of technological innovation of logistics service providers in Taiwan, China, concluded that the influencing factors can be divided into three categories, i.e., technology-based factors, organizational factors, and environmental factors, and also concluded that logistics service providers would innovate logistics accordingly according to market changes and government attitudes, etc. Autry[46] et al. (2008) and

Flint[47] et al. (2008) pointed out that there is a correlation between knowledge (development of supply chain knowledge) and logistics innovation, and empirically showed that supply chain learning has a significant contribution to logistics innovation. Lichtenthaler[48] (2009) found through his study that learning ability affects both innovation and R&D, i.e., through the digestion and absorption of external knowledge, the hindrance of third-party knowledge spillover to innovation can be reduced. Cui Lianguang[49] et al. (2012), by studying the cases of logistics innovation conducted by third-party logistics enterprises in China, pointed out that customer demand, environmental elements, servitization, and differentiation are important influencing factors of logistics innovation. Wagner[50] (2012) studied that logistics service providers should integrate with customers and closely contact new service demanders, and pointed out that targeted investment and benefit sharing system have corporate innovation has a significant impact and argues that service innovation is an important source for logistics service providers to gain competitive advantage in the market. In the next study, Wagner[51] (2013) found that enterprises with borderless organizations and emphasis on introducing and absorbing external knowledge are more conducive to innovation, and pointed out that customers, suppliers, and competitors all contribute to the improvement of service quality in logistics enterprises. Daugherty[52] et al. (2011), in their study of the influencing factors of the innovation capability of corporate logistics services, found that organizational structure of decentralization and

standardization both positively contribute to enterprise logistics service innovation, while the effect of specialization on logistics service innovation is not significant. Grawe[53] et al. (2014) found that social capital and knowledge integration can strongly promote logistics innovation when studying the effect of introducing partner employees on service innovation in logistics enterprises. Wang Xuhui[54] et al. (2010), in their study of the factors influencing the autonomous innovation capability of local logistics enterprises in China, pointed out that there is a positive influence of the developed degree of regional foreign-owned logistics industry, enterprise size, enterprise learning ability and human resource quality on the autonomous innovation capability of logistics enterprises. Du Hongping[55] et al. (2011) pointed out in the study of core competitiveness of logistics enterprises that the innovation of logistics enterprises should focus on several factors such as logistics concept and system, logistics service, logistics technology and logistics organization, and emphasized that logistics technology is the focus among them. Wei Jigang[56] (2014) pointed out that in the "Internet+" environment, the transformation and upgrading of the logistics industry must rely on technology and institutional innovation, and the innovation of both must focus on the market structure, government laws and regulations, innovation system, investment and financing system. Yang Shenyan[57] (2014) in the study of logistics service innovation in the Internet of Things environment pointed out that the three core technologies of sensing technology, network technology and information processing

technology of the Internet of Things are gradually being emphasized and used in logistics operations, which greatly stimulates logistics service innovation, and also emphasized that the Internet of Things technology affects almost all of the logistics system such as transportation, storage, packaging, distribution processing, information services, etc. unit. Liu Jingyan[58] et al. (2015) pointed out that in the new economic form of "Internet+" environment, the lack of logistics high-end management personnel and the high cost of using social infrastructure have brought huge challenges to the logistics industry, and the innovative development of the logistics industry must fully consider the integration of resources, marketing strategies, logistics information technology and the use of big data, cloud computing, IoT, etc. data, cloud computing, Internet of Things and other technologies as the support of intelligent logistics information service platform and other key factors. Hu Yue[59] (2015) pointed out that under the current rapid development of information technology, logistics management innovation becomes very important, and government laws and regulations, logistics infrastructure, logistics management personnel, and enterprise innovation system are important influencing factors for logistics management innovation.

2.2 Dynamic capabilities theory

2.2.1 Connotation of dynamic capability

Teece and Pisano (1994) introduced the "dynamic" viewpoint into the study of

enterprise capability for the first time, and believed that enterprise dynamic capability is the ability of enterprises to integrate, construct and reconstruct their own internal and external capabilities in order to adapt to the rapid changes in the environment[60]. The dynamic capability view represented by Teece believes that dynamic capabilities are influenced by market stability, and the dynamic capability of an enterprise varies inversely with market stability. Jiang Jihai, and Liu Min (2014) believe that dynamic capabilities are the ability of enterprises to manage their internal operating mechanisms, and the renewal of operational capabilities is beneficial to maintain the original or create new competitive advantages[61].

2.2.2 Formation mechanism of Dynamic capability

Dynamic capability theory asserts that an enterprise's resources and capabilities change in response to changes in the environment, and that enterprises should exploit market opportunities derived from dynamic environments to develop new sources of creating and sustaining competitive advantage. Emphasis is placed on the dynamic efficiency of the enterprise, which provides a long-term basis for the enterprise to maintain competitive advantage through the continuous creation of new rules and capabilities. The driving mechanism of innovation is composed of internal and external sources; one is the driving force from within the enterprise, where the vision and aspiration of the enterprise to initiate innovation determine the degree and process of

capability change; the other is the driving force from outside the enterprise, where the driving force of the external environment directs the change of the enterprise's capability.

（1）Internal motivation mechanism

Endogenous factors are the fundamental reason for the development of things, and the decisive force for enterprise development and capacity improvement comes from within the enterprise. The internal power mechanism of the enterprise is formed by the organic structure of various elements, and the function of the internal power mechanism requires the unified and coordinated operation and comprehensive effect of various power elements such as innovation element, right element and incentive element. In particular, the innovation element is the core element in the internal power mechanism of the enterprise, and the innovation subject and innovation resources provide the necessary endogenous power for technological innovation activities.

（2）External power mechanism

External motivation is the external dynamic factors of enterprises that guide and promote the innovation ability of enterprises to be improved. Innovation factors also occupy an important position in the external motivation mechanism of enterprises. Enterprises are influenced by political, economic and social factors in the external environment in the market competition, and opportunities and environment are the external motivation factors essential for technological innovation activities. The social

system, government policies, industry rules, market opportunities, and cultural background in the external environment of enterprises are important factors affecting technological innovation.

2.3 Theories Related to Knowledge Innovation and Knowledge Management

2.3.1 Interpretation of knowledge

Knowledge is the understanding and experience that people gain in practice and are able to identify what is and is not the entity and nature of all things, and there have been many attempts to define knowledge formally by philosophers in Greek and Roman times. There are three main perspectives on the definition and explanation of knowledge today, namely, philosophical perspective, cognitive-psychological perspective, and information processing perspective. From the philosophical perspective, knowledge, as the knowledge of the properties and connections of things, emphasizes the subjective reflection of the objective world. It is usually in the form of perceptions, representations, concepts, laws, etc., and in the content manifests as the concrete reflection of the properties and connections of objective things, which is reflected in two forms: people's perceptual feeling and rational thinking. From the perspective of cognitive psychology, knowledge is a perceptual construction resulting from the mutual exchange between the subject and the environment, thinking and the

object, and knowledge is not a copy of the object, nor is it an a priori consciousness determined by the subject. From the perspective of information processing, knowledge is the information acquired by the subject through interaction with its environment and its organization and integration of information.

Based on different research perspectives, there are different definitions and understandings of knowledge. *Wechsler's Dictionary* (Webster 1997) defines knowledge as the knowledge of implementation or state obtained by practice, research, connection, investigation, etc., the understanding of science, art, or technology, and includes the sum of the knowledge of truths and principles acquired by human beings. *The Modern Chinese Dictionary* (2002 supplement) explains knowledge as the synthesis of understanding and experience acquired by people in the practice of transforming the world. Sowa (1984) considers knowledge as an implicit or explicit description of the objective objects, operations, relations, general or specific enlightening or inferential processes involved[62]. Woolf (1990) argues that knowledge is the activity and process of organizing information efficiently so that it can be used to solve problems[63]. Turan (1992) considers knowledge as information that is organized and analyzed to be understood by people and applied to solve problems and make decisions[64]. Wiig (1993) in his study states that knowledge includes some facts, beliefs, opinions, ideas, judgments, expectations, methodologies, and other practical knowledge[65]. Drucker (1993) considers knowledge as a kind of information that can

change some people or some things, and the use of information makes individuals or organizations capable of making changes or adopting more effective ways of behavior[66]. Nonaka (1994) considers knowledge as verified true beliefs and interpersonal dynamic processes that verify that individual beliefs are close to the truth[67]. Davenport & Prusak (1998) stated that knowledge is a fluid mixture of framed experiences, values, contextualized information, and professional insight that provides a framework for evaluating and integrating new experiences and information that originates in the human brain and is used in the human brain[68]. Johannessen (1999) considered knowledge to be for a specific purpose systematized and structured information[69]. On the relationship between knowledge and the enterprise, Spender (1996) proposed that knowledge is an important source of market value for the enterprise and that the enterprise is essentially a body of knowledge about its environment, resources, mechanisms, goals, attitudes, and policies that are integrated[70]. Grant (1996) argued that the enterprise must be viewed as a body of knowledge and managed from the perspective of knowledge management[71].

2.3.2 Knowledge Innovation Theory

Knowledge innovation is the process of people concretizing their intuition, experience, creativity or inspiration into new knowledge, and the realization of knowledge innovation makes knowledge eventually transform from conceptual

existence to practical existence. The knowledge innovation referred to in this paper is the process of creating, evolving, communicating new ideas and applying them to marketable products or services.

We know that no matter for individuals, teams or enterprise organizations, having knowledge is not equal to having material wealth, and the real value of knowledge does not lie in how to acquire knowledge or how much knowledge is owned, but in how to innovate knowledge. For knowledge innovation, Amidon (1993) first proposed the concept of knowledge innovation, and he pointed out that the purpose of knowledge innovation is to transform various creative ideas into marketable products and services through the creation, dissemination and application of knowledge, so as to promote enterprises to achieve operational success and national economic revitalization and prosperity[72]. Drucker (1993) believed that knowledge innovation is the act of endowing knowledge resources with new wealth-creating capabilities, an interpretation that includes both the idea that knowledge is mobile and can create new value[66]. Nonaka (1994) believes that knowledge sharing is the first stage of knowledge innovation. Organizations themselves cannot create knowledge. Only after the knowledge wealth possessed by organization members is shared, discussed, and analyzed in the collective can the knowledge innovation ability of the organization or community be stimulated. In his SECI knowledge creation spiral model, Nonaka pointed out that knowledge creation is a continuous process of creating new tacit and

explicit knowledge within and among enterprises, and enterprises' tacit knowledge and explicit knowledge realize mutual transformation through four ways of social externalization, synthesis and internalization, and continuously create new knowledge, in which enterprises have to create a good enterprise organizational environment to provide support and guarantee for knowledge innovation[67]. Zander's (1995) study pointed out that knowledge innovation is a dynamic process in which tacit knowledge and explicit knowledge continuously transform each other and continue to function, and enterprise employees must express various new knowledge they have obtained clearly, combine and aggregate these new knowledge and original knowledge in a timely manner, and share them effectively with other employees or departments in order to create more new knowledge[73]. Petrash (1996) proposed a knowledge innovation system consisting of human capital, organizational capital and customer capital, where human capital is the knowledge owned and generated by each employee; organizational capital is the various knowledge of the enterprise in the form of institutionalized organizational structure, organizational processes, and organizational culture; and customer capital refers to the concept of value acquired in the process of providing goods and services to customers, and enhancing the intersection and integration among these three types of knowledge resources as much as possible will be effective in promote the creation of new value spaces for enterprises[74]. In addition, other scholars have studied the role of supporting knowledge innovation from the

perspective of information technology and tool development and utilization. Jan Duffy (2000) found that people mainly follow two clues, knowledge innovation process and knowledge development cycle, to develop information technology tools that contribute to knowledge innovation. The first clue helps people use IT tools to promote the interaction and transformation between explicit and tacit knowledge to enhance knowledge innovation; the second clue helps people develop and integrate applicable IT tools to support knowledge innovation and help enterprises gain maximum competitive advantage [75].

For enterprises, knowledge innovation can be divided into two ways: the full utilization of existing knowledge and the exploration and creation of new knowledge. Knowledge innovation by utilizing existing knowledge is mostly suitable for relatively mature enterprises, which are more concerned with efficiency improvement and cost reduction. The external environment in which the enterprises are located is relatively stable, the product life cycle is long, and there is a lack of breakthrough development opportunities for new technology and new products in the industry. On the other hand, knowledge innovation oriented on exploring new knowledge is suitable for products and technologies that are not yet mature and stable, and there is a large breakthrough development space. The external environment faced by enterprises is unpredictable, the product life cycle is shortened, and the focus of competitive advantage is to quickly seize market opportunities, and enterprises are required to constantly pursue self-

transcendence and rely on effective innovation in products and technologies to achieve outstanding advantages ahead of competitors. Knowledge innovation focusing on the creation of new knowledge is more suitable for the knowledge management and innovation development needs of logistics enterprises.

2.3.3 Knowledge Management Theory

Despite the long history of exploration of the nature of knowledge, it has not been long since knowledge management really emerged and developed as an emerging discipline in the field of management. The concept of knowledge management was first introduced by the United Nations International Labor Organization at the European Management Conference in 1986. Drucker began using the concept of knowledge management in 1988. The first article related to knowledge management was published in *Sloan Management Review* in 1989. Nonaka published his famous "Company" in *Harvard Business Review* in 1991. With the emergence of research results on knowledge management by renowned scholars such as Nonaka, Wiig, Davenport, Stewart, etc., in the following decade or so, academics have successively launched in-depth research exploration on knowledge management from different research perspectives and internal logic, such as principles, techniques, influencing factors, activity processes, performance evaluation, and legal environment of knowledge management. A large number of research results have emerged, and the theory and

practice of knowledge management have developed rapidly. According to Bartezzaghi et al (1997), knowledge management, as an emerging research hotspot in academia, is a series of implementation activities at the micro level of an organization, including knowledge diffusion, knowledge application and organizational learning, which are carried out at the organizational and project levels and influence each other[76]. According to Yogesh (1998), knowledge management is a dynamic process that continuously seeks to combine the creativity and change capabilities of organization members with the information processing capabilities used by the organization in order to improve the adaptive, competitive, and creative capabilities of the organization in the face of the increasing and discrete evolution of the internal and external environment, and the essence of this process is to seek to combine the creative capabilities of people with the information processing capabilities[77]. Alavi &Leidner (2001) argue that knowledge management helps companies win by discovering and exploiting knowledge in the organization in terms of both its role and processes, involving four distinct and intersecting knowledge processes: knowledge storage/retrieval, knowledge transfer, knowledge sharing, and knowledge utilization[78]. Abeeker & Decker (1999), from the perspective of knowledge management process, consider knowledge management as the identification, acquisition, development, decomposition, use and storage of organizational knowledge[79]. O'Dell & Gtayson (1998) propose that knowledge management consists of knowledge creation,

identification, collection, classification and storage, sharing and access, use, improvement and elimination, and is an ongoing process of transferring knowledge in a timely manner to help organizational members take the right actions to enhance organizational performance[80]. Nerney (1997) believes that knowledge management is a process of creating good performance by influencing employees' work attitudes and behaviors, establishing an open and trusting internal environment of the enterprise, so that employees can voluntarily cooperate and share and develop knowledge resources to accomplish goals and tasks[81]. According to Carl (1998), knowledge management is the use of collective wisdom to improve organizational resilience and innovation, and he proposed that knowledge management consists of four inherent functions of knowledge externalization, knowledge internalization, knowledge mediation, and knowledge cognition, which are interchangeable. In particular, externalization is the effective organization of knowledge acquired from outside the organization according to certain criteria; internalization refers to the effective transfer of knowledge; the purpose of intermediation is to find the best source of knowledge for knowledge users; and cognition is the effective application of the knowledge acquired in the above three ways[82]. International research on knowledge management has formed several learning schools after nearly three decades of development from theoretical proposal to practical application. The domestic research on knowledge management has more often introduced the basic concepts and theories of knowledge management, while some

scholars have innovatively explained knowledge management and improved and revised the process model of knowledge management from different perspectives.

Qiu Junping (2000) pointed out that knowledge management in a narrow sense focuses on the management of knowledge itself, which is permeated in the acquisition, processing, storage, dissemination and application of knowledge; while in a broad sense, knowledge management also includes the all-round and whole-process management of various knowledge-related resources such as organizations, personnel, facilities, assets and activities[83]. Xi Jinghua (2003) considered knowledge management as the use of information technology to help enterprise organizations and individual employees achieve knowledge acquisition, sharing, integration, and application, and then form knowledge advantages and create value in terms of goals, tasks, and performance[84]. He Jinsheng et al. (2004) argued that knowledge management incorporates multiple tasks such as knowledge classification, identification, acquisition, coding, storage, sharing, dissemination, integration, application and evaluation, and the effect of knowledge management is influenced by multiple factors such as organizational culture, participants, knowledge technology, organizational learning, organizational strategy and knowledge management strategy[85]. Gu Liping (2004) argued that knowledge management is a dynamic process of effectively mining and capturing the collective knowledge and skills in an organization as well as the internal and external knowledge, experience and skills

required by that organization, and distributing these knowledge, skills and experiences in a way that can help business organizations achieve their maximum output[86]. Qin Yuanjian et al. (2006) considered all activities related to encouraging and facilitating people to apply, absorb, transfer, and share knowledge to achieve individual or organizational goals as knowledge management[87]. Li Jingwen and Ren Ling (2009) believe that knowledge management is the management of knowledge including the creation, acquisition, processing, storage, dissemination and application of knowledge, but also the management of various resources and intangible assets related to knowledge, and involves the all-round and whole-process management of knowledge organization, information technology, knowledge assets, corporate culture and knowledge personnel[88]. Academics at home and abroad have researched knowledge management from different perspectives and directions, and put forward views and insights with different emphases. For enterprises, the essence of knowledge management is the activity process and operation mechanism of acquiring, accumulating, integrating, absorbing and applying knowledge resources to realize the intrinsic value of knowledge. Combining the read literature and the operation practice of logistics enterprises, the knowledge management referred to in this paper can be refined as the process of identifying, acquiring, integrating and absorbing the existing knowledge resources of logistics enterprises.

To sum up, knowledge innovation is realized in the dynamic process of knowledge

management. In this dynamic process, each stage is not connected linearly in sequence, but has cross-fertilization with each other, and each stage contains the activities of other stages. Knowledge innovation is the organic unification of process and result. The dynamic cycle of knowledge management and knowledge innovation is essentially the process embodiment of the accumulation and development of technological innovation capability of enterprises.

III. Research Hypothesis and Model Construction

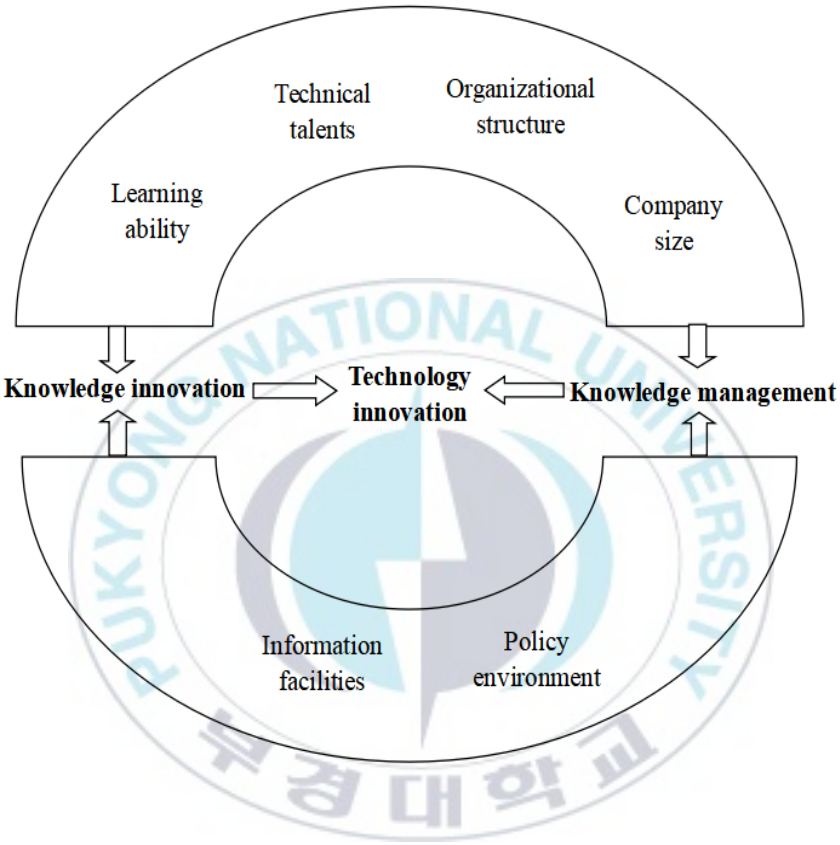
3.1 Definition of Variables and Research Hypothesis

The logistics industry has natural characteristics of sharing economy, and shared logistics is essentially the sharing of logistics resources of the whole society. In recent years, the logistics industry has begun to show the trend of secondary use of personal resources, cross-border sharing of industry resources, external export of enterprise resources, and deep exploration of social resources. Under the development mode of shared logistics, technological innovation activities of enterprises can be applied on a large scale in the whole industry, and cost reduction and efficiency increase can be achieved through technological innovation, which plays an important role in promoting the transformation and upgrading of the logistics industry. The technological innovation capability of logistics enterprises is influenced by a variety of factors in their own conditions and social environment, and this paper will consider the influencing factors of technological innovation capability from two aspects: the internal environment and external environment of logistics enterprises.

The implementation of knowledge management and knowledge innovation requires a series of relevant factors to support. An enterprise is an open organizational system, in which people, as the main body of the dynamic process of knowledge

management, have to build corresponding organizational structures, use various information technology means to enhance learning ability, and rely on the support of technical talents, the guidance of corporate culture and the stimulation of incentive mechanisms to achieve cooperation and synergy with the external environment. Thus, a dynamic, developed and effective knowledge innovation and knowledge management system is formed to promote and maintain the dynamic cycle and development evolution of enterprise technology innovation. Based on the theory of dynamic capability, we analyze the factors affecting logistics technology innovation from the perspective of dynamic factors, and establish the process of influencing factors of logistics technology innovation based on dynamic capability, as shown in <Figure 3.1-1>.

<Figure 3.1-1> Process of factors influencing innovation of logistics technology based on dynamic capabilities theory



As long as an organization can exist forever, there is no end to the identification and acquisition of knowledge, knowledge integration, knowledge absorption and knowledge innovation, and technological innovation. Acquiring in identification, integrating in acquisition, absorbing in integration and innovating in absorption, the dynamic movement of knowledge will always accompany the growth, inheritance and development of enterprises.

3.1.1 Internal environment of the enterprise

（1）Learning ability

Learning capability refers to the ability of each member of an enterprise to transfer and create knowledge through timely acquisition, comprehensive mastery, rapid communication and consensus on information in the internal and external environment in which the enterprise is located, thus enhancing the competitive ability of the enterprise and maintaining its competitive advantage in the knowledge economy. Prahalad, Hamel (1999) argued that the formation of an enterprise's core competitiveness is a process of knowledge and technology coordinated use process and the result of cumulative organizational learning, and that the enhancement of corporate learning capabilities is conducive to improving technological innovation performance and is the main driver of corporate development[89]. Lane, Koka, and Pathak (2006) analyzed in detail 289 literatures related to the topic of knowledge absorption capacity in 14 journals, obtained five key hypothesis-driven studies in the field, and proposed an organizational learning process model of "exploration - transformation - development", which describes the acquisition process of intellectual property rights[90]. Lichtenthale (2009) conducted a survey of 175 employees in industrial enterprises and found that there is a complementary effect between exploratory, transformative and exploitative learning and enterprise technological innovation. Improving absorptive capacity helps enterprises profit from external knowledge and emphasizes the

importance of enterprise dynamic capabilities in a highly volatile technology and market environment[91]. Ren Shengze and Xuan Guoliang (2006) analyzed Nokia's learning strategy from the perspective of patent alliances and found that Nokia is good at joint patent development and patent cooperation with domestic and foreign enterprises, research institutions and universities, learning from advanced experiences and technologies in the industry, actively conducting internal knowledge transfer and learning, and maintaining technological continuity, which makes its own patent technology development and application capabilities soar[92]. Xue Yuanhao and Wang Chongming (2014) constructed an intellectual property strategy (IPS) framework based on organizational learning theory, and conducted content analysis on case data of 35 IP demonstration enterprises, and found that there exists an irreplaceable role of organizational learning in improving the acquisition, maintenance and operation of IP in the knowledge economy[93]. Liu Jing, Zhan Shaowen, and Wang Min (2018) constructed a theoretical framework of factors influencing intellectual property capability of cultural and creative enterprises at the level of resources, capabilities, and environment, and conducted a questionnaire survey and empirical study of 142 cultural and creative enterprises in Xi'an using factor analysis and multiple regression analysis, and found that organizational learning capability has a significant contribution to intellectual property capability[94]. Upstream and downstream enterprises of logistics supply chain essentially constitute a learning system of knowledge acquisition, sharing

and application, and the improvement of learning ability is conducive to the overall value enhancement of the whole chain and scope of logistics supply chain.

Argyris & Schon (1996) argue that learning capability allows organizations to increase their ability to innovate[95]. Mabey & Salaman (1995) argue that learning capability is a major factor in sustaining innovation in organizations[96]. McAdam (2000) learning capability leads organizational innovation. This is especially true in knowledge-intensive industries, where the learning capability of an organization affects not only the initial phase of innovation but also the execution phase of innovation[97]. Wei Jiang (2002) proposed that the essence of technological capability is knowledge, and the acquisition of technological capability of enterprises is a learning process that integrates knowledge accumulation and knowledge application[98]. While improving the stock of organizational knowledge, enterprises continuously improve their technological capability and the evolution of enterprise knowledge through learning, and activate the acquired and owned knowledge to improve technological capability, and this learning process is closely accompanied by knowledge management. Cohen & Levinthal (1989) pointed out that the learning capability of an organization is essentially the ability to identify, absorption, digestion and exploitation of knowledge[99]. Chen Guoquan (2000) and Sun Xiaoqiang (2007) proposed that knowledge management runs through the whole process of organizational learning, and the process of organizational learning is a process of continuous accumulation,

transformation and sharing of knowledge, and the process of knowledge management is the process of organizational learning[100][101]. Learning capability is the competence of an organization to develop and tap the required knowledge and skills, and adapt to the development environment through imitation, improvement and creation of knowledge.

In summary, the following hypotheses are proposed:

H1a: Learning ability significantly and positively affects knowledge innovation in logistics enterprises.

H1b: Learning ability significantly and positively affects knowledge management in logistics enterprises.

<Table 3.1-1> Definition of Learning Ability

Variable	Definition	Reference source
Learning ability	The ability to transfer and create knowledge can be realized through the timely acquisition, comprehensive comprehension, rapid communication and information consensus from the internal and external environment by the members in the logistics enterprises.	Goh、Richards(1997)[102]; Prshalad、Hamel(1999)[89]; Chen guoquan、Zhang zhongxin、Zheng xiaoming(2014)[103]; Zhang huiyan、Qin yao、Wu jihong(2015)[104]

（2）Technical talents

Technical talents not only include highly qualified technicians, but also enterprise managers who have innovative talents in management. They work in the first line of production, service and management, help enterprises accumulate knowledge and management experience in progressive technological innovation, and play a role that cannot be replaced by other talents. People are the main body of knowledge innovation, and knowledge resources can only be truly effective when combined with people and their work. The generation and formation of new knowledge in enterprises is a complex collaborative process, which requires the cooperation and collaboration of multiple departments and personnel. Knowledge innovation at the individual level of enterprise employees is the basis for enterprises to realize knowledge innovation at the team level and at the overall organizational level. Leigh Branham (2004) argues that technical talents are those who are rare and hard to find for enterprises, difficult to be replaced by other human beings, and play a key role in the success of enterprise technological innovation[105]. Guo Weigang (2006) argues that core technical personnel are different from ordinary employees who follow established rules and do a lot of repetitive work, they have more specialized knowledge and skills and are more costly to train; therefore, companies require them to take on the responsibility of mastering core knowledge and skills and actively participating in R&D and innovation activities in order to improve innovation [106]. Wu Yang (2009) proposed that the accumulation of individual

knowledge forms the knowledge structure, individual knowledge structure promotes organizational learning and establishes a creative thinking framework, the richness of individual knowledge accumulation influences the desire for individual knowledge innovation and the formation of creative thinking and makes organizational learning richer, while individual personality motivation, innovation motivation and creative thinking motivate people to actively seek relevant knowledge and innovative skills, frequent organizational learning and communication, innovative cultural atmosphere, and useful external information and demands can stimulate members' desire for knowledge innovation and the presentation of creative thinking[107]. Both knowledge innovation and knowledge management activities of enterprises require the participation of talents. The technical personnel, who are the main movers, play a leading role in knowledge innovation and knowledge management activities[108].

Therefore, the following hypotheses are proposed in this paper.

H2a: Technical talents significantly and positively influence knowledge innovation in logistics enterprises.

H2b: Technical talents significantly and positively affects knowledge management in logistics enterprises.

<Table 3.1-2> Definition of Technical Talents

Variable	Definition	Reference source
Technical talents	The professionals engaging in technical management and R&D who can grasp the pertinent technologies and knowledge of each link of logistics.	Liu fang(2009)[109]、Zhang jimin(2003)[110]

（3）Company size

The Company size is a definition of the scope of its production operations and represents the concentration of labor resources, means of production, products or services in the company. Schumpeter (1942) argues that company size varies positively with the company's technological innovation performance and that larger company have a greater capacity for technological innovation[111]. The larger the size of an company means more external network relationships, more resources embedded in network relationships, and richer knowledge resources that may be accessed externally. Rowley et al[112] concluded that the more external partners an company has, the more opportunities an company has to evaluate external information, and thus the richer awareness of external information access. The richer the company's knowledge of external information, the higher the success rate of the company's innovation. The larger the scale of an company, the more resources embedded in its external relationships, the easier it is to obtain various resources needed for survival and development; and knowledge sharing provides opportunities for learning, exchange, and cooperation among each other and stimulates innovation of company

knowledge[113]. Compared with smaller company, large company tend to invest more energy in knowledge activation activities. In the knowledge transformation phase, large companies have more organizational resources to integrate activated knowledge with existing knowledge (Garud & Nayyar, 1994)[114]. Large companies are able to better understand the connection between stored knowledge and current tasks, overcome bottlenecks in knowledge flow and integration between different areas of expertise, and complete the transformation of activated knowledge, which in turn solves problems in innovation or captures business opportunities (McIver et al., 2013)[115]. In summary, the following hypotheses are proposed:

H3a: Company size significantly and positively affects knowledge innovation in logistics enterprises.

H3b: Company size significantly and positively affects knowledge management in logistics enterprises.

<Table 3.1-3> Definition of Company Size

Variable	Definition	Reference source
Company size	The definition of the production and business scope of logistics enterprises, representing the level of intensity for the labor resource information, products or services in enterprises.	Vossen(1998)[116]; Brouwer、Kleinknecht(1999)[117]; Xu minghua(2008)[118]; Wang jinming(2015)[119]

（4）Organizational structure

Organizational setting is an important factor that affects the performance of enterprise knowledge management; organizational structure describes the framework system of the organization and represents the formal control mechanism in the organization; different organizational structures differ in the way of organizing knowledge resources, which will not only have an impact on the path of knowledge transfer, but also on the degree and efficiency of knowledge utilization, and furthermore will affect the enterprise's cooperation in knowledge alliance for new knowledge. Scholars such as Trussler (1988), Davenport (1998), Armbrecht (2001), and Gold (2001) have mentioned in their respective studies that decentralized, informal organizational structures facilitate intra-enterprise communication and play a key role in the successful implementation of knowledge management[120][121][122][123]. Menon et al. (1992) suggested that organizational institutional factors that influence organizational knowledge management include centralization and formalization. In particular, centralization is the extent to which the organization is physically controllable by decision makers, and formalization can be interpreted as the extent to which decisions are controlled in terms of formal provisions, procedures, and standard policies in relation to work. A high degree of centralization of decision-making power undoubtedly curbs creativity, while decentralization of power promotes spontaneous experimentation and free expression, which are necessary prerequisites for knowledge

innovation, and a centralized organizational structure can be detrimental to communication and knowledge sharing between different departments due to the single communication channel[124]. Knowledge innovation needs to be flexible and nimble; strict and formal control of provisions is not conducive to the generation of new ideas and can stifle knowledge innovation. Cardinal (2001) uses the concepts of centralization and formalization to measure the characteristics of organizational structures. Centralization reflects the degree to which decision-making power is concentrated at the top of the enterprise. In general, if most of the decision-making power is concentrated at the top, the enterprise must be highly centralized; while formalization reflects the extent to which the enterprise uses formal rules or procedures to regulate employee behavior[125]. Kogut & Zander (1992) suggest that an enterprise's prior knowledge base affects the enterprise's absorption of new external knowledge by influencing the enterprise's organizational form and organizational capacity[4]. Rod & Richard (1998) pointed out that knowledge management practices vary from enterprise to enterprise and that enterprises should choose the appropriate knowledge management approach according to their own circumstances[126].

Undoubtedly, an organization with flexible responsiveness, smooth communication, and efficient decision making and execution can create opportunities for various cross-departmental activities, break down the invisible walls between different departments of the enterprise, minimize or eliminate compartmentalization,

and draw a blank, broaden the communication channels between departments, promote the smooth flow of information and knowledge, and include the aggregation and application of enterprise knowledge in the processes of the enterprise. Zack (1999) suggested that the success of enterprise strategy depends on the degree of matching between organizational structure and cultural factors affecting knowledge management[127]. Bosch et al (1999) suggested that the organizational form of an enterprise has an impact on the knowledge absorption capacity of the enterprise[128]. The research of Tsai (2001) showed that departments that occupy a central position in a network of business units within an enterprise are more likely to acquire other business departments, thus increasing their knowledge integration and innovation capabilities[129]. Zou Hailin (2000) proposed that in order to implement knowledge management successfully, the organizational structure of an enterprise needs to be redesigned to make the enterprise organization highly flexible, adaptable and flexible in terms of the network[130]. Han Zhihui et al. (2004) also argued that the flexibility and operational efficiency of enterprise organizations play a key role in the accumulation, operation and creation of enterprise knowledge and the establishment of learning organizations[131]. Based on an empirical study, Linshan et al. (2007) concluded that the organizational structure with low degree of centralization and formalization is powerful for corporate knowledge innovation[132].

Taken together, the following hypotheses are proposed in this paper.

H4a: Organizational structure significantly and positively affects knowledge innovation in logistics enterprises.

H4b: Organizational structure significantly and positively affects knowledge management in logistics enterprises.

<Table 3.1-4> Definition of Organizational Structure

Variable	Definition	Reference source
Organizational structure	The actual distribution of obligations and authority for the individual in the logistics enterprise organization, including plan and control system and processes like decision-making, coordination and implementation.	Zou hailin (2000)[130] 、Han zhihui(2004)[131]、Lin shan(2007)[132]

3.1.2 External Environment of Enterprises

(1) Information facilities

Information technology is the core that constitutes the information infrastructure of an enterprise and has an important impact on the accumulation, dissemination and sharing of knowledge. The rapid development of modern electronic information technology has laid the foundation for enterprises to use the information technology platform to promote the realization of knowledge management activities. In a sense, the rapid development of information technology has given rise to many new methods for implementing knowledge management. As the technical support for the

implementation of knowledge management, information technology plays an important fundamental role in the implementation of knowledge management. In the dynamic process of knowledge identification, acquisition, integration, consolidation, application and innovation, the information technology infrastructure and application capability of enterprises are considered to be the enablers of successful implementation of knowledge management.

O'Dell et al. (1998) suggest that the widespread application of modern information technology represented by the Internet serves as a powerful catalyst for achieving knowledge sharing, which not only facilitates communication among people but also enhances strong support for the success of knowledge management[133]. Teece (1998) believes that enterprises use information technology to organically combine scattered information and knowledge, and timely monitor the integration, absorption and innovative application effects of internal and external knowledge[134]. Brown & Duguid (1998) argue that information technology provides technical support for formal or informal communication between different groups and enables knowledge to cross the boundaries of different ownership subjects[135]. Skyrme (1999), Armbrecht (2001), Tanriverdi (2005), Sher & Lee (2004) and other scholars suggest that information technology infrastructure and technological tools have a significant impact on the transfer, storage and creation of knowledge[136][122][137] [138]. Accenture Consulting, combined with its own knowledge management practice, proposed that information

technology platform is conducive to the communication and learning among organization members and is one of the essential tools to promote knowledge management, and the implementation of knowledge management can only be put into practice if enterprises continuously strengthen the information technology foundation and create a good knowledge system environment. Mohamed & Vanessa (2003) studied the relationship between information technology factors, knowledge management process capabilities and enterprise innovation performance, and concluded that information technology affects the performance of enterprise technological innovation by affecting the whole process of enterprise knowledge management[139]. The exchange and sharing of knowledge requires an information technology platform as a carrier, and the degree of approach and access of enterprise employees to knowledge and information directly depends on the information technology platform and the degree of openness of information data, and the effective use of information technology greatly improves the efficiency of knowledge sharing and knowledge utilization while accelerating the internal traffic of enterprises.

Taken together, the following hypotheses are proposed in this paper.

H5a: Information facilities significantly and positively influence knowledge innovation in logistics enterprises.

H5b: Information facilities significantly and positively affect knowledge management in logistics enterprises.

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<Table 3.1-5> Definition of Information Facilities

Variable	Definition	Reference source
Information facilities	The IT-based infrastructures, such as, internet, email, video/audio meeting system, communication software, electronic bulletin boards, electronic communities of practice and search engines.	Skyrme(1999)[136] 、Armbrecht(2001)[122]、Tanriverdi(2005)[137]、Sher & Lee(2004)[138]

(2)Policy environment

Policy environment is a fundamental condition for the innovation-driven development of a country or a region's economy. Established research shows that a good policy environment helps to provide property rights definition and incentive mechanisms for enterprise innovation activities, strong property rights protection for the market transformation of enterprise innovation results, and a rule-based framework for the cultivation and development of innovative industries, which in turn guides and motivates enterprises to actively engage in innovation activities, and ultimately promotes the improvement of innovation-driven development of regional economy and realizes the optimal allocation of economic resources[140]. The policy environment may influence innovation-driven development not only through property rights protection, but also through bureaucracy, legal system, government policies, and market-oriented reforms. For example, Tan et al[141] and Mitchell et al[142] analyzed the impact of external

uncertainty, institutional environment, and legal system on entrepreneurial innovation. Herrington et al[143] investigated South African entrepreneurs and found that the efficiency of bureaucracy, appropriate tax rate, and labor regulation policies affect entrepreneurial innovation behavior. Studies have shown that strengthening the policy environment helps intellectual property protection, motivates enterprises to engage in knowledge innovation, facilitates the orderly management of existing knowledge, alleviates the externalities faced by enterprises' investment in R&D and innovation, and ultimately promotes the advancement of enterprises' technological innovation[144].

H6a: Policy environment significantly and positively affects knowledge innovation in logistics enterprises.

H6b: Policy environment significantly and positively affects logistics enterprise knowledge management.

<Table 3.1-6> Definition of Policy Environment

Variable	Definition	Reference source
Policy environment	The government legal system, fiscal taxation policy and the guarantee system that can provide delimitation of property rights and incentive mechanism to the innovation established by logistics enterprise and the outside world.	Yue hu(2008)[140]、Tan et al(1994)[141]、Mitchell et al(2000)[142]

3.1.3 Innovation capability of logistics technology from a knowledge perspective

(1) Knowledge innovation and logistics technology innovation capability

Knowledge innovation, as a source of continuous thriving development of the nation, provides a theoretical source for the development of technological innovation in China[145] and is an important influencing factor in achieving innovative development. Domestic scholars represented by Lu Yongxiang believe that knowledge innovation refers to the process of acquiring new knowledge in natural and technical sciences through scientific research. The purpose of knowledge innovation is to pursue new discoveries, explore new laws, create new doctrines, create new methods, and accumulate new knowledge. Knowledge innovation is the basis of technological innovation, the source of new technologies and new inventions, and a revolutionary force to promote scientific and technological progress and economic growth. He Jinsheng et al. (2004) proposed that knowledge is the basis of innovation, knowledge learning cannot be jumped, competencies cannot be introduced, and neither organizations nor individuals can obtain real innovation beyond their own knowledge content level, and only the growth of knowledge can obtain the improvement of innovation ability[146]. Veugelers and others suggest that establishing a strategy for acquiring knowledge within an organization and beyond its core competencies can effectively promote technological innovation[147]. Federica et al. through an empirical

analysis in Austria, pointed out that advanced technological innovation in enterprises will use more innovative knowledge resources and technological innovation depends on the creation of knowledge within the organization[148]. Knowledge innovation provides knowledge support for technological innovation. Firstly, knowledge innovation is fundamental in that technological innovation is often inspired, induced, and guided at the beginning of technological innovation and references existing knowledge innovations when conducting technological innovation; secondly, knowledge innovation occurs not only at the source of technological innovation, but also at each stage of the technological innovation process (any stage of research, development, marketization, and diffusion).

In summary, the study proposes the following hypotheses.

H7: Knowledge innovation significantly and positively affects logistics technology innovation capability.

<Table 3.1-7> Definition of Knowledge Innovation

Variable	Definition	Reference source
Knowledge innovation	Knowledge innovation is a process to create, evolve and exchange new ideas and apply the new ideas to the market products (services).	Lin changkui(2009)[149]

(2)Knowledge management and logistics technology innovation capability

With the increasing importance of knowledge as a resource in enterprises,

domestic and foreign scholars study innovation from the perspective of knowledge management and organizational learning, and explore how enterprises can effectively manage knowledge to gain core competitive advantages. Bassi (1997) proposed that knowledge management is the process of creating, acquiring, and using knowledge in order to enhance the capabilities of an organization, which can be expressed dynamically as an enterprise's identification, acquisition, integration, and absorption of its owned knowledge resources[150]. Wiig (1997) argues that knowledge management in enterprises mainly involves the following aspects, specifically (1) monitoring knowledge and promoting knowledge activities; (2) creating and maintaining knowledge infrastructure; (3) updating and transforming organizational knowledge assets; and (4) using knowledge to enhance its value[151]. Yuan Qinghong (2001) argued that knowledge management, which targets knowledge producers, knowledge holders, knowledge exchange and use sites, and knowledge exchange environment of an enterprise, is a powerful lever to drive the overall core resources of an enterprise to add value[152]. From the conclusions of previous scholars, it is easy to find that a complete knowledge management system of an enterprise should include both technical and behavioral levels, with the former emphasizing on solving the problems of organizing enterprise knowledge sources, managing enterprise knowledge base, and transferring enterprise knowledge flow with the help of knowledge processing technology; and the latter focusing on the influence of enterprise employee behavior, enterprise behavior,

and inter-enterprise relationship behavior on knowledge management. One of the purposes of knowledge management is to realize the sharing and conversion of explicit knowledge and tacit knowledge, prompt and motivate employees to contribute knowledge wealth to the maximum extent, and enhance the innovation and development ability of enterprises.

For the relationship between knowledge management and corporate innovation, McElroy (1999) argues that the purpose of knowledge management is to support and promote innovation and that knowledge management is the key for enterprises to maintain their innovative capacity[153]. Lester (2001) confirms through a case study that knowledge management and the application of new technologies can increase corporate innovation[154]. Tranfield etal (2003) explained in their study the role of knowledge management activities in supporting the process of discovery, implementation and enhancement of innovation[155]. García-Muiña et al. argued the impact of knowledge coding management on the success of technological innovation through an empirical study of Spanish biotechnology companies[156]. Dong Xiaoying et al. (2006) verified through an empirical study that the level of knowledge management is the main factor that affects the innovation capability of enterprises[157]. Lai and Lin et al. argued that in manufacturing enterprises, knowledge and technology are strategic assets and major sources of creating competitive advantage, that successful technological innovation must rely on a solid knowledge base, and that knowledge management can improve

technological innovation and influence product development[158].

Synthesizing the above-mentioned scholars' researches, this study argues that knowledge management, as an intrinsic driving force for the continuous development and enhancement of enterprise technological capability, is not only a catalyst but also a direct power source of enterprise innovation, and the internalization, dissemination and application of knowledge play a significant role in promoting and facilitating enterprise technological innovation. Therefore, the following hypotheses are proposed.

H8: Knowledge management significantly and positively affects logistics technology innovation capability.

<Table 3.1-8 > Definition of Knowledge Management

Variable	Definition	Reference source
Knowledge management	The process for the logistics enterprise to identify, acquire, integrate and absorb the knowledge resources that they possess.	Bassi(1997)[150]

For logistics enterprises, the activity links of knowledge identification, knowledge acquisition, knowledge integration, knowledge absorption and knowledge innovation, driven by factors such as learning ability, technical talents, company size, organization, information technology infrastructure and policy environment, positively influence the technological innovation capability of enterprises and thus enhance their core competitiveness, as summarized in the research hypotheses in <Table 3.1-9>.

< Table 3.1-9> Research hypothesis

Observed variables	Label	Research hypothesis
Learning ability	H1a	Learning ability has a significant positive impact on Knowledge innovation
	H1b	Learning ability has a significant positive impact on Knowledge management
Technical talents	H2a	Technical talents has a significant positive impact on Knowledge innovation
	H2b	Technical talents has a significant positive impact on Knowledge management
Company size	H3a	Company size has a significant positive impact on Knowledge innovation
	H3b	Company size has a significant positive impact on Knowledge management
Organization structure	H4a	Organization structure has a significant positive impact on Knowledge innovation
	H4b	Organization structure has a significant positive impact on Knowledge management
Information facilities	H5a	Information facilities has a significant positive impact on Knowledge innovation
	H5b	Information facilities has a significant positive impact on Knowledge management
Policy environment	H6a	Policy environment has a significant positive impact on Knowledge innovation
	H6b	Policy environment has a significant positive impact on Knowledge management
Knowledge innovation	H7	Knowledge innovation has a significant positive impact on logistics technology innovation ability
Knowledge management	H8	Knowledge management has a significant positive impact on logistics technology innovation ability

3.2 Model Construction

3.2.1 Structural Equation Modeling

Structural Equation Modeling (SEM) is an applied statistical method proposed by K. Jorekog in 1973 for the study of multiple indicators and variables. Firstly, compared with traditional evaluation methods, which require accurate data, SEM model not only has no strict restrictions and limitations on indicators, but also can analyze and deal with the data of indicators with errors, so it is closer to the actual situation; secondly, compared with common evaluation methods, which cannot reflect the process and influence degree of indicators, SEM model can determine the action path between indicators by simulating the observed values and calculating the correlation coefficient, reflecting the direct and indirect action process between indicators. The relationship between multiple indicators is clearly visible. A complete structural equation model consists of two parts, measurement equation and structural equation, for the problem under study, the measurement equation is used to measure the relationship between observed and latent variables, and the structural equation is used to reflect the relationship between latent variables, and the equation is as follows.

$$Y = \Lambda Y\eta + \varepsilon \quad (1)$$

$$X = \Lambda X\zeta + \delta \quad (2)$$

$$\eta = B\eta + \Gamma\zeta + \xi \quad (3)$$

Where the Y vector is the composition of the endogenous observed variables and the X vector is the composition of the exogenous observed variables; η denotes the endogenous latent variable and ζ denotes the exogenous latent variable; ΛY is the factor loading matrix of the endogenous observed variable on the endogenous latent variable, also known as factor loading, and ΛX is the factor loading of the exogenous observed variable on the exogenous latent variable; ε is the error term of the endogenous observed variable Y, δ is the error term of the exogenous observed variable X, and B is the between the endogenous latent variables; Γ is the effect of the exogenous latent variable on the endogenous latent variable; and ξ is the error term of this structural equation, reflecting the part of η in the equation that fails to be explained.

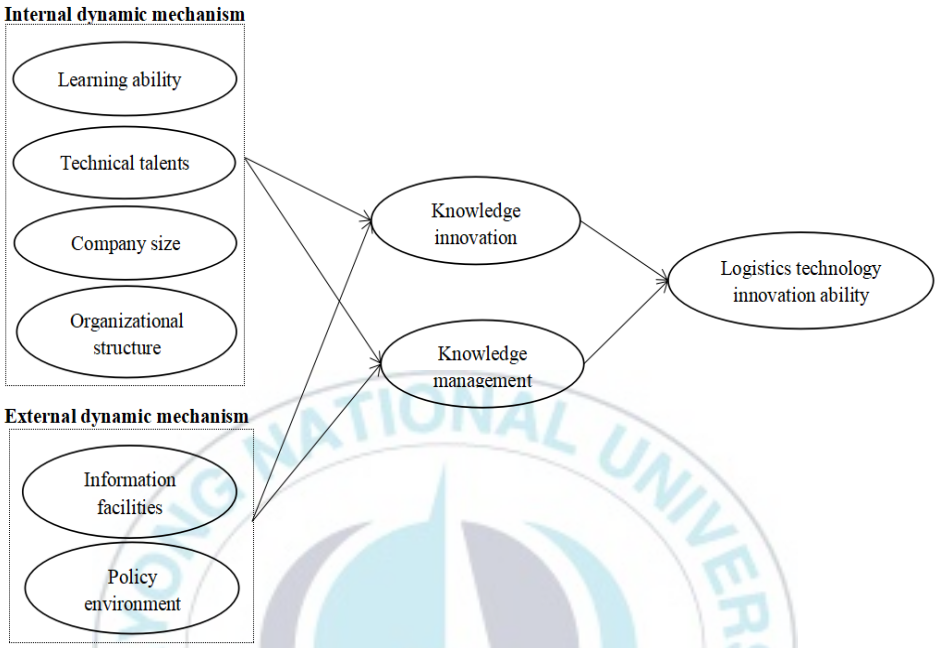
SEM is a statistical method to analyze the relationship between variables based on the covariance matrix of the variables, and it is a hypothesis testing method based on a structural theory. SEM is a general statistical method that is widely used in behavioral sciences. It can be regarded as an extension of the general linear model. Structural equation modeling has several advantages: it can consider and deal with multiple dependent variables simultaneously; it allows for measurement error in both the independent and dependent variables; similar to factor analysis, it allows for latent variables to be composed of multiple observations, and the reliability and validity of each indicator can be estimated simultaneously; it allows for a more flexible measurement model than traditional methods, e.g., an indicator can be subordinated to

two variables within; and the researcher can design the relationship between the variables and estimate the fit of the whole model to the data.

3.2.2 Framework model

From the knowledge perspective, combined with the theory of enterprise dynamic capability, the influencing factors affecting the technological innovation capability of logistics enterprises are divided into two aspects: internal environmental factors and external environmental factors of enterprises. From the above analysis, it can be seen that the internal and external environmental factors of enterprises further affect the technological innovation capability of enterprises through influencing enterprise knowledge innovation and knowledge management. The study takes learning ability, technical talents, company size and organizational structure as the internal environmental factors of enterprises, and Information facilities and policy environment as the external environmental factors of enterprises, and synthesizes the theoretical basis and domestic and foreign research reviews to initially propose a conceptual model of the influencing factors of logistics technology innovation capability under the perspective of knowledge, as shown in <Figure 3.2-1>.

<Figure 3.2-1> Model framework-Influencing factors of logistics technology innovation ability



IV. Empirical Analysis

4.1 Questionnaire Design

4.1.1 Methodology of questionnaire design

The questionnaire in this paper adopted the Likert (five-point) scale . The Likert scale was developed by Rensis Likert (1970), hence the name. The Likert scale is also called the summative scale, as the result of a questionnaire is often achieved by summing numerical assignments to the responses given.Responden ts rate certain attitudes, objects, persons or things in terms of agreement or disagreement. Specifically, the questionnaire rating scale is divided into five levels, strongly disagree,tend to disagree,neither agree nor disagree,tend to agree,strongly agree, while each level is assigned a corresponding score, strongly agree (5 points), tend to agree (4 points),neither agree nor disagree (3 points), tend to disagree (2 points), and strongly disagree (1 point).

4.1.2 The process of questionnaire design

（1）By referring to relevant literature at home and abroad, the scale related to measurement variables is found. Based on the research results of scholars and the actual development characteristics of Chinese logistics enterprises, the preliminary test items of each measurement variable are designed.

（2）Based on the discussion of relevant literature, experts in the logistics industry were interviewed in small scale, and the measurement items were discussed, modified and supplemented in detail, so as to exclude those items that were difficult to understand or not clearly expressed, and the initial scale was established.

（3）The reliability and validity of the small sample test results were analyzed to test the reliability and validity of the scale. Combined with exploratory factor analysis, the scale items were purified, and finally an effective questionnaire for large-scale investigation was obtained.

4.1.3 Respondents of the Questionnaire

This study collected data by issuing questionnaires to enterprises. Given this research there is no specific funds investment, also considering the centralized logistics companies, to improve the recovery rate of the questionnaire and enterprise information, the accuracy of the logistics enterprises a more developed region, north will research focused on the logistics industrial park, from Beijing, Shanghai and guangdong, Hong Kong and nearly 100 of logistics enterprise, the screen more than 50 target companies, Using the author's social relations resources, questionnaire survey was conducted with the help of local government departments such as entrepreneur associations and chambers of commerce, social organizations and classmates and friends.

In view of the questions in this questionnaire mainly involve the management level

of logistics enterprises, which has high requirements for respondents, in order to ensure the purpose of requirements and relatively reliable reliability, the research objects are mainly middle and senior management personnel in enterprises. With the assistance of the above-mentioned local competent departments and social organizations, the questionnaire is sent to the relevant enterprises by E-mail, and the investigated enterprises directly reply to the author after the questionnaire is adjusted.

Although the structural equation model has certain requirements on the number of samples, the opinions of different scholars are quite different, and a relatively unified standard has not yet been formed. Benter(1989) suggested that the survey object should reach more than five times of the measurement item, that is, N/t>5. This study adopts this standard. There are 28 measurement items in the questionnaire, and the total research sample should be more than 140.

The results of the questionnaire survey in this study are only for academic research, and the company name is not required to be shown. Meanwhile, we promise that the valuable analysis results of the questionnaire survey will be fed back to the investigated companies by email for reference.

4.2 Measurement of Variables

Adequate reference to previous research results is a prerequisite for generating scientifically sound measurement items, and a metric that can cover the connotation of

a theoretical structural variable can be called a suitable variable metric. In this paper, the metrics of each variable are determined by the literature research method, as shown in <Table 4.2-1>.

<Table 4.2-1> Constructs and scale items

Note: All items use five-point Likert scales anchored at 1 (strongly disagree/very dissatisfied) and 5 (strongly agree/very satisfied)			
Latent variables	**Observed variables**		
	Item	**Measurement**	**Source**
Learning ability	LA1	We can acquire and seize the new information in a rapid and comprehensive manner.	Nevis、DiBella、Gould(1998)[159]; Buekley、Halbesleben、Wheeler(2005)[160]; Gao Junshan、Mao Jianjun、Gu Dongyuan(2008)[161].
	LA2	We frequently dispatch R&D team for field investigation or training to learn the advanced technologies and experiences.	
	LA3	We frequently launch learning activities like knowledge lecture to promote the knowledge popularization and knowledge transfer.	
Technical talents	TT1	Our R&D team consists of members with various knowledge background.	Walon(1985)[162]; Bae、Clien、Lawler(1998)[163]; Liu Shanshi、Liu Tingting(2007)[164] ; Li Wei(2011)[165]
	TT2	Our R&D team has in-depth knowledge and skills in our field of expertise.	
	TT3	The proportion of our R&D personnel of technology shows an increasing tendency and they have strong quality.	
Company size	CS1	Our total asset is leading in the industry.	Scherer(1965)[166]; Beck、Demirguc-Kunt(2008)[167]; Li Lulu、Zhu Bin(2014)[168]; Yu
	CS2	Our sales revenue is leanding in the industry.	

Note: All items use five-point Likert scales anchored at 1 (strongly disagree/very dissatisfied) and 5 (strongly agree/very satisfied)			
Latent variables	**Observed variables**		
	Item	**Measurement**	**Source**
	CS3	Our staff scale is leading in the industry.	Changhong、Yuan Yijun(2017)[169]
Organizational structure	OS1	Our organizational structure can be rapidly adapted to the change of external environment.	Wan Rongshui、Zhuang Limin、Jiang Fenghuang(2008)[170]
	OS2	We proactively promote the innovative policies than can improve the organizational performance.	
	OS3	Our organizational culture is conducive to the implementation and advancement of innovation.	
Information facilities	IF1	We have provided perfect and advanced information hardware and software system so as to bring great convenience for the staff to acquire, exchange, share and reserve business knowledge.	Hefu Liu、Qian Huang、Shaobo Weial(2015)[171]
	IF2	We keep developing new IT application for future products/services.	
	IF3	We share business information with our major partners through internet.	
Policy environment	PE1	We have established better collaborative innovation mechanism.	Kiteh(1997)[172]; Kemperer(1990)[173]; Li Liming、Chen Mingyuan(2017)[174]
	PE2	The government has provided innovation incentives like financial revenue.	

Note: All items use five-point Likert scales anchored at 1 (strongly disagree/very dissatisfied) and 5 (strongly agree/very satisfied)			
Latent variables	**Observed variables**		
	Item	**Measurement**	**Source**
	PE3	We believe that the continuous improvement of legal system of knowledge protection can create better environment for the corporate innovation.	
Knowledge innovation	KI1	We can rely on the company's self-strength to create new knowledge through independent research and development.	Artz、Norman、Hatfield(2010)[175]; Lichtenthaler(2010)[176]; Cao Yong，Zhao Li(2013)[177]; Yuan Lin、Tan Wen、Shao Yunfei(2015)[178]
	KI2	We possess the majority of patents of major products or services and we grasp the core capability of technical field.	
	KI3	We are good at improving, exploiting and improving the existing knowledge and technologies by introducing the new knowledge.	
Knowledge management	KM1	We have built perfect internal knowledge library and assigned special personnel for updating and maintenance.	Liao et al.(2003)[179] Park & Yang (2007)[180] Andrawina et al.(2008)[181]
	KM2	We can integrate and absorb the obtained knowledge and the priori knowledge quickly.	
	KM3	We can effectively analyze and understand the acquired knowledge and grasp the market change in a timely manner and discover the opportunity for innovation.	

Note: All items use five-point Likert scales anchored at 1 (strongly disagree/very dissatisfied) and 5 (strongly agree/very satisfied)			
Latent variables	**Observed variables**		
	Item	**Measurement**	**Source**
Logistics technology innovation ability	TI1	Our investment in R&D is higher than the average level in the industry and the remuneration of R&D personnel and the resources are superior to the rivals.	Mengue、Auh(2010)[182]; Lopez、Camison(2013)[183]; Qin Junxing、Wang Baijie(2018)[184]
	TI2	We can launch new products or services quickly than our rivals, furthermore, our sales revenue of new products accounts for a large proportion of the total sales for the period.	
	TI3	The average cost of new products or services development is lower than that of our rivals and the labor productivity is relatively high.	
	TI4	We proactively carry out satisfaction survey in terms of products or services. Technical improvement against main problems will be conducted accordingly.	

4.3 Data collection

The questionnaire was distributed from June 3, 2021 to July 15, 2021, lasted more than one month. In total, 331 questionnaires were returned with usable data from 452 distributed, giving a return rate of usable data of 73.23 percent. Respondents were described and analyzed in terms of education, Position, Years of working, and

Enterprise size, as shown in <Table 4.3-1> .

<Table 4.3-1> Basic information description and analysis

	Category	Frequency	Percent
Education	Junior college	69	20.8
	Bachelor	190	57.4
	Master	59	17.8
	Doctor	13	3.9
Position	Top management	18	5.4
	Middle management	43	13
	Grass-roots management	60	18.1
	Staff	210	63.4
Years of working	Less than 1 year	73	22.1
	2-4 years	90	27.2
	5-7 years	102	30.8
	More than 8 years	66	19.9
Enterprise size	Less than 100 employees	93	28.1
	100-300 employees	120	36.3
	300-1000 employees	63	19
	More than 1000 employees	55	16.6

4.4 Parameter estimation and fitting inspection

4.4.1 Reliability analysis

In this paper, SPSS22.0 has been adopted to calculate the coefficient of reliability of the research variables and general Cronbach α, as shown in <Table 4.4-1>.

<Table 4.4-1> The table for the coefficient of reliability of factors and general Cronbach α

Factor	Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Learning ability	LA1	0.748	0.818	0.869
	LA2	0.745	0.821	
	LA3	0.758	0.809	
Technical talents	TT1	0.74	0.777	0.852
	TT2	0.71	0.806	
	TT3	0.718	0.798	
Company size	CS1	0.701	0.741	0.825
	CS2	0.634	0.805	
	CS3	0.719	0.724	
Organizational structure	OS1	0.75	0.82	0.871
	OS2	0.745	0.826	
	OS3	0.763	0.808	
Information facilities	IF1	0.796	0.806	0.88
	IF2	0.748	0.848	
	IF3	0.762	0.837	
Policy environment	PE1	0.702	0.806	0.85
	PE2	0.713	0.796	
	PE3	0.744	0.766	
Knowledge innovation	KI1	0.72	0.798	0.853
	KI2	0.728	0.792	
	KI3	0.724	0.795	
Knowledge management	KM1	0.804	0.832	0.892
	KM2	0.764	0.867	
	KM3	0.797	0.839	
Technology innovation	TI1	0.799	0.885	0.911
	TI2	0.801	0.884	
	TI3	0.784	0.89	
	TI4	0.809	0.881	

As known from the table, the α coefficient of reliability of each variable is greater

than 0.7. The general α coefficient of reliability of data surpasses 0.8, indicating that the variables have better internal consistency reliability. The CITC is greater that the standard of 0.5, demonstrating that the measuring item conforms to the study requirements. Judging from “deleting the Cronbach’s Alpha value of the item”, the deletion of any item will not make the value of Cronbach's Alpha increase, which also indicates that the variables have better reliability.

4.4.2 Validity analysis

(1) Exploratory factor analysis

The SPSS22.0 has been adopted to conduct the exploratory factor analysis. KMO test and Bartlett sphericity test have been carried out. The specific results are shown in below <Table 4.4-2> .

<Table 4.4-2 > The test of influencing factors KMO and Bartlett

Kaiser-Meyer-Olkin Measure of Sampling		**0.912**
Bartlett's Test of	**Approx. Chi-Square**	5743.813
	df	378
	Sig.	.000

According to the results, the test value of KMO is 0.912, which is greater than 0.7. The Bartlett's spherical test value is significant (Sig.<0.001). The results indicate that the questionnaire data conform to the prerequisite of factor analysis. Therefore, further analysis has been conducted. The principal component analysis has been adopted for

the factor extraction and the factor with a characteristic root greater than 1 has been taken to extract the common factor. The variance maximum orthogonal rotation has been adopted for the factor rotation so as to conduct the factor analysis. The analysis results are shown as below <Table 4.4-3> .

As can be seen from this table, 9 factors have been obtained from the factor analysis results. The total explanatory ability has been up to 79.184%, which is greater than 50%. It demonstrates that the 9 factors screened out have better representative. The above table shows the factor load coefficient. The factor loading of each measuring item are all greater than 0.5, besides, the cross loading is smaller than 0.4. Each item can fall on the corresponding factor, indicating that the scale has better structural validity.

<Table 4.4-3 > The factor analysis results

Item	Component								
	Technology innovation	Information facilities	Learning ability	Technical talents	Knowledge management	Policy environment	Company size	Organizational structure	Knowledge innovation
TI1	0.844	0.136	0.035	0.083	0.127	0.037	0.093	0.131	0.135
TI2	0.841	0.037	0.132	0.081	0.141	0.128	0.044	0.135	0.108
TI3	0.837	0.103	0.068	0.124	0.065	0.097	0.094	0.128	0.1
TI4	0.832	0.074	0.174	0.062	0.146	0.097	0.128	0.106	0.136
IF1	0.1	0.85	0.162	0.109	0.137	0.097	0.099	0.127	0.106
IF3	0.113	0.828	0.101	0.168	0.182	0.073	0.098	0.129	0.057
IF2	0.11	0.823	0.108	0.1	0.127	0.144	0.129	0.105	0.126
LA2	0.118	0.148	0.802	0.084	0.133	0.173	0.1	0.136	0.162
LA1	0.127	0.158	0.792	0.137	0.19	0.077	0.128	0.128	0.179
LA3	0.158	0.098	0.786	0.162	0.163	0.087	0.179	0.182	0.142
TT3	0.082	0.147	0.096	0.816	0.132	0.118	0.075	0.122	0.167
TT1	0.128	0.096	0.179	0.796	0.136	0.222	0.032	0.145	0.105
TT2	0.126	0.144	0.087	0.784	0.152	0.13	0.095	0.155	0.159
KM3	0.192	0.2	0.176	0.137	0.805	0.112	0.085	0.18	0.101
KM2	0.184	0.163	0.156	0.154	0.796	0.109	0.167	0.119	0.087
KM1	0.139	0.157	0.182	0.182	0.79	0.176	0.162	0.179	0.115
PE1	0.086	0.1	0.102	0.123	0.046	0.817	0.128	0.156	0.11
PE2	0.105	0.103	0.105	0.19	0.136	0.809	0.091	0.116	0.08
PE3	0.146	0.113	0.106	0.134	0.17	0.797	0.172	0.042	0.197
CS3	0.127	0.125	-0.027	0.06	0.139	0.122	0.85	0.109	0.112
CS1	0.085	0.084	0.171	0.04	0.102	0.094	0.822	0.116	0.104
CS2	0.103	0.102	0.224	0.092	0.097	0.151	0.75	0.012	0.123
OS1	0.151	0.136	0.239	0.112	0.13	0.136	0.042	0.811	0.111
OS3	0.174	0.14	0.127	0.179	0.165	0.118	0.09	0.793	0.175
OS2	0.224	0.136	0.093	0.18	0.174	0.109	0.163	0.754	0.191
KI1	0.109	0.088	0.135	0.1	0.095	0.124	0.125	0.195	0.819
KI2	0.168	0.072	0.195	0.187	0.088	0.142	0.163	0.137	0.775
KI3	0.252	0.174	0.173	0.2	0.109	0.159	0.108	0.12	0.737
Eigenvalue	3.312	2.487	2.408	2.368	2.366	2.36	2.312	2.305	2.252
% of Variance	11.828	8.881	8.601	8.457	8.452	8.43	8.258	8.233	8.044
Cumulative %	11.828	20.709	29.31	37.768	46.219	54.649	62.907	71.141	79.184

(2) Confirmatory factor analysis

The fitting index and standardized factor load coefficient can be utilized to test the validity level of structural equation model in terms of confirmatory factor analysis. It mainly compares the calculated fitting index with the reference value of each fitting index. Better fitting condition of model can be proved in the event that the obtained fitting index is within the reference range, otherwise, it has non-ideal fitting condition, which should be further corrected. When the model has better fitting index, the size of standardized factor load coefficient can be utilized to test its validity. In general, it is acceptable if the mentioned index is greater than 0.5. If it is greater than 0.7, then, it means that the validity is relatively high. AMOS 23.0 has been utilized for the confirmatory factory analysis of data. The fitting index is shown as <Table 4.4-4> .

<Table 4.4-4> The fitting index table of confirmatory factory analysis

Model fit	Recommended values	Measurement model
CMIN	——	331.285
DF	——	314
CMIN/DF	<3	1.055
RMR	<0.08	0.043
GFI	>0.8	0.935
AGFI	>0.8	0.917
NFI	>0.9	0.944
IFI	>0.9	0.997
TLI	>0.9	0.996
CFI	>0.9	0.997
RMSEA	<0.08	0.013

As known from above table, CMICMIN/DF is 1.055， which is smaller than standard, i.e., less than 3. GFI, AGFI, NFI, TLI, IFI and CFI can meet the standard, which is more than 0.9. RMR is 0.043, which is smaller than 0.08 and RMSEA is 0.013， which is smaller than 0.08. Each fitting index conforms to the general research standard; therefore, it can be inferred that the model has better goodness of fit.

<Table 4.4-5 > The results of confirmatory factor analysis

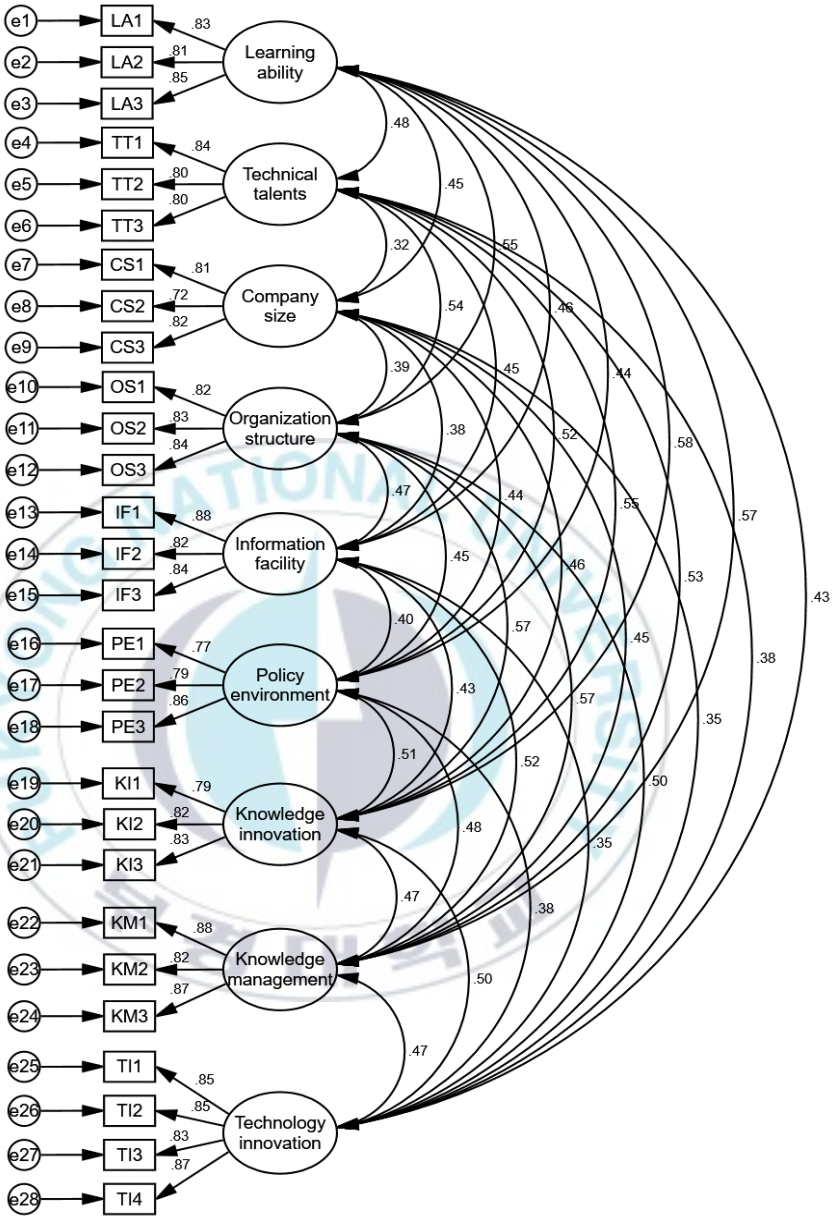
	Item	Factor loading	CR	AVE
Learning ability	LA1	0.83	0.87	0.69
	LA2	0.815		
	LA3	0.846		
Technical talents	TT1	0.838	0.852	0.658
	TT2	0.797		
	TT3	0.798		
Company size	CS1	0.807	0.829	0.619
	CS2	0.725		
	CS3	0.824		
Organization structure	OS1	0.818	0.871	0.692
	OS2	0.833		
	OS3	0.845		
Information facility	IF1	0.878	0.881	0.712
	IF2	0.817		
	IF3	0.836		
Policy environment	PE1	0.772	0.85	0.654
	PE2	0.794		
	PE3	0.858		
Knowledge innovation	KI1	0.786	0.853	0.659
	KI2	0.817		
	KI3	0.832		
Knowledge management	KM1	0.883	0.892	0.734
	KM2	0.821		
	KM3	0.865		
Technology innovation	TI1	0.846	0.911	0.72
	TI2	0.852		
	TI3	0.828		

	TI4	0.867

As known from the above <Table 4.4-5>, each standardization factor load of measurement index is greater than 0.6, the component reliability (CR) is greater than 0.7 and the average variation extraction (AVE) is greater than 0.5. All of them indicate that each variable has better convergent validity.

The confirmatory factor analysis can be carried out based on the better fitting index, obtaining the path diagram of confirmatory factor analysis of influencing factors, which is shown as <Figure 4.4-1>.

<Figure 4.4-1> Path diagram of confirmatory factor analysis



The standardization factor load coefficient of each variable can be obtained from the figure. Each standardization path coefficient is greater than 0.5, namely, the questionnaire has higher validity, passing the test.

(3) Discriminant validity analysis

In this study, the more rigorous AVE method was used to evaluate the discriminant validity. Fornell and Larcker, 1981, AVE square root of each factor should be greater than the correlation coefficient of each pair of variables, indicating that factors have discriminant validity. The AVE square root of each factor is greater than the standardized correlation coefficient outside the diagonal, so this study still has discriminant validity, and the lower oblique triangle is the correlation coefficient, which is shown as <Table 4.4-6>.

<Table 4.4-6> The results of discriminant validity

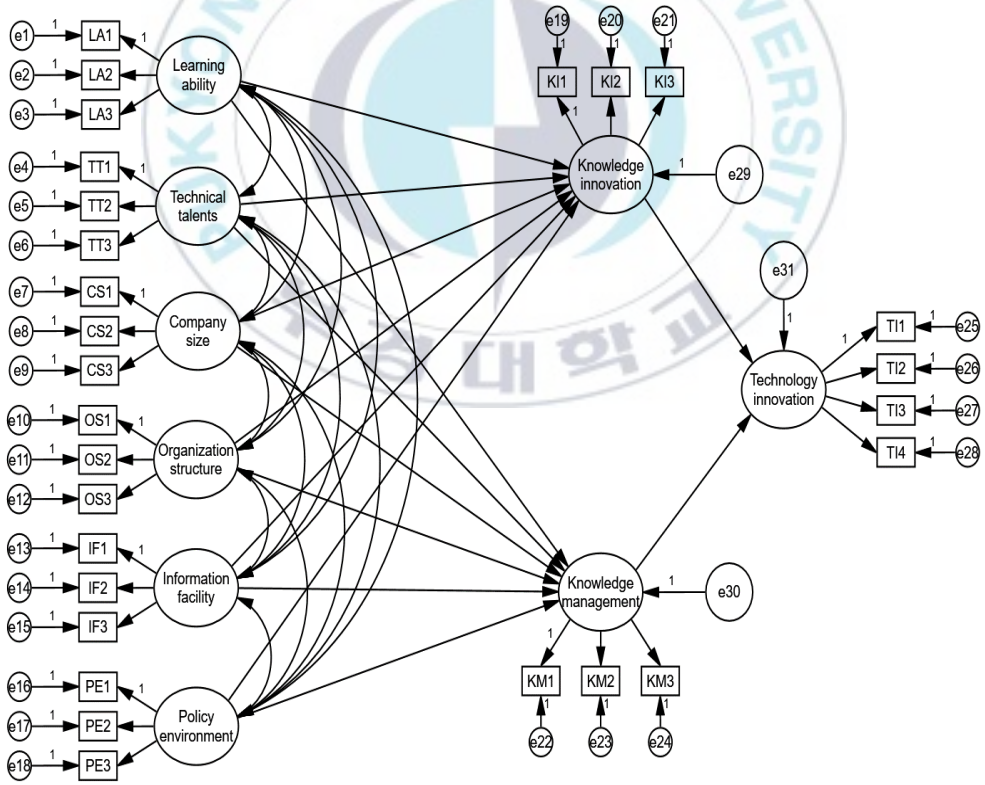
	Learning ability	Technical talents	Company size	Organization structure	Information facility	Policy environment	Knowledge innovation	Knowledge management	Technology innovation
Learning ability	0.831								
Technical talents	.414**	0.811							
Company size	.391**	.274**	0.787						
Organization structure	.476**	.463**	.331**	0.832					
Information facility	.405**	.393**	.334**	.411**	0.844				
Policy environment	.379**	.444**	.377**	.391**	.346**	0.809			
Knowledge innovation	.496**	.467**	.390**	.492**	.367**	.432**	0.812		
Knowledge management	.500**	.460**	.395**	.496**	.466**	.411**	.403**	0.857	
Technology innovation	.375**	.332**	.309**	.441**	.314**	.327**	.432**	.425**	0.849

Note: **, P<0.01.

（4）Test and correction of structural equation model

According to the research hypothesis and model frame, the structural equation path model of influencing factors of logistics technology innovation has been established in the paper, which is shown as, where the oval refers to the latent variable, the rectangular stands for the observational variable and the circle signifies the error term.

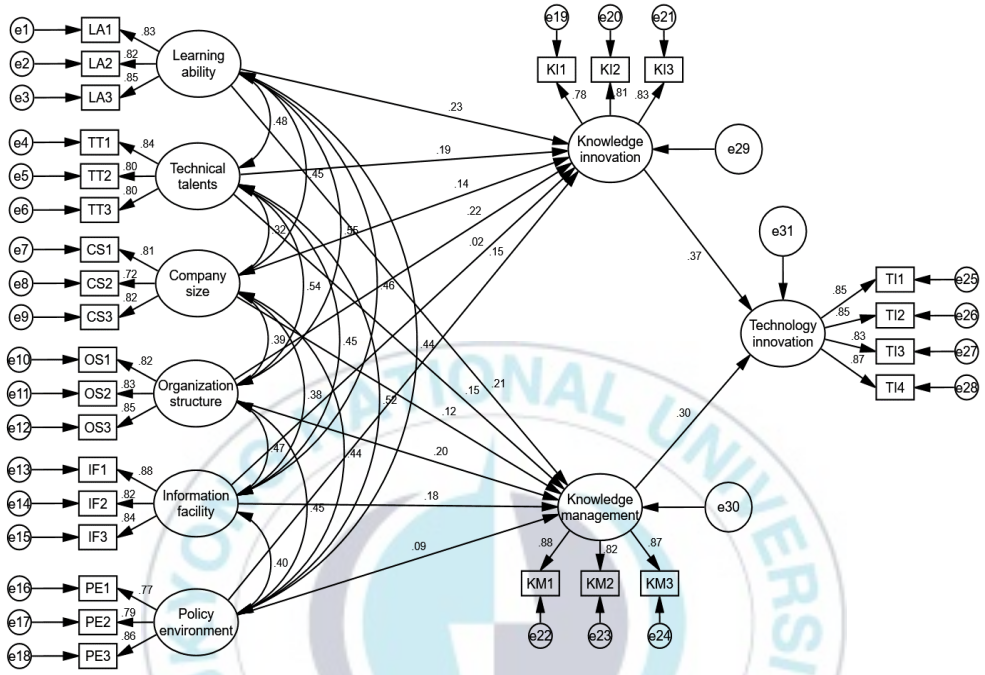
<Figure 4.4-2> Initial path model diagram of influencing factors of logistics technology innovation



Software Amos23.0 has been utilized for calculation and the method of maximum

likelihood has been adopted for estimation. The results are shown as below：

<Figure 4.4-3> The model diagram of initial path coefficient



<Table 4.4-7 > The initial model path coefficient

Path			Standardized estimates	Unstandardized estimates	S.E.	C.R.	P	Result
Knowledge innovation	<---	Learning ability	0.232	0.223	0.067	3.333	***	Support
Knowledge innovation	<---	Technical talents	0.189	0.174	0.065	2.673	0.008	Support
Knowledge innovation	<---	Company size	0.136	0.135	0.063	2.159	0.031	Support
Knowledge innovation	<---	Organizational structure	0.221	0.211	0.067	3.133	0.002	Support
Knowledge innovation	<---	Information facilities	0.022	0.019	0.054	0.353	0.724	No Support
Knowledge innovation	<---	Policy environment	0.149	0.154	0.07	2.213	0.027	Support
Knowledge management	<---	Learning ability	0.207	0.23	0.074	3.103	0.002	Support
Knowledge management	<---	Technical talents	0.149	0.16	0.072	2.207	0.027	Support
Knowledge management	<---	Company size	0.124	0.143	0.07	2.051	0.04	Support
Knowledge management	<---	Organizational structure	0.199	0.221	0.075	2.954	0.003	Support
Knowledge management	<---	Information facilities	0.182	0.184	0.06	3.038	0.002	Support
Knowledge management	<---	Policy environment	0.095	0.114	0.077	1.468	0.142	No Support
Technology innovation	<---	Knowledge innovation	0.367	0.394	0.072	5.512	***	Support
Technology innovation	<---	Knowledge management	0.304	0.281	0.059	4.772	***	Support

As obtained from the above <Table 4.4-7>, the Information facilities has oblivious significance on the Knowledge innovation and the Policy environment has in-distinctive impact on Knowledge management. Other paths have significant impact. Therefore, the model should be corrected.

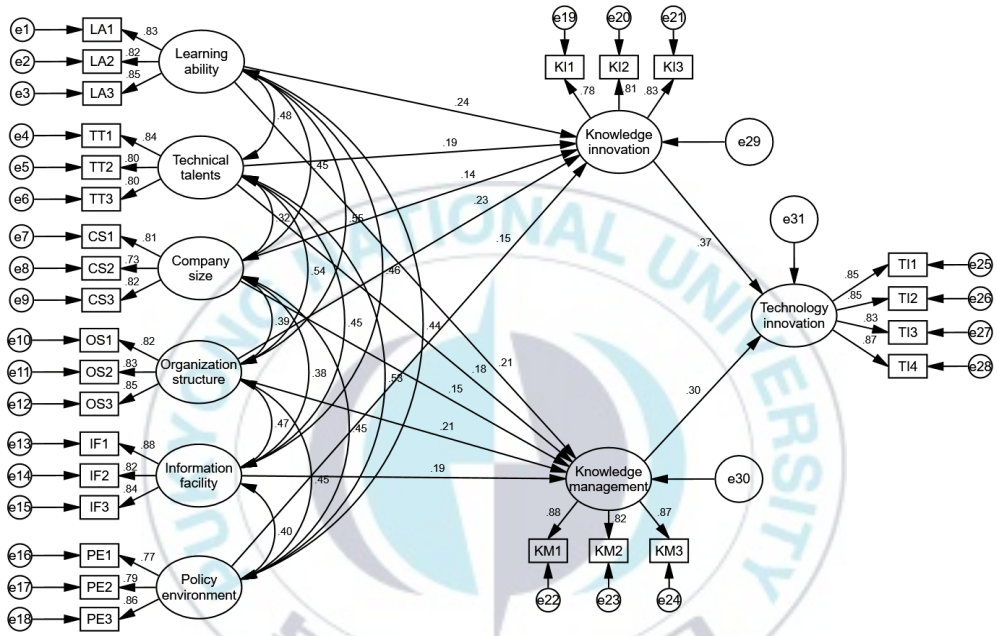
<Table 4.4-8 > Table of research hypothesis test results

Label	Research hypothesis	P	Test results
H1a	Learning ability has a significant positive impact on Knowledge innovation	***	Support
H1b	Learning ability has a significant positive impact on Knowledge management	0.002	Support
H2a	Technical talents has a significant positive impact on Knowledge innovation	0.008	Support
H2b	Technical talents has a significant positive impact on Knowledge management	0.027	Support
H3a	Company size has a significant positive impact on Knowledge innovation	0.031	Support
H3b	Company size has a significant positive impact on Knowledge management	0.04	Support
H4a	Organization structure has a significant positive impact on Knowledge innovation	0.002	Support
H4b	Organization structure has a significant positive impact on Knowledge management	0.003	Support
H5a	Information facilities has a significant positive impact on Knowledge innovation	0.724	No support
H5b	Information facilities has a significant positive impact on Knowledge management	0.002	Support
H6a	Policy environment has a significant positive impact on Knowledge innovation	0.027	Support
H6b	Policy environment has a significant positive impact on Knowledge management	0.142	No support
H7	Knowledge innovation has a significant positive impact on logistics technology innovation ability	***	Support
H8	Knowledge management has a significant positive impact on logistics technology innovation ability	***	Support

In order to obtain more reasonable model, the estimated results based on original model parameters should be corrected so that the oblivious paths can be eliminated and

the structural equation model can be re-constructed. The corrected model is shown as <Figure 4.4-4>.

<Figure 4.4-4> The corrected path model diagram of influencing factors of logistics technology innovation



<Table 4.4-9 > The path coefficient of influencing factors of logistics technology innovation

Path			Standardized estimates	Unstandardized estimates	S.E.	C.R.	P	Result
Knowledge innovation	<---	Learning ability	0.237	0.227	0.066	3.44	***	Support
Knowledge innovation	<---	Technical talents	0.193	0.178	0.064	2.766	0.006	Support
Knowledge innovation	<---	Company size	0.14	0.139	0.062	2.239	0.025	Support
Knowledge innovation	<---	Organizational structure	0.225	0.216	0.067	3.241	0.001	Support
Knowledge innovation	<---	Policy environment	0.149	0.153	0.07	2.205	0.027	Support
Knowledge management	<---	Learning ability	0.214	0.238	0.074	3.203	0.001	Support
Knowledge management	<---	Technical talents	0.184	0.197	0.068	2.884	0.004	Support
Knowledge management	<---	Company size	0.15	0.173	0.067	2.573	0.01	Support
Knowledge management	<---	Organizational structure	0.207	0.23	0.075	3.068	0.002	Support
Knowledge management	<---	Information facilities	0.187	0.189	0.061	3.125	0.002	Support
Technology innovation	<---	Knowledge innovation	0.368	0.395	0.071	5.557	***	Support
Technology innovation	<---	Knowledge management	0.304	0.282	0.059	4.809	***	Support

The fitting index of corrected model is shown as <Table 4.4-10>. The fitting index in the corrected model can reach the level required by the reference value. It demonstrates that the fitting condition of model is relatively ideal and the obtained results are of certain reference value.

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<Table 4.4-10 > The fitting index table of corrected model

Model fit	Recommended values	Structural model
CMIN	——	344.273
DF	——	323
CMIN/DF	<3	1.066
RMR	<0.08	0.052
GFI	>0.8	0.934
AGFI	>0.8	0.917
NFI	>0.9	0.942
IFI	>0.9	0.996
TLI	>0.9	0.996
CFI	>0.9	0.996
RMSEA	<0.08	0.014

4.4.3 Result interpretation

The influence coefficient of eight influencing factors on logistics technology innovation can be obtained from the output results of the model, which is shown as <Table 4.4-11> .

<Table 4.4-11 > Table of factor influencing coefficient

Variable relation	Direct impact	Indirect impact	Total
Learning ability→Technology innovation	-	0.15	0.15
Technical talents→Technology innovation	-	0.12	0.12
Company size→Technology innovation	-	0.1	0.1
Organizational structure→Technology innovation	-	0.15	0.15
Information facilities→Technology innovation	-	0.06	0.06
Policy environment→Technology innovation	-	0.06	0.06
Knowledge innovation→Technology innovation	0.37		0.37
Knowledge management→Technology innovation	0.3		0.3

According to the output results of the model, the influencing coefficient for

Learning ability, Technical talents, Company size, Organizational structure, Information facilities, Policy environment and Knowledge innovation to Knowledge management is 0.15, 0.12, 0.1, 0.15, 0.06, 0.06, 0.37 and 0.3, demonstrating that the above eight factors have significant impact on the logistics technology innovation, which conforms to the previous hypothesis. Among others, the learning ability, organizational structure, technical talents and company size in the internal environment of logistics enterprises can positively influence logistics technology innovation by positively influencing knowledge innovation and knowledge management. The information facilities in the external environment positively influence logistics technology innovation through positively influencing knowledge management, and the policy environment positively influences logistics technology innovation through positively influencing knowledge innovation. The validation of the positive influence of information facilities on knowledge innovation and the positive influence of policy environment on knowledge management did not pass, and the possible reasons are as follows:

Firstly, knowledge innovation is the process of enterprises creating, evolving and communicating new ideas, and applying them to marketable products or services. The carriers of new ideas are people, and information facilities are only tools, which do not possess innovative consciousness and talent themselves, and their use helps enterprises to manage knowledge and improve operational efficiency. Therefore, information

facilities have a significant impact on knowledge management, while they do not have a significant impact on knowledge innovation.

Secondly, knowledge management is the process of identification, acquisition, integration and absorption of the existing knowledge resources of logistics enterprises. The whole process is greatly influenced by the enterprises' own environment, such as managers' knowledge structure, management ability and internal organizational structure and process system. The policy environment provides more institutional guarantee and incentive policies to prompt enterprises to carry out knowledge innovation, and the good or bad policies do not directly lead to the high or low management efficiency. Therefore, the policy environment has a significant impact on knowledge innovation, but not on knowledge management.

V. Conclusion and Prospect

This chapter mainly reviews and summarizes the research development of this paper; makes policy recommendations; and points out the limitations of the paper as well as future research directions.

5.1 Research Conclusion

This paper aims to explore the influence factors of logistics technology innovation from the perspective of knowledge. On the premise of clarifying the research background and significance of the paper, through reading and combing a large amount of domestic and foreign related literature, the main influence elements of logistics technology innovation from the perspective of knowledge are refined and identified. A structural equation model of logistics technology innovation influence factors is established, according to which the corresponding dynamic mechanisms are analyzed from both internal and external aspects, so as to comprehensively grasp the structure of logistics technology innovation system and reveal the influence path of logistics technology innovation. The specific research work is as follows:

(1) The influencing factors of logistics technology innovation under the knowledge perspective are clarified. Through studying and analyzing the literature, the influencing factors related to logistics technology innovation are extracted, summarized from both internal and external aspects of enterprises. Knowledge

innovation and knowledge management are introduced as mediating variables to clarify the interaction relationship of each factor and lay the foundation for the SEM construction.

(2) The measurement items of the variables influencing the innovation capability of logistics technology under the knowledge perspective were designed and validated. The initial measurement questions were formed through literature research. The formal questionnaire was determined through pre-research and discussion. 331 valid questionnaires were collected, and the reliability and validity analysis of the questionnaire was completed.

(3) A SEM of the factors influencing logistics technology innovation was constructed and hypothesis testing completed. The SEM is constructed, the fit of the model is evaluated and revised, and 14 hypotheses are tested, among which 12 hypotheses pass the test and 2 hypotheses fail the test. The detailed results are as follows. In the internal environment of enterprises, learning ability, organizational structure, technical talents and company size have indirect positive influence on logistics technology innovation through positively influencing knowledge innovation and knowledge management, and the influence coefficients are 0.15, 0.15, 0.12, and 0.1. In the external environment of enterprises, information facilities have an indirect positive influence on logistics technology innovation by positively influencing knowledge management, with an influence coefficient of 0.06. The policy environment

has an indirect positive influence on logistics technology innovation by positively influencing knowledge innovation, with an influence coefficient of 0.06. Knowledge innovation and knowledge management have a significant direct impact on logistics technology innovation, with impact coefficients of 0.37 and 0.3. The positive impact of information facilities on knowledge innovation and the positive impact of policy environment on knowledge management failed to pass the verification.

5.2 Policy Recommendations

Based on the results of the empirical study, and combined with the current situation of the development of the logistics industry, countermeasure suggestions for the improvement of logistics technology innovation capacity under the knowledge perspective are proposed from the following five aspects：

(1) Strengthening their own learning ability to achieve a reasonable construction of learning organization

In the modern information age, knowledge is updated more and more rapidly, and the environment in which enterprises are located is also changing and developing continuously. Therefore, in order to have a favorable competitive environment and competitive advantages in the rapidly developing and changing environment, modern logistics enterprises need to establish a good learning environment and internal learning mechanism under the premise of clear development direction. To cultivate and improve

the learning ability of employees, the way of learning not only includes formal education or spare time education, but more importantly, it is done through practice. It is to focus on creating an atmosphere of learning. This requires all members of logistics enterprises to change their concepts, change the traditional thinking stereotypes of organizational managers and the managed, establish the concept of lifelong learning, and form an active learning atmosphere within logistics enterprises. Through the publicity and education of the employees, we shall let each employee clearly understand the importance of learning to the development of logistics enterprises and individuals, guide the members of logistics enterprises to transform learning into everyone's conscious action and actively participate in learning. Logistics enterprises should study learning methods and improve learning effectiveness according to their own characteristics, so that employees can achieve continuous self-transcendence through learning, and the sporadic knowledge resources scattered in the minds of employees are integrated into a strong and beneficial knowledge synergy. The purpose of such learning is not only to obtain knowledge and information from outside, but also to activate the knowledge innovation ability of employees and enterprises.

Although learning is very important for logistics enterprise organizations and individuals, learning is after all a means, and the results of learning must be integrated and utilized in order to be transformed into the development momentum and competitive advantage of the organization. The fundamental purpose of building

logistics enterprises into learning organizations is to achieve the development goals of logistics enterprises, to integrate learning, innovation and application into the process of organizational learning, and to treat the knowledge gained from organizational learning as an asset or capital, and to manage it effectively like other business resources, so as to achieve higher goals and generate higher benefits.

(2) Optimize enterprise organization structure and building enterprise knowledge network

The effective implementation of enterprise knowledge innovation and management requires an organizational structure that can be adapted to knowledge activities and the participation and coordination of all employees. A reasonable organizational structure with flexible responsiveness is the guarantee of technological innovation in logistics enterprises.

At present, logistics enterprises adopt a centralized organizational system to improve decision-making efficiency. In the vertically integrated organizational system, the hierarchy of enterprises is well-defined and information is mostly transmitted and exchanged in a vertical manner. Although such an organization is meticulously divided, closely managed and relatively efficient in decision-making, it is inflexible and lacks interaction and communication between employees and departments, which is not conducive to the play and exhibition of employees' creativity and is also not conducive to the integration, sharing and absorption of knowledge. For logistics enterprises, the

implementation of knowledge management requires them to change the traditional over-centralized organizational structure, reduce the inefficient nodes in the organizational process. From the perspective of facilitating knowledge management and knowledge innovation, logistics enterprises are required to take into account the balance and unity between centralization and decentralization in the design of organizational structure, establish a flexible and flat organizational structure that facilitates effective communication between vertical and horizontal, so that they can effectively improve the responsiveness to internal and external environment through authorization management, effectively realize the coordination and cooperation among various departments and positions as well as the effective control on the generation, communication, feedback, recording and management of information in the operation process through the optimization of organizational structure. We can shorten the time and space of knowledge transmission, promote the members within the enterprise to effectively acquire, integrate, share and innovate knowledge, improve the enterprise's own response to the changes in the external environment, and promote the production of knowledge. The purpose is to promote the production, flow, sharing and use of knowledge.

Logistics enterprises should form cross-functional task teams according to market opportunities and establish the knowledge network of enterprises, so that each employee becomes an important node on the knowledge network of enterprises and can

better contribute his or her knowledge and ability, so that employees can support and collaborate with each other, form a close collaborative relationship and jointly use individual and collective knowledge for value creation. Knowledge resources of enterprises are precious intangible assets of enterprises, which need special people or departments to excavate, collect, manage and spread in order to be truly transformed into core competitiveness of enterprises, which also requires logistics enterprises to create conditions and set up corresponding knowledge management departments or full-time positions, responsible for the construction of knowledge environment inside and outside enterprises, the construction and maintenance of knowledge management system and the training and re-education of other employees. Thus, the benefits of knowledge management and knowledge innovation can be improved to achieve the goal of technological innovation.

(3) Broadening the source of technical talents and enhancing knowledge innovation and management ability

People are the important carrier of knowledge. Logistics enterprises in the development process must pay attention to the introduction of various types of talent, digging more experts and scholars in the field of logistics, not only rely on the internal talent power of enterprises, but also need to seek the national universities in the field of logistics research experts and scholars and logistics people with entrepreneurial spirit. The internal staff has the advantage of more comprehensive understanding of the

development of the enterprise itself, but the external talents can go beyond the enterprise and discover new perspectives that the internal staff cannot observe, which is more conducive to the development of enterprise technology innovation. In the enterprise internal actively cultivate industry talents, promote the modern enterprise system, professional manager system and other aspects of system innovation, realize the staff's authority, stimulate human resources motivation and vitality; at the same time, the enterprise in the external can be held in the form of logistics design competition in colleges and universities, held logistics issues seminars and exchanges, etc., gathering elites in the field of logistics, for the development of enterprises to recruit innovative talents, inject new vitality. For the well-known scientific research experts in the industry, due to the high cost of direct introduction, enterprises can use the hiring of consultants, the formation of expert work is and other ways to cooperate, and access to their research results at low cost.

In addition, enterprises should establish corresponding systems and processes that help reserve and accumulate knowledge, increase investment in staff learning and training, improve the education level and academic background of employees, and encourage employees to improve their knowledge through self-study, further education and continuing re-education, etc. While the knowledge management ability is improved, knowledge innovation ability can also achieve certain growth， then improve the logistics industry technology innovation ability.

(4) Taking the road of professional scale and strengthening technical cooperation among enterprises

company size varies. Small-scale enterprises is the status quo of China's logistics enterprises. company size has become an important factor affecting the industry's technological innovation capacity. The real scale of enterprises is not a patchwork, and the scale artificially put together can only be a tangible scale and hard product production scale. In the era of knowledge economy, there are new requirements and new norms for the connotation of scale economy, and the old concept and practice of "diversified operation and low-cost expansion" must be changed. Specialization scale is more adaptable than diversification scale. It strips out its own businesses that have nothing to do with its main business or have little to do with it, and develops from diversification to specialization.

There are two widely accepted axioms in the knowledge-based market: it favors the first one to hit the market; it favors the one with superior technology. Of course, product development and technological innovation also emphasize a high degree of integration, and over-emphasis on technological unitization or specialization will certainly hinder technological innovation, but the way to make up for it is not necessarily to expand the scale of enterprises; instead, through the technical cooperation between relevant enterprises, the implementation of professional division of labor, independent research and development and cooperative research and

development, in the process of technological innovation, through the form of innovative network to achieve the purpose of intellectual resources sharing, economic benefits are shared, in order to improve the efficiency of technological innovation.

(5) Improving knowledge management infrastructure and building a policy environment for knowledge innovation

Knowledge management is knowledge-centered management, and the knowledge from inside and outside the enterprise usually presents a discrete distribution and is relatively sporadic and unsystematic. For logistics enterprises in particular, they need to establish a perfect knowledge management foundation platform, which firstly requires them to make systematic planning in terms of optimal setting of organizational structure and construction of software and hardware information infrastructure to adapt to the development demand of knowledge management, and to promote orderly on this basis. The basic platform of knowledge management includes information platform and entity platform, and logistics enterprises should import the knowledge management system into the auxiliary decision support system of enterprises with the support of modern information technology and equipment. Especially in the construction of entity platform, enterprises should create good learning and exchange places and environment for employees, explore the establishment of enterprises' own knowledge base, knowledge map and e-learning system by using modern information technology, promote mutual exchange and learning among employees, departments and between

enterprises and external knowledge and technology sources, encourage employees or departments to establish Informal communication groups or virtual communities similar to experimental communities are encouraged to provide platforms and opportunities for knowledge sharing, integration and absorption, and facilitate the recording, filtering, classification, accumulation and search of knowledge, so as to effectively improve the organizational embeddedness of knowledge employees and enhance the learning power and competitiveness of enterprises.

Furthermore, to improve the enthusiasm of logistics knowledge innovation and encourage its innovation, it is necessary to formulate corresponding laws and regulations, policies and systems, so as to reduce the risk of logistics knowledge innovation on the one hand, and ensure the satisfaction of the capital demand on the other. For the incentive support policy, firstly, in terms of funds, we should improve the loan and financing policies related to logistics knowledge innovation to ensure sufficient innovation funds, and at the same time, implement a tax reform system for innovation revenue, so as to solve the financial problems faced in the process of its innovation; secondly, the government should create a corresponding innovation platform to provide the relevant resources needed for logistics system innovation, and at the same time, promote the cooperation between industry, academia and research and knowledge innovation to improve the logistics technology innovation capability; furthermore, encourage logistics enterprises to use the current advanced logistics

information technology and realize tax preferential policies for the introduction of this aspect; and finally, formulate a corresponding legal protection system to protect the interests generated by the results of logistics technology innovation, so as to build a good innovation policy environment, which is of great significance to provide support and guarantee for logistics technology innovation and promote its positive innovation.

5.3 Limitations and Prospect

This paper takes knowledge perspective of logistics technology innovation influence factors as the research object. Through reading a lot of literature and establishing SEM model, we finally accomplished the expected goal, but there are still certain limitations as follows:

Although the questionnaire development process is subject to strict statistical control, some errors are inevitable due to the limitations of the questionnaire method itself, which is only an indirect measure, i.e., the traits to be measured are indirectly inferred from the measurement of verbal behavior, etc.

The respondents of the questionnaire in this paper are mainly middle and senior management personnel in logistics enterprises, but the data collection results show that 73 respondents have less than one year of work experience, accounting for a large proportion (22.1%), so the data collection lacks professionalism. In addition, the sample data needs to be expanded. Among the questionnaires collected in this study,

most of the respondents belong to logistics enterprises in the developed cities such as Beijing, Shanghai and Guangdong, and the number of surveyed enterprises in other regions is relatively small, so the sample data may not have complete generality and reliability. In future studies, we can try to expand the scope of the questionnaire, increase the number of questionnaires distributed, improve the quality of the returned questionnaires, enrich the level of enterprises, and collect more personal information of the respondents to make the sample data more realistic and objective.

The factors influencing logistics technology innovation capability need to be extended. The study divides the factors influencing logistics technology innovation capability under the knowledge perspective into internal environment factors and external environment factors, among which the internal environment includes four influencing factors of learning ability, technical talents, company size and organizational structure, and the external environment includes two influencing factors of information technology facilities and policy environment. In addition to these factors, factors such as entrepreneurial quality, enterprise market resources, and enterprise strategic management ability in the internal environment of enterprises may have an impact on the technological innovation ability of enterprises; factors such as international political situation, patent policy, and intellectual property culture in the external environment of enterprises may have an impact on the technological innovation ability of enterprises. In future research, the influencing factors in the

internal and external environment of enterprises can be extended to make the theoretical model richer.

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