GREEN SUPPLY CHAIN INTEGRATION FOR ENTERPRISE PERFORMANCE: MEDIATING ROLE OF AMBIDEXTROUS GREEN INNOVATION AND MODERATING EFFECT OF GREEN LEGITIMACY IN THE CHINESE PHARMACEUTICAL MANUFACTURING INDUSTRY

YANG GUIMEI

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF
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ABSTRACT

This study aimed to examine the effects of green supply chain integration on the performance of pharmaceutical manufacturing enterprises in China from an organizational capability perspective. The research also explored the mediating role of ambidextrous green innovation and the moderating role of green legitimacy. The conceptual framework was based on theories of organizational capability, ambidextrous innovation, and new institutional theory, incorporating ambidextrous green innovation as a mediating factor and green legitimacy as a moderating factor.

A quantitative research approach was adopted, targeting 400 pharmaceutical manufacturing enterprises in China, with data collected from face-to-face and indirect interactions, and through email questionnaires. Structural equation modeling (SEM) and the Process Macro model were used to analyze the data and test the hypotheses.

The results demonstrated that green supply chain integration directly and positively impacted both enterprise performance and ambidextrous green innovation. Moreover, ambidextrous green innovation was found to positively influence enterprise performance and partially mediate the relationship between green supply chain integration and performance. Finally, the study revealed that green legitimacy strengthened the effects of ambidextrous green innovation on enterprise performance. The findings suggest that pharmaceutical companies can enhance their performance by integrating green supply chain practices and fostering green innovation while maintaining a strong green legitimacy to support this process. The study contributes to the understanding of how green practices and innovation drive business success in the Chinese pharmaceutical manufacturing industry.

Keywords: green supply chain integration, ambidextrous green innovation, green legitimacy, reconfiguration capability, enterprise performance

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Yang Guimei

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List of Abbreviations

GSCI	green supply chain integration
GII	green internal integration
GCI	green customer integration
GSI	green supplier integration
AGI	ambidextrous green innovation
ERGI	exploratory green innovation
EIGI	exploitative green innovation
EP	enterprise performance
ENVP	environmental performance
ECOP	economic performance
SOCP	social performance
GL	green legitimacy
GNL	green normative legitimacy
GCL	green coercive legitimacy
GML	green mimetic legitimacy

CHAPTER 1
INTRODUCTION

1.1 Background and Statement of the Problems

Pharmaceutical manufacturing enterprises not only create well-being for human health and quality of life (Milanesi et al., 2020) but also have a significant contribution to the national economy and are considered the most relevant sector of the global economy (EFPIA, 2019). It has a significant impact on the global economy, both in terms of generating GDP contribution and providing employment opportunities (Ostwald et al., 2020).

Chinese pharmaceutical manufacturing enterprises show good prospects for development. Since the 21st century, the Chinese pharmaceutical manufacturing industry has risen rapidly. It has developed into the world's second-largest pharmaceutical market, with the production and export of active pharmaceutical ingredients ranking first globally. China has become a major pharmaceutical manufacturing country. In 2016, The State Council of China issued the Outline of the Healthy China 2030 Plan, making Healthy China a national strategy. The pharmaceutical industry is closely related to this strategy and is therefore considered a pillar industry related to the safety of national life (Zhuang & Duan, 2023). By the end of 2022, 14.9% of the Chinese total population was over the age of 65, and this percentage continues to rise. This greatly increases the rigid demand for pharmaceuticals (Communique on the Development of China's Cause for Aging in 2022). In addition, with the reform of the medical and healthcare system, a new round of technological change and cross-border integration, and the improvement of health awareness and health literacy of the whole population, the market environment and consumption capacity have also been improved, which makes Chinese pharmaceutical manufacturing industry have a great deal of room for development.

Pharmaceutical manufacturing companies have promising development prospects but also face serious environmental issues. Pharmaceutical manufacturing companies, classified as heavily polluting industries, generate significant environmental pollution and high carbon emissions during their operations (Sahoo et al., 2022; Tao et al., 2023). As early as 2015, the pharmaceutical industry's total greenhouse gas emissions reached 52 Mt CO_2 equiv, equivalent to 0.1% of the global anthropogenic carbon emissions, with a carbon intensity 55% higher than that of the automotive industry. When considering carbon emissions from the supply chain, this figure becomes even more significant (Tao et al., 2023). Addressing the dilemma of balancing economic development and environmental protection, managing social, economic, and environmental issues in its operations to achieve sustainable performance, is a practical challenge that pharmaceutical manufacturing companies cannot avoid.

In response to this challenge, scholars in the fields of chemistry, engineering, and environmental science are dedicated to utilizing green biology and green chemistry approaches to promote the sustainable development of pharmaceutical manufacturing enterprises (Milanesi et al., 2020). Governments around the world are also actively implementing policy measures to promote the sustainable development of the pharmaceutical manufacturing industry (Zhang et al., 2023). Pharmaceutical manufacturing enterprises have started actively exploring green innovation methods, but the outcomes have not been significant (Sahoo et al., 2022). For example, Xinhua Pharmaceutical has invested more than 20 million yuan to rectify environmental problems, and Northeast Pharmaceutical has invested more than 1 billion yuan to build environmental protection projects in recent years. However, the two enterprises are still fined for environmental violations in 2022 and face economic losses and environmental violations (SOHU.com, 2022). This situation has caused scholars and practitioners to think about the green practices of pharmaceutical manufacturers, and what kind of green practices pharmaceutical manufacturers should adopt to get out of the environmental dilemma and realize sustainable development.

Pharmaceutical products directly affect human health and safety (World Health Organization, 2010). The manufacturing process of pharmaceuticals involves multiple production steps and material transformation processes. Pharmaceutical products contain active sensitive molecular entities, requiring strict temperature monitoring during their production, storage, and transportation (Kumar et al., 2019; Donkor et al., 2022). Enterprises cannot rely solely on themselves to overcome environmental challenges and achieve the goal of sustainable development (Gölgeci et al., 2019; Zhao et al., 2018). An increasing number of enterprises are seeking to pursue sustainable development through green integration with supply chain partners (Ji et al.,2020).

As early as 2011, Wolf proposed the concept of "sustainable supply chain integration", which emphasizes the integration of product and service flows, information flows, capital, and decision-making flows to achieve environmental, economic, and social sustainability and provide maximum value to multiple stakeholders (Wolf, 2011). As the demand for environmental practices grew, scholars developed the concept of green supply chain integration (GSCI) based on supply chain integration. It is now commonly defined as "the extent to which firms strategically collaborate with supply chain partners on environmental aspects and collaboratively manage intra- and inter-organizational processes to improve environmental performance" (Wu, 2013; Lo et al., 2018; Sun & Sun, 2020). The concept of GSCI highlights three aspects: environmental orientation, strategic cooperation, and internal and external process management (Jiang & Feng, 2022).

In the GSCI process, enterprises usually enter into strategic partnerships with their supply chain partners to share information on product flow, information flow, capital flow, and other aspects (Huo, 2012). The collaborative approach identifies more economical solutions to environmental issues and builds a common vision for green development (Han & Huo, 2020). In this way, GSCI, in addition to its function of improving resource utilization efficiency and reducing production costs through traditional supply chain integration (Sahu et al., 2018), can also share the risks faced in solving environmental problems, create a good image of commitment to environmental problem solving and green development to relevant stakeholders, attract more customers, and improve performance (Han & Huo, 2020).

Research on GSCI has attracted increasing attention from scholars, but studies on the impact of GSCI on the performance of pharmaceutical manufacturing enterprises are scarce. Pharmaceutical manufacturing enterprises lack the appropriate knowledge to assess, identify, or understand the relationship and mechanisms between GSCI and enterprise performance. This hinders enterprises from leveraging the power of supply chain partners to address the dilemma of balancing economic development and environmental protection and achieving sustainable performance by managing social, economic, and environmental issues in their operations.

Additionally, empirical evidence regarding how GSCI affects enterprise performance is still limited, and research findings have not yet yielded consistent conclusions. Some studies suggest a positive correlation (Han & Huo, 2020; Kong et al., 2021), while others argue for a negative or indeterminate relationship (Feng et al., 2021). One reason for this discrepancy is that the current definition of the GSCI concept remains static and does not address how enterprises, especially those in emerging economies, manage the uncertainty and dynamism inherent in their business processes (Wong et al., 2020).

Sahu et al. (2023) argued that supply chain management should be aligned with strategic cooperation, environmental orientation, risk management, and sustainability. The same holds true for the GSCI, which serves as the cornerstone of green supply chain management. Therefore, redefining GSCI from an organizational capability perspective and broadening its connotation to adapt to the increasingly turbulent external business environments is imperative.

It is widely believed that green innovation is a key behavior to balance economic growth and ecological development, enhancing sustainability (Fernando et al., 2019). Green innovation refers to innovations related to green products, processes, or services (Wang & Huang, 2022). Depending on the degree of innovation, it can be divided into exploratory green innovation and exploitative green innovation. Exploitative green innovation refers to enterprises utilizing existing environmental knowledge, information, and capabilities to make incremental, small changes to existing green products, processes, and services. Exploratory green innovation involves enterprises utilizing new environmental knowledge, information, and capabilities to develop new green products, processes, and services. As a technology latecomer, China is in the early stage of green transformation (Zhang, 2022). At this stage, enterprises need to not only adopt exploitative green innovation to meet the requirements of current green regulations, but also undertake exploratory green innovation to meet the needs of emerging green markets (Jia et al., 2022). Ambidextrous innovation theory suggests that enterprises can balance short-term performance and long-term development goals by simultaneously engaging in exploitative and exploratory innovation to achieve sustainable business development (Benner & Tushman, 2003).

According to Jia et al. (2022), ambidextrous green innovation contributes to sustainable organizational development by enhancing its green image, gaining consumer recognition, and expanding market reach. At the same time, GSCI is identified as an important intangible resource stimulating ambidextrous green innovation (Sun & Sun, 2021). Ambidextrous green innovation is likely to play a mediating role between GSCI and enterprise performance. However, there is no literature exploring the mechanism between GSCI and enterprise performance from the perspective of ambidextrous green innovation. Shehzad et al. (2023) emphasize the necessity to advance potential mechanisms linking resources with ambidextrous green innovation to stimulate enterprise performance. Therefore, the limitations of ambidextrous green innovation's role in the relationship between GSCI and enterprise performance imply that the interaction of these variables needs further investigation.

As widely acknowledged, green innovation differs from conventional innovation in that it not only possesses knowledge externalities but also pollution abatement externalities (Doran & Ryan, 2016). If enterprises cannot derive benefits from ambidextrous green innovation activities, they are unlikely to actively engage in ambidextrous green innovation behaviors (Stojčić, 2021). Western developed countries have well-functioning, stringent policy frameworks, and a range of private incentives for green innovation (Horbach, 2016). However, China is still in the initial stages of green transformation, with a relatively weak green intellectual property rights system (Yang & Wang, 2020), and relevant laws and regulations still require improvement. This perspective of protecting green innovation based on the approach of Western developed countries poses certain challenges in China (Pei et al., 2013).

However, according to new institutional theory, enterprise innovation behavior is influenced by the legitimacy formed by social support and recognition (Janssen & Nonnenmann, 2017). Legitimacy is an important concept in new institutional theory, referring to the perception that within a specific social norm, value, and belief system, the behavior of enterprises is considered appropriate and legitimate (Suchman, 1995; Scott, 1995). If the innovation behavior of an enterprise has higher legitimacy, the enterprise is more likely to benefit from this innovative behavior (Zimmerman, 2002).

Green legitimacy is an extension of legitimacy into the environmental domain, focusing on the extent to which enterprises are accepted, supported, and recognized by the external environment for their green activities and behaviors (Wang & Huang, 2022). According to new institutional theory, when the ambidextrous green innovation behavior of enterprises is more widely accepted and recognized by the market, its innovation results are more likely to be converted into firm performance. In other words, in markets with higher green legitimacy, firms' ambidextrous green innovations are more likely to be acknowledged, and their behavioral outcomes are more likely to be translated into performance (Zimmerman, 2002; Wang & Huang, 2022). Therefore, this study suggests that green legitimacy plays a significant moderating role in enhancing performance through ambidextrous green innovation in enterprises. However, existing literature has not yet addressed the impact of green legitimacy on ambidextrous green innovation.

In summary, the existing literature provides a good opportunity for researchers: based on the realistic background of green transformation in the Chinese pharmaceutical manufacturing industry, we explore the relationship between GSCI and enterprise performance from the perspective of organizational capability and explore the mediating role of ambidextrous green innovation and the moderating role of green legitimacy based on ambidextrous innovation theory and new institutional theory.

1.2 Purpose of the Study

The purpose of this study is to explore the effect of GSCI on enterprise performance from an organizational capability perspective with ambidextrous green innovation as the mediator and green legitimacy as the moderator. We combine GSCI, ambidextrous green innovation, and green legitimacy-related literature to propose the following specific research objectives:

1. To redefine GSCI from an organizational capability perspective and investigate the relationship between GSCI and enterprise performance.

2. To analyze the effect of GSCI on enterprise performance through ambidextrous green innovation.

3. To explore if there is a moderating role for green legitimacy in the relationship between ambidextrous green innovation and enterprise performance.

1.3 Research Questions and Hypotheses

This study explores the effect of GSCI on enterprise performance from an organizational capability perspective with ambidextrous green innovation as the mediator and green legitimacy as the moderator. Then, this study would lead to the research questions as below:

RQ1: How does GSCI have a causal relationship with enterprise performance?

RQ2: How does GSCI have a causal relationship with enterprise performance through ambidextrous green innovation?

RQ3: How does ambidextrous green innovation have a causal relationship to increased enterprise performance with favorable green legitimacy?

The following research hypotheses were formulated to address the research objectives and questions. They are as follows:

H1: GSCI has a positive impact on enterprise performance.

H2: Ambidextrous green innovation has a positive impact on enterprise performance.

H3: GSCI has a positive impact on ambidextrous green innovation.

H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.

H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.

1.4 Scope of Study

The purpose of this study is to examine the influencing mechanism of GSCI on enterprise performance from the mediating effect of ambidextrous green innovation and the moderating effect of green legitimacy. Chinese pharmaceutical manufacturing industry provides an ideal research environment for this purpose.

The reasons are as follows: (1) The Pharmaceutical manufacturing industry is an important part of the Chinese national economy, a strategic industry related to national security and national livelihood, and occupies a high share of the international market. At present, China has become the second largest pharmaceutical market in the world, and the production and export of active pharmaceutical ingredients rank first in the world, the industry has a very good development prospect. (2) However, pharmaceutical manufacturing enterprises are seriously polluted, with strong green innovation pressure, while the green innovation ability is insufficient, the ambidextrous green innovation has become the pharmaceutical manufacturing enterprises' green transformation of the requirements of the times. (3) The pharmaceutical manufacturing industry is located in the "pharmaceutical supply chain". The vertical division of labor for the "pharmaceutical supply chain" is large, and pharmaceutical manufacturing enterprises have 50% of carbon emissions from the supply chain. Through GSCI, enterprises can establish a sustainable supply chain with lean, agile, resilient, and green characteristics, thus reducing the risk of ambidextrous green innovation and improving enterprise performance. (4) The Chinese legal system for green intellectual property rights is weak, and the concept of relying on a formal property rights system to protect the interests of green innovation behavior faces challenges. Green legitimacy has a significant impact on the effectiveness of ambidextrous green innovation behavior in pharmaceutical enterprises.

1.5 Definition of Terms

Green Supply Chain Integration (GSCI): An enterprise's ability to strategically collaborate with its supply chain partners in environmental protection.

Green Internal Integration (GII): Different departments within the enterprise work together to address in-house environmental issues through information sharing and collaboration.

Green Supplier Integration (GSI): The enterprise works closely with its core suppliers to understand environmental risks and responsibilities, share information, set common goals, and work together to address environmental issues.

Green Customer Integration (GCI): The enterprise works closely with its core customers to understand environmental risks and responsibilities, share information, set common goals, and work together to address environmental issues.

Ambidextrous Green Innovation: To more effectively address environmental challenges, enterprises engage in both exploitative and exploratory green innovation behaviors simultaneously.

Exploitative Green Innovation: Enterprises utilize existing environmental knowledge, information, and capabilities to make incremental, minor adjustments to existing green products, processes, and services.

Exploratory Green Innovation: Enterprises utilize new environmental knowledge, information, and capabilities to develop innovative green products, processes, and services.

Enterprise Performance: The self-development, along with social and ecological benefits, achieved by an enterprise through implementing GSCI and ambidextrous green innovation, based on a combination of self-interest, social responsibility, and environmental protection issues.

Economic Performance: The enhancement of enterprise profitability, as demonstrated in its financial statements, is accompanied by market share and customer satisfaction.

Environmental Performance: The enhancement of an enterprise's environmental impact level, typically linked with energy conservation, waste reduction, pollution control, and emission mitigation.

Social Performance: The enhancement of an enterprise's social responsibility and impact, encompassing its dedication to areas such as health and safety, education and training, as well as quality management.

Green Legitimacy: The extent to which an enterprise's green innovation behavior is accepted and recognized by the public.

Green coercive legitimacy: The enterprise is recognized by governments and regulators for green innovation.

Green normative legitimacy: enterprise is recognized by stakeholders such as the market, industry, environmental organizations, and customers for green innovation.

Green mimetic legitimacy: The enterprise is recognized by imitating other enterprises that have succeeded with green innovations.

1.6 Conceptual Framework

The conceptual framework is depicted in Figure 1.1.

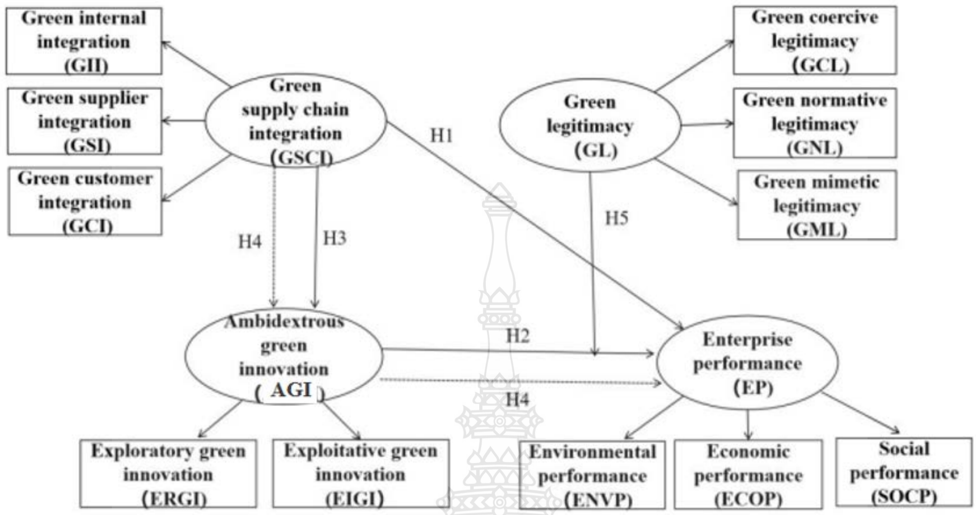

Figure 1.1 The model of conceptual framework

1.7 Benefits of Research

The expected results of this study may include the following:

(1) This study provides a new direction for future GSCI research and practice in pharmaceutical manufacturing enterprises. Enterprises should focus on developing GSCI capabilities to promote its positive impact on enterprise performance through ambidextrous green innovation adoption. Moreover, they must emphasize the acquisition of green legitimacy, which provides a certain degree of security to realize the benefits of ambidextrous green innovation.

(2) The results of this study can help relevant organizations, such as government departments and pharmaceutical industry associations, to consider which factors related to pharmaceutical manufacturing enterprises should be promoted and emphasized to promote green practices of pharmaceutical manufacturing enterprises, help them get rid of environmental protection difficulties, and achieve sustainable development.

(3) This study offers the following four theoretical contributions. Firstly, applying organizational capability theory to the GSCI field provides a novel dynamic perspective for GSCI from the standpoint of organizational capabilities. Secondly, the relationship between GSCI and enterprise performance in pharmaceutical manufacturing enterprises is clarified from the perspective of organizational capability theory. Thirdly, the mechanism of GSCI's role in shaping enterprise performance is investigated from the ambidextrous green innovation perspective. Fourth, the incentive effect of green legitimacy on the transformation from ambidextrous green innovation to enterprise performance was emphasized.

CHAPTER 2
REVIEW OF THE LITERATURE

2.1 Introduction

This study has a purpose to explore the impact of GSCI on enterprise performance from an organizational capability perspective. Additionally, this study investigated the mediating effect of ambidextrous green innovation and the moderating effect of green legitimacy.

In order to better fulfill the purpose of the study, this chapter conducts a systematic literature review, focusing on the concepts and dimensions of GSCI, enterprise performance, ambidextrous green innovation, and green legitimacy, and identify studies related to the relationship between these variables. Then, according to organizational capability theory, ambidextrous innovation theory, new institutional theory, and previous research results, the research hypothesis and conceptual framework are put forward.

2.2 Business of the Pharmaceutical Manufacturing Industry in China

2.2.1 Economic Status and Development Prospects of the Pharmaceutical Manufacturing Industry

Since the 21st century, Chinese pharmaceutical manufacturing industry has risen rapidly and has developed into the world's second-largest pharmaceutical market, and its API production and export has been steadily ranked first in the world, and China has become a major pharmaceutical manufacturing country. In 2016, the Chinese State Council released the "Healthy China 2030" Planning Outline, which elevates "Healthy China" was elevated to a national strategy. The pharmaceutical industry is closely related to "big health", and is not only a major component of the "big health" industry but also its cornerstone. Pharmaceutical manufacturing is a pillar industry related to the safety of national life and has an irreplaceable position in the national economic development, its importance is not only reflected in the economic development level but also related to the health of the general public and social stability and order (Zhuang & Duan, 2023).

By the end of 2022, the population over 65 years of age in China accounted for 14.9% of the total population, and this percentage continues to rise. This greatly increases the rigid demand for pharmaceuticals (Pharmaceutical Manufacturing Industry 2023 Blue Book, 2023). In addition, along with the reform of the healthcare system, the new round of technological change and cross-border integration, the increase in health awareness and health literacy of the whole population, the market environment and consumption capacity have also been improved, which makes Chinese pharmaceutical manufacturing industry has a lot of room for development.

2.2.2 Development Characteristics of the Pharmaceutical Manufacturing Industry

2.2.2.1 Ambidextrous green innovation has become the requirement of the times for the green transformation of pharmaceutical manufacturing enterprises.

Back in 2015, the pharmaceutical industry's total GHG emissions amounted to 52 Mt CO2 equiv, which is equivalent to 0.1% of the total global anthropogenic carbon emissions, and the carbon intensity is 55% higher than that of the automotive industry. This figure will be even more significant if carbon emissions from the supply chain chain are considered (Tao et al., 2023). Therefore, countries have recognized the urgency of implementing green manufacturing in pharmaceutical manufacturing enterprises and actively explored the road of green transformation in the pharmaceutical manufacturing industry. Although some results have been achieved, pharmaceutical manufacturing enterprises are still an important source of environmental degradation (Sahoo et al.,2022).

In recent years, as Chinese environmental requirements have tightened, more and more pharmaceutical enterprises have been penalized for environmental issues, resulting in economic losses while also facing the risk of production restrictions, production shutdowns, and rectification. In December 2022 alone, three pharmaceutical enterprises were fined for discharging water pollutants in excess of standards and environmental violations. Environmental protection's strong regulatory posture has made more and more pharmaceutical enterprises realize the importance of environmental compliance, pharmaceutical enterprises gradually choose to turn passive into active and actively lay out environmental protection strategies to promote the green transformation of enterprises, but the results are not significant. For example, Xinhua Pharmaceutical has invested more than 20 million yuan to rectify environmental problems, and Northeast

Pharmaceutical in recent years has invested more than 1 billion yuan to build environmental protection projects. However, these two enterprises are still fined for environmental violations. This shows that more than increasing environmental investment funds, the establishment of the correct form of governance, and choosing the appropriate green transformation strategy may be more important.

Ambidextrous green innovation has begun to gain attention in helping enterprises to better balance traditional business with green development (Martínez-Falcó et al.,2024). Like other heavily polluting industries, it is unlikely that the traditional development model of pharmaceutical manufacturing enterprises will be completely changed in a short period. However, the government's environmental policy is increasing day by day, and pharmaceutical manufacturing enterprises will face stricter environmental policy regulations. In this context, exploitative green innovation of ambidextrous green innovation, which focuses on the improvement of existing business processes and product quality, is relatively easy to implement and will help enterprises to cope with the government's environmental regulatory requirements in the short term. Exploratory green innovation of ambidextrous green innovation, which focuses on original, international cutting-edge green technology research and development and breakthroughs, is characterized by a long cycle, high risk, and high difficulty, and is unable to address the shortfall needs of enterprises. However, the concept of green development is developing deeply, and exploratory green innovation is crucial for enterprises to obtain long-term sustainable development amid stricter environmental policy regulation (Wang & Liu, 2020). This is because exploratory green innovation is the high point of industrial competition among countries in the future, and once a breakthrough is made, it will lead enterprises to the high end of the global pharmaceutical industry chain and value chain, which will help to open up new green markets globally and achieve a leading position.

In addition, with the booming development of artificial intelligence, big data analysis, quantum communications, and other high-tech technologies, the shortening of product life cycles in the high-tech industry will certainly affect the diversification and personalization of market demand. Implementing an ambidextrous green innovation strategy will not only target the green upgrading of products and extend the product life cycle but also help enterprises explore the new "S-shaped innovation curve" to gain a head start in the global industrial competition and improve their sustainable competitiveness (Liu & Zhou, 2023). Therefore, it has become a requirement of the times that pharmaceutical manufacturing enterprises must maintain the ambidexterity of green innovation.

2.2.2.2 Green Supply Chain Integration is an Important Way for Pharmaceutical Manufacturing Enterprises to Reduce Green Innovation Risks and Improve Corporate Performance.

According to the September 2019 ARUP and Health Care Without Harm (HCWH) report, the global healthcare sector accounts for 4.4% of overall carbon emissions. The CEOs of several major global pharmaceutical enterprises, in July 2023, signed an open letter calling on suppliers to adopt carbon reduction measures, while noting that half of the healthcare sector's carbon emissions come from the supply chain. Increasing global pressures on multiple fronts, including environmental, economic, and security, have prompted the pharmaceutical industry to focus not only on green innovation initiatives but also on green supply chain management in their operations (Kumar et al., 2019; Sahoo et al., 2022).

GSCI is the core and soul of green supply chain management (Chen et al., 2022) and the development goal of green supply chain management (Sahu et al., 2023). In the process of GSCI, enterprises usually reach a strategic partnership with their upstream and downstream supply chain enterprises and carry out comprehensive cooperation in various aspects such as product flow, information flow, and capital flow (Huo, 2012). This means that GSCI presents a management optimization process from the inside out and from the local to the whole, which in turn helps to significantly improve management and operation efficiency, reduce operation costs, and thus enhance corporate benefits. Pharmaceutical products contain active and sensitive molecular entities, and their production, storage, and transportation require strict temperature monitoring, their supply chains are characterized by higher complexity and high costliness (Kumar et al., 2019; Donkor et al., 2022). The supply chain activities in the pharmaceutical manufacturing industry also generate large amounts of waste, which is hazardous to the environment and human health (Faisal, 2016). Pharmaceutical manufacturing across the globe is facing challenges such as global quality standards, healthcare reforms, patent expiration and increased green service requirements, as well as high uncertainty in demand and capacity planning. Through GSCI, organizations can build sustainable supply chains with lean, agile, resilient, and green features to enhance business performance (Zhang et al., 2022; Sahu et al., 2023).

In addition, enterprises face risks such as long R&D cycles, short product life cycles, and uncertainty in market demand and capacity planning in the process of green innovation in pharmaceutical enterprises (Sahoo et al.,2022). Pharmaceutical enterprise's GSCI approach to green innovation with the help of external information and resources is more likely to be successful.

2.2.2.3 Green legitimacy Has a significant Impact on the Effectiveness of Ambidextrous Green Innovation Behaviors in Pharmaceutical Enterprises.

How to translate green innovation into firm performance has become an important topic of concern for both theory and practice in emerging economies (Wang & Huang, 2022). Unlike developed Western countries, the legal system of green intellectual property rights is weaker in emerging economies, and the notion of relying on formal property rights systems to protect the benefits of green innovation behavior faces challenges (Yang & Wang, 2020). However, new institutional theory suggests that firms' innovation behavior is also influenced by organizational legitimacy (Janssen & Nonnenmann, 2017). Green legitimacy is regarded as an extension of organizational legitimacy in the field of green innovation, which is the degree of recognition and acceptance of firms' green behaviors by stakeholders (Chang & Chen, 2013; Zhou et al., 2021). If a firm's green innovation behaviors can gain a higher degree of recognition from stakeholders, its green innovation activities are more likely to be transformed into firm performance; conversely, it may face greater difficulties (Wang & Huang, 2022). Green legitimacy plays an important role in whether dual green innovation in pharmaceutical manufacturing enterprises can be transformed into corporate performance.

2.3 Green Supply Chain Integration

2.3.1 Definition of Green Supply Chain Integration

In the realm of supply chain management, theoretical research on supply chain integration (SCI) predates GSCI. Early studies on SCI concentrated on enhancing resource utilization efficiency to reduce production costs through SCI (Sahu et al., 2018). With the growing demand for environmentally friendly practices, scholars began incorporating supply chain integration concepts into environmental management. As far back as 2011, Wolf introduced the notion of "sustainable supply chain integration," emphasizing the integration of product and service flows, information flows, capital, and decision-making flows to achieve environmental, economic, and social sustainability, ultimately delivering maximum value to various stakeholders (Wolf, 2011). Subsequent scholars delved into the environmental impacts of corporate behavior, developed the concept of GSCI, and explored its dimensional components (see Table 2.1).

As demonstrated in Table 2.1, the definition of GSCI has evolved and expanded over time. The initial GSCI primarily focused on environmental orientation and internal and external process management (Wu, 2013), while more recent literature has incorporated characteristics of strategic cooperation (Lo et al., 2018; Kong et al., 2020; Han & Huo, 2020). These features provide a robust foundation for further field development. However, the current definition of the GSCI concept remains static and does not address how enterprises, particularly those in emerging economies, can manage the natural uncertainties and dynamics inherent in their business processes (Wong et al.,2020). According to Sahu et al. (2023), supply chain management should align with strategic cooperation, environmental orientation, risk management, and sustainability. The same holds for GSCI, which serves as the cornerstone of green supply chain management. Therefore, redefining GSCI from a new perspective and broadening its connotation to adapt to the increasingly turbulent internal and external business environments is imperative.

Organizational capabilities are closely linked to the Resource-Based View (RBV), which investigates how resources and capabilities can be leveraged to achieve a competitive advantage (Huo, 2012). RBV underscores the significance of a firm's resources and capabilities. The comprehensive organizational capabilities guided by this theory encompass organizational culture and values, resources and capital, efficient operational processes and procedures, and the capacity to collaborate and communicate effectively (Newbert, 2007). This aligns closely with the static-level connotations of GSCI. In the context of GSCI, its environmental orientation embodies the organizational culture and values pertinent to environmental management, while the strategic cooperation and internal and external process management facets involve organizational resources and capital, operational processes and procedures, and collaborative communication capabilities.

As the external business environment for firms has grown increasingly volatile, scholars have progressively extended the RBV theory to concentrate on the dynamic capabilities of organizations. Dynamic capabilities theory posits that to secure and uphold a competitive edge, firms must cultivate the ability to adapt effectively to environmental changes, with the proactive acquisition of new resources being a vital component (Teece et al., 1997). Consequently, dynamic capabilities should not solely rest on a firm's existing resources and capabilities but should also encompass the firm's capacity to efficiently obtain external resources and innovate continually to cultivate new resources and capabilities. Dynamic capabilities theory can be regarded as an extension of RBV theory, recognizing the pivotal role of resources and capabilities while placing increased emphasis on how organizations capture, integrate, and reconfigure them to support strategic adaptability, flexibility, and ongoing innovation to maintain a competitive advantage (Song & Zhang, 2018).

Drawing inspiration from this concept, the understanding of GSCI can be expanded by framing it from a dynamic perspective through dynamic capability theory. Furthermore, research endeavors have initiated the exploration of this concept within the domain of GSCI. For instance, Wong et al. (2015) classify four types of GSCI practices, namely internal, supplier, customer, and stakeholder GSCI. They conclude that these four GSCI practices empower organizations to access, bundle, and leverage internal and external resources and capabilities, thereby enhancing the success of environmental management. In the analysis of the mediating role of GSCI between firms' environmental orientation and firm performance, Zhou et al. (2020) argue that GSCI not only enhances operational efficiency by swiftly integrating internal and external resources from supply chain partners through internal and external process management but also facilitates the sharing of environmental risks and responsibilities through strategic cooperation and collaborative green innovation. These efforts collectively contribute to the achievement of a shared objective of green development. In essence, the goal of GSCI is to realize shared green development through strategic cooperation and collaborative green innovation.

Additionally, Huo (2012) contends that SCI exhibits characteristics of complexity and ambiguity. He posits that enterprises, when implementing SCI, must possess multiple capabilities such as resource integration, information sharing, cooperation, and coordination. From Huo's perspective, SCI represents a dynamic capability.

Drawing from the preceding analysis and research background, GSCI can be regarded as a dynamic capability. It is defined as an enterprise's ability to strategically collaborate with its supply chain partners in environmental protection. This approach aims to enhance environmental performance, thereby reducing environmental impacts, increasing sustainability, and adapting to evolving market conditions. Such a capability aligns with the fundamental objectives of green supply chain management.

2.3.2 Dimension of Green Supply Chain Integration

Some studies have explored GSCI as a single-dimensional variable, while most studies recognize it as a multidimensional concept and conduct in-depth analysis from multiple dimensions (Han & Huo, 2020) (See table 2.1). Wolf was the first to extend SCI to the environment, proposing sustainable supply chains and studying them as a single dimension (Wolf, 2011). Other scholars referred to the traditional SCI and categorized GSCI based on the entities involved, such as green internal integration (GII), green supplier integration (GSI), and green customer integration (GCI) (Wu, 2013; Wong et al., 2015; Lo et al., 2018; Kong et al., 2020; Han & Huo, 2020).

Table 2.1 Summary of green supply chain integration concepts and dimensions

Definition	**Dimension**	**Sources**
Sustainable supply chain integration refers to maximizing value for multiple stakeholders by integrating product and service flows, information flows, capital, and decision-making flows to achieve environmental, economic, and social sustainability.	Single dimension	Wolf (2011)
GSCI is defined as enterprises working with their supply chain partners to manage environmental behavior within and across organizations.	Three dimensions (GII, GSI.GCI)	Wu (2013)
GSCI is a way for enterprises to leverage resources and capabilities among supply chain partners.	Four dimensions (Internal GSCI,Supplier GSCI,Customer GSCI,Community stakeholder GSCI)	Wong et al. (2015)
GSCI is defined as the extent to which manufacturers and their supply chain partners strategically collaborate and synergistically manage intra- and inter-organizational processes to improve environmental performance.	Three dimensions (GII, GSI, GCI)	Lo et al. (2018)
GSCI relates to the extent to which manufacturers work strategically with suppliers and customers, as well as internal functions, to meet environmental requirements.	Three dimensions (GII, GSI, GCI)	Kong et al. (2020)
GSCI can be defined as the extent to which a manufacturer builds a strategic relationship with its supply chain partners and collaboratively integrates environmental concerns into the intra-and inter-organizational processes.	Three dimensions (GII, GSI, GCI)	Han and Huo (2020)

Han & Huo (2020) conducted a more comprehensive analysis based on these three dimensions, considering GSCI as a second-order concept. They proposed that the content of the three sub-dimensions could be further manifested in three aspects: green information sharing, green process coordination, and green strategic alliances. Wong et al. (2015) added community stakeholder GSCI to the three dimensions of GSCI based on stakeholder and resource orchestration theory.

Consistent with most studies, this study categorized the GSCI into three dimensions: GII, GSI, and GCI (see Figure 2.1). In this study, continuing the view of Huo (2012) and Wong et al. that GII belongs to the internal core incentive competencies of firms and GSI and GCI belong to the external core incentive competencies of firms (Huo, 2012; Wong et al.,2015)

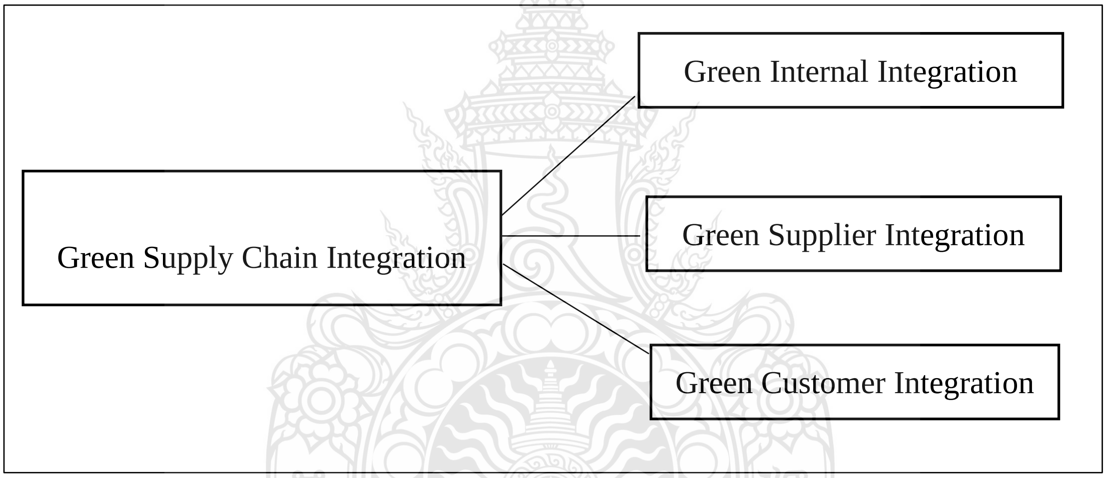

Figure 2.1 Dimension of GSCI

GII pertains to collaborative ability among different parts of the organization, encompassing the sharing of information resources and coordination to promote environmental management practices within the enterprise. This capability ensures that enterprise operations and decision-making align with environmental objectives, thus promoting sustainability and environmental responsibility.

GSI entails close collaboration between an enterprise and its core suppliers. It involves understanding environmental risks and responsibilities, sharing information, establishing common goals, and collaborating to address environmental issues and achieve shared environmental objectives. This capability encourages suppliers in the supply chain to adopt sustainability measures to comply with evolving environmental regulations.

GCI focuses on collaboration between an enterprise and its core customers, encompassing information sharing, joint decision-making, and collaborative resolution of environmental issues to attain common environmental goals. This capability caters to customer demands for environmentally friendly products and practices, heightening environmental awareness and establishing a competitive advantage in the marketplace.

2.3.3 Effect of Green Supply Chain Integration as Independent Variable

There are few studies on the effects of GSCI outcomes (see Table 2.2). These studies mainly focused on the impact of GSCI on enterprise performance and green innovation. In terms of enterprise performance, the main concern is environmental performance and economic performance, and less attention was paid to sustainable performance (Han & Huo, 2020). As for green innovation, the main focus was on green product innovation and green process innovation, and less attention was paid to ambidextrous green innovation green innovation.

In addition, existing studies mainly explained the impact of GSCI on enterprise performance and green innovation behavior based on the logical viewpoints provided by the natural resource base view (NRBV) and resource dependence theory (RBV). GSCI helps enterprises break through resource constraints, obtain more source information, and achieve centralized resource allocation to meet sustainability goals. GSCI facilitates the sharing and coordination of information and resources among suppliers, customers, and internal departments within enterprises. This collaboration ensures alignment towards common strategic objectives across the supply chain, fostering innovation in pollution prevention strategies and product management plans. Consequently, it effectively enhances enterprise performance (Wu, 2013; Han & Huo, 2020; Sun & Sun, 2021). Kong et al. (2020), based on RBV, especially emphasized and verified the mediating role of information sharing between GSCI and corporate financial performance.

Some scholars integrate other theories into RBV to study the influence mechanism of GSCI on enterprise performance. Ji et al. (2020) integrated the knowledge-based view and RBV, examining the mediating effect of supply chain resilience between

GSCI and firm environmental performance. Furthermore, they elucidated the positive facilitating role of knowledge integration on the relationship between GSCI and supply chain resilience.

Feng et al. (2020) and Feng et al. (2021) combined RBV and transaction cost economics to explore the mediating role of information sharing and opportunistic behavior in the relationship between GSCI and enterprise performance. They also emphasized the difficulties and obstacles that may arise during GSCI's implementation process, and they believed that excessive dependence on information and resources from external partners would lead to an asymmetric power status, inducing opportunistic behavior among partners. They found that this negative effect would be highlighted particularly when integrating with customers for green practices (Feng et al., 2020; Feng et al., 2021).

There are also scholars who combine the knowledge-based view and RBV to explore the impact of GSCI on enterprises' green innovation behavior. They argued that the integration with suppliers and customers achieves knowledge creation between organizations through mergers and exchanges, thereby helping enterprises more fully identify environmental needs, acquire valuable environmental knowledge, and successfully breed green innovation products (Kong et al., 2020).

However, NRBV and RBV do not explain how the uncertainties and dynamics inherent in the green innovation process can be addressed through GSCI (Wong et al.,2020). Huo (2012) argues that organizational capability can help to examine how enterprises use resources and capabilities to gain competitive advantage in a dynamic environment of uncertainty. GSCI can be considered as a combination of internal and external capabilities that directly or indirectly contribute to firm performance (Huo,2012; Zhou et al.,2020). Therefore, to understand the link between GSCI and the uncertainty and dynamics of green innovation, this study explores the relation of GSCI and enterprise performance from the perspective of organizational capability

Table 2.2 Summarizing the effects of green supply chain integration

Theoretical foundation	Independent	Dependent variable	Mediators	Moderators	Main Findings	Source
Natural-resource-based view	GSCI	Green product innovation and green process innovation	None	Demand uncertainty, technological uncertainty	GII, GSI, and GCI foster green product and process innovations. Demand uncertainty positively influences each GSCI-green innovation link, while the moderating effect of technological uncertainty is negligible.	Wu (2013)
	GSCI	Enterprise performance	None	None	GII promotes firms' environmental and social performance, GCI promotes firms' social performance, and only GSI promotes firms' economic performance.	Han & Huo (2020)
	GSCI	Environmental performance	Supply chain resilience	knowledge combination	Supply chain resilience partially mediates the link between green supplier integration and environmental performance, knowledge combination strengthens the positive impact of green supplier integration on the reactive dimension of supply chain resilience.	Ji et al. (2020)

Table 1.2 Summarizing the effects of green supply chain integration (Cont.)

Theoretical foundation	Independent	Dependent variable	Mediators	Moderators	Main Findings	Source
Resource-based view	GSCI	Environmental performance and economic performance	None	None	GSCI has a positive influence on environmental performance and economic performance.	Zhou et al. (2020)
	GSCI	Ambidextrous Green Innovation	None	None	GSCI has a positive influence on ambidextrous green innovation.	Sun & Sun (2021)
	GSCI	Financial performance	Information Sharing	None	Supplier, customer, and internal integration promote financial performance through information sharing.	Kong et al.(2021)
Resource-based view and transaction cost economics	GSI	Environmental performance and financial performance	Information sharing and opportunistic behavior	dependence and trust	Over-dependence on suppliers can trigger opportunistic behavior in suppliers, which is detrimental to the firm's environmental and financial performance. Trust can inhibit opportunistic behavior.	Feng et al. (2020)

Table 2.2 Summarizing the effects of green supply chain integration (Cont.)

Theoretical foundation	Independent	Dependent variable	Mediators	Moderators	Main Findings	Source
	GCI	Financial performance	Information sharing and opportunistic behavior	dependence and trust	Over-dependence on customers can trigger opportunism and harm financial performance.	Feng et al. (2021)
Resource-based view and Knowledge -based view	GSCI	Green product innovation and green process innovation	Knowledge creation	None	GSCI can be regarded as an excellent knowledge creation mechanism that promotes green product innovation and process innovation through the knowledge creation process.	Kong et al. (2020)

2.4 Enterprise Performance

2.4.1 Definition of Enterprise Performance

The most intuitive explanation for performance is an effect, where behavior produces an effect and performance. As the name suggests, enterprise behavior produces enterprise performance, which leads to two different perspectives to define the concept of enterprise performance.

Creating enterprise performance is a dynamic process. From a dynamic perspective, Chen et al. (2014) believe that enterprise performance is a behavioral process in which an enterprise formulates reasonable behavioral norms and implements them to pursue established goals. This behavioral norm is elastic and needs to be continuously adjusted according to changes in enterprise resources and fluctuations in the external environment, continuously regulating and improving behavior, and ultimately achieving the set goals. There are both quantitative and non-quantitative methods for measuring these behaviors, and definitions from different perspectives can have significant differences in the way performance is measured.

Enterprise performance is the outcome of a process. Lebas (1995) demonstrated through empirical research that enterprise performance is the ultimate form of transformation of corporate behavior. During a period of time, an enterprise engages in production and operation activities, and enterprise performance is the most favorable indicator to measure the effectiveness of its production and operation activities. This is mainly reflected in financial data such as profits on the enterprise's financial statements. With the development of the economy and society, the definition of enterprise performance has also expanded. Financial data cannot fully represent the entire process of enterprise behavior behind enterprise performance, and the measurement method is too one-sided. It is necessary to combine the perspectives of process and results to provide a new definition of enterprise performance.

Yu and Si (2017) comprehensively summarized that the measurement of enterprise performance should not only reflect the contributions of managers during a certain period but also reflect the efficiency of the entire enterprise's production and operation activities. Currently, scholars believe that enterprise performance encompasses not only economic performance but also non-economic performance. With the advancement of sustainable development theory, the concept of enterprise performance has expanded, emphasizing the balanced development of the economy, society, and the environment (Büyükzkan & Karabulut,2018).

Based on the above analysis, we define enterprise performance as the economic, environmental, and social benefits achieved by enterprises through the implementation of GSCI and ambidextrous green innovation. This definition takes into account their own interests, social responsibility, and environmental protection issues.

2.4.2Dimension of Enterprise Performance

Since Elkington first introduced the concept of sustainability, numerous scholars have begun to apply it to several areas, including the field of enterprise performance. A growing body of literature adopts Elkington's (1998) view to measure enterprise performance, also known as the triple performance model (see figure 2.2) (Fauzi et al.,2010; Büyükzkan & Karabulut, 2018). This study adopts Elkington's (1998) view to measure enterprise performance too.

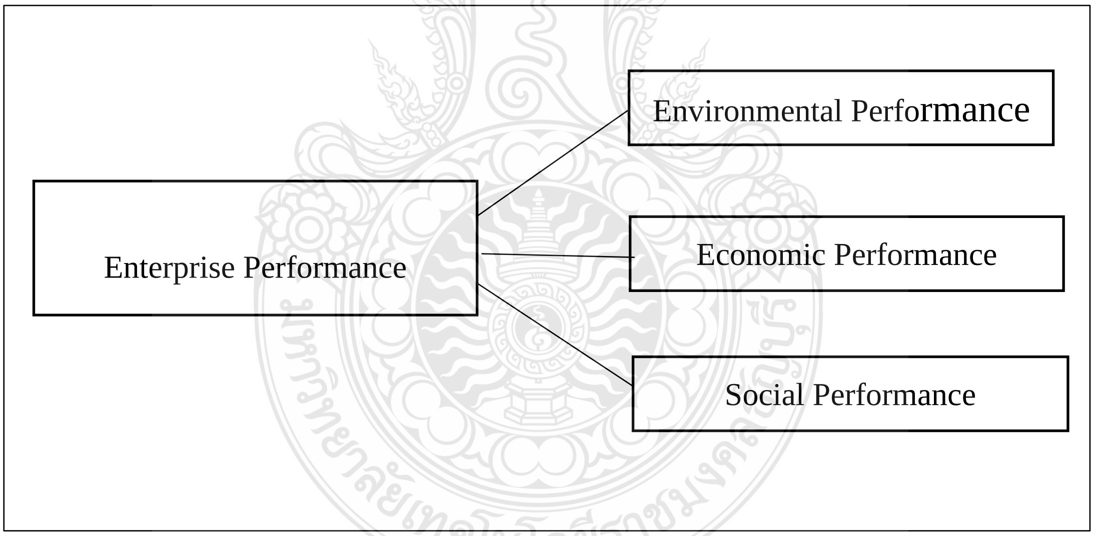

Figure 2.2 Dimension of enterprise performance

Based on the triple performance model, if enterprises want to achieve sustainable development, they must not violate the three bottom lines of improving their own economic benefits, maintaining their environment, and fulfilling their obligations in the social environment in which they operate. As a for-profit commercial institution, enterprises should improve their economic efficiency; Enterprises, as institutions in human society, should contribute a portion of their strength to the society they are in; Enterprises are in an ecological environment and should maintain their surrounding ecological environment to achieve sustainable development.

Economic performance refers to the enhancement of enterprise profitability, as demonstrated in its financial statements, which is accompanied by market share and customer satisfaction. Social performance focuses on the performance of enterprises in terms of social responsibility and social impact, covering the enterprise's commitment to social responsibilities such as health and safety, education and training, and quality management. Environmental performance refers to the improvement in the level of enterprises' environmental impact, which is usually associated with energy conservation, reduction of waste, pollution, and emissions.

Good economic performance is critical to the long-term growth of an enterprise, providing it with the capital and resources to facilitate its sustained growth and support its ongoing creation of social value. It is seen as a core motivation for building profitable enterprises (Geng et al., 2017; Agyabeng-Mensah et al., 2020).

Good environmental performance helps to protect ecosystems, reduce environmental risks, and meet consumer and stakeholder expectations of corporate environmental responsibility, which in turn promotes customer loyalty and brand awareness (Agyabeng-Mensah et al., 2020). Social performance addresses the relationship between an enterprise and its stakeholders, including employees, consumers, communities, and society as a whole (Geng et al., 2017; Agyabeng-Mensah et al., 2020).

2.4.3 Research on Enterprise Performance Evaluation

In recent years, many scholars have evaluated enterprise performance from different perspectives and established multiple evaluation systems and indicators, such as the Balanced Scorecard, EVA, entropy method, gray correlation analysis, BP neural network method, etc., enabling people to measure enterprise performance more objectively and accurately.

Mamun (2011) found through research that EVA can better reflect the performance level of logistics enterprises compared to traditional performance evaluation indicators. Hai and Xian (2016) established a comprehensive evaluation system of grey correlation analysis combined with entropy weight method to evaluate the performance of listed real estate enterprises and solved the problems of subjective evaluation and adverse indicators in the evaluation process. Hua et al. (2016), from a unique perspective of the carbon emission value chain, have improved and adjusted traditional green EVA by establishing innovative green EVA indicators to evaluate the impact of low-carbon operation on enterprise performance. Lobkov et al. (2020) uses the Balanced scorecard to model the performance assessment of industrial enterprises, so as to evaluate the effectiveness of industrial enterprise management activities. Yi et al. (2020) established an entropy weight-improved TOPSIS evaluation model to more accurately and reasonably evaluate the performance of Baijiu enterprises. Xu and Xue (2020) used a combination weighting model to study the G1 method and BP neural network method. Based on data from 25 5A-level logistics enterprises in 2018, they found that the influencing factors that formed the gap between Chinese 5A-level logistics enterprises include asset return ability and customer service level.

Although there are more and more methods for evaluating enterprise performance and the results are getting better, there are still certain problems. Yu (2014) pointed out that the performance evaluation objectives in the current performance evaluation are relatively backward, and the combination of financial and non-financial evaluation indicators is not sufficient. The setting of non-financial evaluation indicators needs to be supplemented, and the performance evaluation subject is also too single. Li (2016) summarized the misconceptions of some scholars using factor analysis: it is unreasonable to solely determine evaluation criteria and weights based on data logic; The weights generated by mathematical operations are not unique and lack practical significance; Improper application of factor analysis method to specific objects can lead to unreasonable conclusions, etc. To improve scientific, she suggests improving factor analysis and combining it with Analytic Hierarchy Process or expert scoring methods. Xue and Ning (2018) believe that the current problems in the performance evaluation of state-owned enterprises include incomplete relevant institutional systems, the lack of long-term strategic and formal supervision of existing performance evaluation indicators, and other issues. In response to these issues, state-owned enterprises need to strengthen the construction of relevant systems, improve the evaluation index system, and actively develop value evaluation and external evaluation.

Lin et al. (2010) used production capacity and supply chain capacity to measure enterprise performance. Arginelli (2015) divided the performance of high-tech enterprises into innovation performance and financial performance. By evaluating the effectiveness of policy implementation, it was found that tax incentives for corporate performance can have a positive impact during the implementation process. McLean and Round (1978) studied Australian manufacturing enterprises and selected financial profitability as a measure of corporate performance. They found positive feedback between the level of R&D investment and corporate performance.

2.5 Ambidextrous Green Innovation

2.5.1 Ambidextrous Innovation Theory

As competitive pressures increase, the ambidextrous innovation behavior of firms has gradually become one of the hot topics in management research. According to ambidextrous innovation theory, firms' innovative behaviors can be classified into exploratory and exploitative innovation according to the degree of innovation (March, 1996). Exploratory innovation involves complex search, fundamental research, experimentation, risk-taking, and the ongoing pursuit of new knowledge and product development to cater to the needs of potential or emerging users. Conversely, exploitative innovation focuses on continually extending existing technologies and knowledge through ongoing quality enhancements and expanding current products and services. Additionally, it emphasizes enhancing the efficiency of utilizing existing products and management strategies to meet current user demands and external requirements (Han et al., 2023).

Ambidextrous innovation theory suggests that exploration and exploitation are often contradictory opposites in an enterprise's operations, but that a single exploration or exploitation will not only fail to achieve better results, but may even accelerate the enterprise's demise (Tushmanmal & O'Reilly, 1996; Wang et al., 2012; Christensen, 2013). Specifically, too many exploitative innovation activities, while yielding more short-term gains and efficient returns, may lock the enterprise into an established capability pattern, blocking the horizon for exploring new technologies and making it difficult to dynamically adapt to changes in the environment, gradually falling into a 'capability trap' (Wang et al.,2012; Christensen, 2013). Exploration innovation generally involves long-term, new technology development with high variables, which makes the enterprise more adaptable to market changes, but the failure rate of innovation is high, and enterprises that often interrupt their regular operations and focus their limited resources on exploratory innovation will fall into the "innovation trap" and form a vicious cycle of "exploration-failure-no return" (Gupta et al., 2006; Wang et al., 2012). The vicious cycle of "exploration-failure-no return" will have a negative impact on enterprise performance (Gupta et al., 2006; Wang et al., 2012).

Jansen et al. (2006) argue that a combination of exploration and exploitation can lead to greater viability and better performance of enterprises. At the same time, recent literature suggests that due to the ambiguity and uncertainty of the future, enterprises need to combine and co-exist two innovation activities, not only to combine the advantages of both, but also to create a collaborative and complementary effect like running, where the forward movement of one side drives the other (Han et al., 2023; Wang et al., 2012). It is clear that ambidextrous innovation emphasizes the coexistence and balance of exploitative and exploratory innovation, and that successful companies derive their success from the combined effect of both.

2.5.2 Definition and Dimension of Ambidextrous Green Innovation

Focusing on ambidextrous green innovation, the existing literature defines its connotation based on ambidextrous innovation theory. They primarily defined ambidextrous green innovation from three distinct perspectives, which are showed in Table 2.3.

Table 2.3 Summary of ambidextrous green innovation concepts and dimensions

Perspective	Definition	Sources
Based on the novelty of environmental knowledge	Exploratory green innovation refers to the use of new environmental knowledge, information, and capabilities by enterprises for the development of entirely new green products, processes, and services to meet potential market and consumer needs. Exploitative green innovation refers to the enhancement of existing green products, processes and services by enterprises based on their existing environmental knowledge, information, and capabilities to meet the green needs of existing markets and consumers.	Wang et al. (2020); Sun & Sun (2021); Asiaei et al. (2023); Meiting et al. (2023)
Based on the novelty of the technology	Breakthrough green innovation refers to the innovation behavior of enterprises breaking through the existing green technology track, which is mainly manifested in the reconstruction of green knowledge and technology, and may produce new green products and processes, and help enterprises to establish green technology barriers to meet the green needs of emerging customers or markets; Progressive green innovation refers to the innovations carried out by enterprises on the existing green technology track, which is mainly manifested in the improvement and refinement of green knowledge and technology, and may be accompanied by technological upgrading, upgrading of green products and services, and reduction of green development costs.	Zeng & Li (2022); Jia et al. (2022); Wang & Liu (2020)
Based on the novelty of the product	Exploratory green product innovation refers to the enterprise to emerging markets and customer demand-oriented, dedicated to the creative development of resource-saving, clean and healthy environmentally friendly new products. Exploitative green product innovation focuses on the improvement of the green performance of existing products, to improve the efficiency of resource utilization, reduce the negative impact on the environment.	Zhao et al. (2022)

Firstly, ambidextrous green innovation is divided into two dimensions based on the knowledge base and degree of innovation: exploitative green innovation and exploratory green innovation. The former enhances existing green products, processes and services based on existing environmental knowledge, information and capabilities to meet existing market and consumer green needs; the latter develops new green products, processes and services based on new environmental knowledge, information and capabilities to meet potential market and consumer needs (Wang et al., 2020; Sun & Sun, 2021; Asiaei et al,2023; Meiting et al., 2023). It is argued that ambidextrous green innovation is the magic formula for firms to successfully address environmental challenges, and that there are complementary and synergistic effects between the two that jointly contribute to improved environmental performance (Asiaei et al, 2023; Wang et al., 2020).

Secondly, from the perspective of similarity with existing technology trajectories, ambidextrous green innovations are classified as breakthrough green innovations and incremental green innovations. The former refers to the innovation behavior of breaking through the existing green technology track, which is manifested as the reconstruction of existing green knowledge and technology, often accompanied by the generation of new green products and processes, and helps enterprises to form green technology barriers and meet the green needs of emerging customers or markets; the latter refers to the innovation behavior along the existing green technology track, which is manifested as the improvement and perfection of existing green knowledge and technology, often accompanied by the technology enhancement, upgrading of green products and services, and reduction of green development costs (Wang & Liu, 2020; Zeng & Li, 2022; Jia et al., 2022). It is argued that maintaining the ambidexterity of green innovation helps firms to balance short-term performance and long-term development, but the mechanisms and effects of the two actions are heterogeneous and a relative balance between them needs to be maintained (Wang & Liu,2020; Jia et al., 2022).

Thirdly, ambidextrous green innovation is defined in terms of the degree of novelty of products: exploratory green innovation refers to enterprises' commitment to creatively develop new environmentally friendly products that are resource-saving, clean and healthy, oriented to the needs of emerging markets and customers; exploitative green innovation focuses on the improvement of green performance of existing products by integrating the existing knowledge system for technology enhancement and process improvement to improve the efficiency of resource utilization and reduce the negative impact on the environment(Zhao et al., 2022）.

In summary, many scholars tend to inherit Benner & Tushman's (2003) viewpoint when defining ambidextrous green innovation, dividing it into exploratory and exploitative types; on the other hand, they emphasize the balanced complementation between the two. This is consistent with the idea of ambidextrous innovation, which is the result of the greening of ambidextrous innovation and belongs to the subset of ambidextrous innovation in the field of green development (Wang et al., 2020; Sun & Sun, 2021; Asiaei et al., 2023).

Given that the path of green transformation for Chinese manufacturing enterprises is characterized by a balance between technological progress and product value-added enhancement, the need to update knowledge and increase the degree of innovation fits with the first category of views. Therefore, based on the perspective of knowledge base and degree of innovation, this study divides ambidextrous green innovation into two dimensions, namely exploitative green innovation and exploratory green innovation, and draws on Benner and Tushman (2003) and Lubatkin et al (2006) to define the meaning of ambidextrous green innovation. Exploratory green innovation is the use of new environmental knowledge, information, and capabilities to develop new green products, processes, and services to meet the green needs of potential or emerging users; exploitative green innovation is the innovation of small, incremental changes to existing green products, processes and services to meet the green needs of existing users and external parties.

2.5.3 Related Research on Ambidextrous Green Innovation

Ambidextrous green innovation started late. In 2020, Wang et al. first proposed the concept of ambidextrous green innovation based on ambidextrous innovation theory and related research results of green innovation. They believe that green dual innovation is the result of ambidextrous innovation in green aspect, which helps enterprises to better cope with environmental challenges. At present, China has put forward high-quality development goals and dual-carbon goals, which put forward higher requirements for enterprises. However, as a latecomer technology country, Chinese green innovation, especially green technology innovation, is characterized by complexity, high cost, and negative externalities. It is difficult for enterprises to realize exploratory innovation in green technology in the short term, but they must achieve achievements in this area. Therefore, in the Chinese academic circles, the ambidextrous green innovation has received more and more attention. The existing literature mainly focuses on the antecedent variable and the result variable of ambidextrous green innovation.

2.5.3.1 Research on the Influencing Factors of Ambidextrous Green Innovation.

Despite the belated inception of ambidextrous green innovation, research into its precursor variables offers a diverse array of perspectives (refer to Table 4), outlined as follows:

(1) Resource-based perspective

Resource-based perspective is a relatively early perspective. Based on a resource-based view, Wang et al. (2020) argue that green innovation requires new environmental knowledge and green technology resources, green knowledge is an important resource for enterprises to carry out ambidextrous green innovation, and green learning orientation facilitates enterprises to identify, absorb and even create green knowledge, so green learning orientation actively promotes the ambidextrous green innovation practice of enterprises through green knowledge acquisition. Sun and Sun (2021), based on RBV, argue that the cooperative relationship established by enterprises through GSCI constitutes a bridge between green innovation strategy and ambidextrous green innovation. In other words, the green innovation strategy influences the ambidextrous green innovation behavior of the enterprise through GSCI.

(2) Knowledge base view perspective

Based on the knowledge base view, Jia et al. (2022) argue that firms promote ambidextrous green innovation by acquiring, sharing and applying customer green knowledge to improve existing products and services or create new products and services. That is, customer participation in the development of new green products has an important role in promoting ambidextrous green innovation. Based on organizational learning theory, Zhao et al. (2022) argued that scientific knowledge search, market knowledge search, and supply chain knowledge search have a positive impact on the ambidextrous green innovation of construction enterprises.

(3) Resource orchestration perspective

Based on the natural resource orchestration theory, Asiaei et al (2023) argue that green intellectual capital components, including (a) green human capital, (b) green structural capital, and (c) green relational capital, are positively associated with ambidextrous green innovation.

(4) Executive characteristics perspective

Yang and Yang (2023), based on the upper echelon's theory and ambidextrous innovation theory, concluded that CEO green transformational leadership has an important role in promoting ambidextrous green innovation in enterprises. Based on imprinting theory and upper echelons theory, Meiting et al. (2023) concluded that if the senior management team has a technical education imprint, they are more likely to adopt exploratory green innovation; if they have a technical positional imprint, they are more inclined to adopt exploitative green innovation. In this process, environmental attention plays a mediating role.

(5) Configuration perspective

Zeng and Li (2022) believed that exploratory green innovation and exploitative green innovation have great differences in innovation degree and innovation demand, and there is a lack of in-depth exploration into the reasons for the differentiation of enterprise ambidextrous green innovation. Therefore, from the perspective of configuration, they adopted the TOE analysis framework to explore the driving path of ambidextrous green innovation from the three levels of technology, organization, and environment. The results show that the driving path of ambidextrous green innovation requires the linkage of multiple factors of technology, organization, and environment, and the driving paths of exploratory green innovation and exploitative green innovation differ.

Table 2.4 Summary of influencing factors of ambidextrous green innovation

Research perspective	Influence factor	Mediators	Moderators	Main findings	Source
Resource-based view	Green learning orientation	Green knowledge acquisition	None	Green learning orientation actively promotes the ambidextrous green innovation practice of enterprises through green knowledge acquisition	Wang et al. (2020)
	Green innovation strategy	GSCI	None	Green innovation strategy influences the ambidextrous green innovation behavior of the enterprise through GSCI	Sun & Sun (2021)
Knowledge-based view	Customer participation	None	None	Customer participation has a positive influence on ambidextrous green innovation	Jia et al. (2020)
	Scientific knowledge search, market knowledge search, and supply chain knowledge search	None	None	Scientific knowledge search, market knowledge search, and supply chain knowledge search have a positive impact on the ambidextrous green innovation of construction enterprises	Zhao et al. (2022)
Resource orchestration perspective	Green intellectual capital	None	None	Green intellectual capital components, including green human capital, green structural capital, and green relational capital, are positively associated with ambidextrous green innovation.	Asiaei et al. (2023)
Executive characteristics perspective	Green transformation leadership	None	None	CEO green transformation leadership has an important role in promoting ambidextrous green innovation in enterprises	Yang & Yang (2023)

Table 2.4 Summary of influencing factors of ambidextrous green innovation (Cont.)

Research perspective	Influence factor	Mediators	Moderators	Main findings	Source
Configuratio n perspective	Technological imprint	Environmen tal attention	None	An executive team with a technical education imprint is more likely to adopt exploratory green innovation; whereas, an executive team with a technological positioning stamp is more likely to adopt exploitative green innovation. Environmental attention plays a mediating role in this process.	Meiting et al. (2023)
Configuratio n perspective	Technology, organization, and environment	None	None	The driving path of ambidextrous green innovation requires the linkage of multiple factors of technology, organization, and environment, and the driving paths of exploratory green innovation and exploitative green innovation are different	Zeng & Li (2022)

2.5.3.2 Research on the Effect of Ambidextrous Green Innovation.

The literature on ambidextrous green innovation outcome variables is relatively limited, with two sources from the Web of Science and two from the China Knowledge Network (Refer to Table 2.5). Further details are provided below:

(1) Environmental performance

Asiaei et al. (2023), drawing from the ambidextrous innovation theory, posited that exploratory green innovation and exploitative green innovation complement each other and ware closely intertwined. They argued that enterprises engaging in both types of green innovation activities are more likely to attain enhanced environmental performance compared to those focusing solely on one type of green innovation activity.

(2) Competitive advantage

In 2020, Wang and Liu (2020) employed ambidextrous theory and competitive advantage theory to investigate the correlation between exploratory and exploitative green innovation and enterprises' customer advantage, technological advantage, and financial advantage. They also analyzed the moderating influence of technological turbulence, focusing on the Chinese manufacturing industry. The findings reveal that both exploratory and exploitative green innovations exert substantial positive impacts on firms' customer advantage, technological advantage, and financial advantage. However, the effects of both on manufacturing enterprises' competitive advantage exhibit differentiation.

(3) Financial performance

Jia et al. (2022) proposed a conceptual model with customer participation as the independent variable and ambidextrous green innovation as the mediating variable to enhance enterprise performance, in line with the central themes of enterprise innovation-driven and green development amidst the realistic backdrop of intelligent scenarios and rising consumer demand for personalized customization. Their findings revealed that customer participation significantly boosted both exploitative and exploratory green innovation. Furthermore, both forms of green innovation positively impacted enterprise performance.

Based on relevant research on ambidextrous green innovation, the predominant focus is on exploring its driving factors, with relatively fewer studies examining its outcome variables. Presently, only a minority of studies have delved into the impact of ambidextrous green innovation on enterprise performance and competitive advantage.

Table 2.5 Summary of the effects of ambidextrous green innovation

Research perspective	Influence factor	Mediators	Moderators	Main findings	Source
Resource-based view	Green learning orientation	Green knowledge acquisition	None	Green learning orientation actively promotes the ambidextrous green innovation practice of enterprises through green knowledge acquisition.	Wang et al. (2020)
	Green innovation strategy	GSCI	None	Green innovation strategy influences the ambidextrous green innovation behavior of the enterprise through GSCI.	Sun & Sun (2021)
Knowledge-based view	Customer participation	None	Product Intelligence	Customer participation positively impacts ambidextrous green innovation, while product intelligence exerts a negative moderating influence on it.	Jia et al. (2020)
	Scientific, market, and supply chain knowledge search	None	None	Scientific knowledge search, market knowledge search and supply chain knowledge search have a positive impact on the ambidextrous green innovation of construction enterprises.	Zhao et al. (2022)
Resource orchestration perspective	Green intellectual capital	None	None	Green intellectual capital components, including green human capital, green structural capital, and green relational capital, are positively associated with ambidextrous green innovation.	Asiaei et al. (2023)
Executive characteristics perspective	Green transformation leadership	None	None	CEO green transformation leadership has an important role in promoting ambidextrous green innovation in enterprises.	Yang & Yang (2023)

Table 2.5 Summary of the effects of ambidextrous green innovation (Cont.)

Research perspective	Influence factor	Mediators	Moderators	Main findings	Source
	Technological imprint	Environmental attention	None	An executive team with a technical education imprint is more likely to adopt exploratory green innovation; whereas, an executive team with a technological positioning stamp is more likely to adopt exploitative green innovation. Environmental attention plays a mediating role in this process.	Meiting et al. (2023)
Configuration perspective	Technology, organization and environment	None	None	Driving path of ambidextrous green innovation requires the linkage of multiple factors of technology, organization and environment, and the driving paths of exploratory green innovation and exploitative green innovation are different.	Zeng & Li (2022)

2.6 Green Legitimacy

2.6.1 Definition of Green Legitimacy

Organizational legitimacy was first introduced into sociological research by Weber (1968). Parsons (1960) expanded on Weber's (1968) view by arguing that the focus of legitimacy goes beyond the political power system to include the congruence of organizational values with social contextual values, i.e., legitimacy reflects the extent to which organizational actions are endorsed by shared or universal values in the social system. Since then, the new institutional theory school has further developed the concept of legitimacy and extended it to the fields of organizational behavior and management, such as business and nonprofit organizations. After rich development by scholars, the concept that is now widely accepted and recognized is the one given by Suchman (1995): the appropriateness and legitimacy of a business or organizational behavior is widely recognized within an environmental system with specific social norms, values, and beliefs. That is, an organization is considered to have organizational legitimacy when it is recognized or supported by a specific audience, and vice versa (Wang et al., 2020).

Green legitimacy is the result of the greening of organizational legitimacy. Green legitimacy is proposed by Chang and Chen (2013) based on Suchman's (1995) concept of organizational legitimacy, which is an extension of organizational legitimacy in the environmental field and belongs to a branch of organizational legitimacy (Zhou et al. 2021). Green legitimacy started late, research is scattered, and the concept has not yet been unified, and different studies have given different names to green legitimacy, such as environmental legitimacy (Li et al., 2018; Zhou et al.,2021), environmental organizational legitimacy (Chang & Chen, 2013), and environmental legitimacy pressure (Li et al., 2017). Others directly follow the concept of organizational legitimacy and analyze its relationship with green innovation (Yu et al., 2021). Therefore, we consider green legitimacy as a fusion of organizational legitimacy and green innovation, and the existing literature gives different definitions depending on the audience of legitimacy, but in general, they all contain the factors of recognition and green innovation. For details, see Table 2.6.

Table 2.6 Summary of green legitimacy concepts and dimensions

Audience	Definition	Dimension	Sources
stakeholder	The extent to which an organization's environmental goals and activities are consistent with its stakeholders' widely shared environmental norms, beliefs, and value systems.	Single dimension	Chang & Chen (2013）
Government and citizens	Businesses' environmental protection behaviors are considered desirable or appropriate by governments and citizens.	Two dimensions (Citizen legitimacy at the individual level and government legitimacy at the collective level)	Fu et al. （2017）
Stakeholder	The degree of consistency between the organization's activities and the norms, beliefs, values and expectations of stakeholders related to environmental issues.	Two dimensions (Political legitimacy and commercial legitimacy)	Soewarno et al. （2019）
Governments, consumers, non-governmental organizations, and competitors	The extent to which firms obtain the approval of stakeholders in their operating environment as a result of their green innovation behavior.	Three dimensions (coercive legitimacy, normative legitimacy, mimetic legitimacy)	Yu et al. （2021）
Public	The consistency of a company's environmental performance with the general expectations of society.	Two dimensions (Environmental legitimacy in the formal system and in the informal system)	Zhou et al. （2021）
Governments, consumers, non-governmental organizations, and competitors	The extent to which a company's green activities and behaviors are accepted, supported, and recognized by the outside world.	Three dimensions (coercive legitimacy, normative legitimacy, mimetic legitimacy)	Wang & Huang (2022)

Environmental protection has become imminent, and green innovation is both a challenge and an opportunity. The existing scholars' definition of green legitimacy focuses on the relationship between organizational behavior and the environment, while green innovation behavior is considered as a means to realize the economic and social-environmental benefits of enterprises themselves, but with the characteristics of high-risk, long-period period, and externality, whether and how the green innovation behavior of enterprises can be transformed into performance is related to the initiative of green innovation of enterprises.

This study aims to explore whether green legitimacy plays an incentive role in the process of transforming green innovation into corporate performance from the perspective of innovation benefits, focusing mainly on the social public recognition of green innovation in the Chinese institutional environment. Combining the above definitions and the purpose of this study, green legitimacy is defined as the degree to which a firm's green innovation behavior is accepted and recognized by the social public.

2.6.2 Dimension of Green Legitimacy

As shown in Table 2.6, scholars have employed various dimensional approaches to study green legitimacy, ranging from a single dimension to three dimensions:

(1) Single dimension. Chang and Chen (2013) refer to Suchman (1995) and Massey (2001) to measure green legitimacy, measuring six items: (a) the company has a perfect environmental plan; (b) the company has an insightful environmental vision or mission; (c) the company has communicated its environmental plans to its employees; (d) the company has communicated its environmental vision or mission to its stakeholders; (e) the company has a well-developed environment, health, and safety unit, environmental management board, or environmental committee; (f) the company's budget planning includes the concerns of environmental investment or procurement. Soewarno et al. (2019) continue Chang and Chen's (2013) measure by exploring the mediating role of green legitimacy between green organizational identity and green innovation.

(2) Two dimensions. Soewarno et al (2019) divided green legitimacy into political legitimacy and commercial legitimacy when studying the moderating effect of green legitimacy on the relationship between corporate green orientation and corporate performance. Among them, political legitimacy refers to the consistency of corporate

green entrepreneurial behavior with relevant policies, norms, and other standards set by government and regulatory agencies (Soewarno et al, 2019; Sun & Tao,2020); commercial legitimacy emphasizes the degree of recognition and acceptance of green startups and their products and services by suppliers, customers, and partners, with entrepreneurs more value the role of business legitimacy on the value realization of green opportunities (Delmar & Shane, 2004). Zhou et al. (2021) consider environmental legitimacy as a driver of green innovation, dividing it into formal system environmental legitimacy and informal system environmental legitimacy, mainly from official institutions (e.g., local or central government), NGOs, and public media, respectively. Fu et al. (2022) divided environmental legitimacy into citizen legitimacy at the individual level (bottom-up) and government legitimacy at the collective level (top-down) from individual and collective perspectives, arguing that environmental legitimacy judgments originate from these two opposite directions.

(3) Three dimensions. Li et al (2017) regard green legitimacy as the external pressure of corporate green innovation and divide it into three dimensions: regulatory pressure, normative pressure, and cognitive pressure, which come from government agencies, NGOs customers, and competitors. Li et al (2018) regarded environmental legitimacy as an external informal mechanism for corporate green innovation and carbon disclosure and divided it into government regulatory legitimacy pressure, customer regulatory legitimacy pressure, and competitor cognitive legitimacy pressure. Yu et al. (2021) classified green legitimacy into regulatory legitimacy, normative legitimacy, and cognitive legitimacy based on institutional theory.

In summary, scholars' dimensions of green legitimacy cover three types of measurement from a single dimension to three dimensions, mainly based on the institutional perspective of new institutional theory, which regards green legitimacy as a pressure and divides it dimensionally in terms of the audience target of green legitimacy. In contrast, the strategic perspective of new institutional theory, which considers legitimacy as a key resource for organizations, emphasizes the operability, purpose, and resource characteristics of legitimacy, and argues that the process of organizational legitimacy is often a process of active action.

This study is designed to explore the technological latecomer China context in the early stages of green transformation (Zhang, 2022), where the green IPR regime is relatively weak (Yang & Wang, 2020), whether green legitimacy plays an incentive role in the process of translating ambidextrous green innovation into firm performance. The strategic perspective of new institutional theory, which views green legitimacy as a resource for innovation gains, fits well with this study. Therefore, this study refers to the studies of Yu et al. (2021) and Wang and Huang (2022) and measures green legitimacy based on the strategic perspective of new institutional theory by dividing green legitimacy into three dimensions: Green coercive legitimacy, green normative legitimacy, and green cognitive legitimacy (see Figure 2.3).

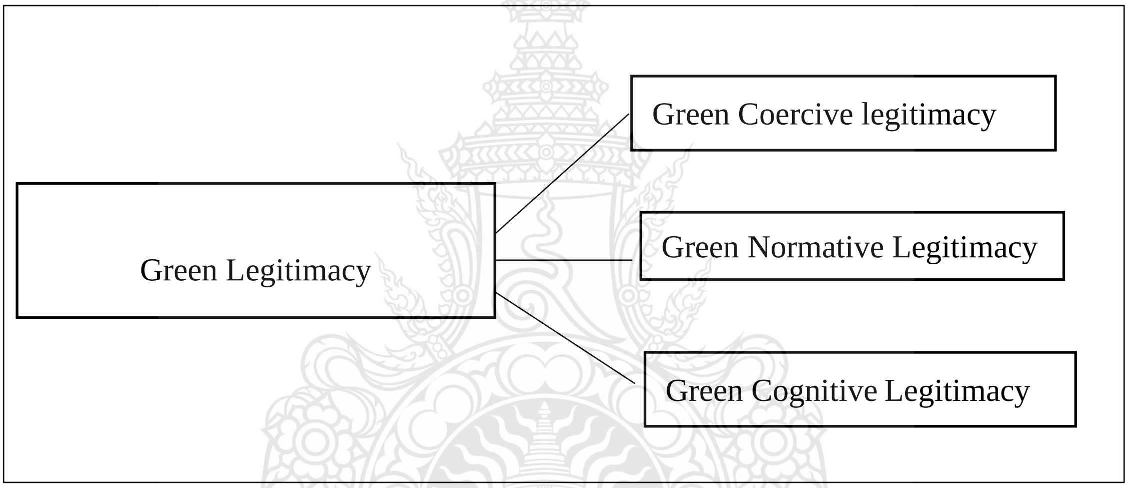

Figure 2.3 Dimension of green legitimacy

Green coercive legitimacy pertains to enterprises adopting green innovation practices to comply with governmental environmental regulations and directives, aiming to secure government and regulatory agency recognition. This approach is pursued with the intention of obtaining policy support, financial assistance, tax incentives, or avoiding penalties.

Green normative legitimacy involves organizational actions in response to green innovation to align with the expectations, standards, and norms set by stakeholders, including the market, industry, environmental organizations, and customers. This alignment is sought to gain recognition, fostering innovation advantages and competitive benefits.

Green mimetic legitimacy relates to an organization's capacity to achieve recognition and legitimacy in a competitive landscape by emulating the behaviors or practices of successful organizations, ultimately resulting in a competitive edge within a particular sector or market.

2.6.3 Related Research on Green Legitimacy

2.6.3.1 Research on the Influencing Factors of Green Legitimacy

Research on the factors affecting green legitimacy is relatively limited, primarily concentrating on the strategic viewpoint of new institutional theory. Existing studies have predominantly examined three aspects of these influencing factors (refer to Table 2.7), outlined as follows:

(1) Environmental proactivity

Alrazi et al. (2015) state that maintaining environmental legitimacy is a key objective of companies committed to environmental protection. To ensure environmental legitimacy, organizations need to demonstrate good environmental accountability, i.e., through high-level environmental performance reporting. At the same time, proactive environmental behaviors can significantly contribute to corporate environmental accountability. On the other hand, Berrone et al. (2017), based on a study of longitudinal data from 325 publicly traded companies in the U.S. polluting industry, also support the view that environmental proactivity helps companies earn environmental legitimacy. At the same time, the study points out that if a company's environmental performance declines, it will face intense scrutiny from non-governmental organizations, and the only way to ensure environmental legitimacy is to obtain a genuine green certificate. Yu et al. (2021), in the context of Chinese economic transformation, also argue that green innovation is a strategy for firms to actively build legitimacy and gain government support in this way.

(2) Environmental disclosure

Kuo and Yi-Ju Chen (2013) studied the relationship between environmental disclosure and environmental legitimacy using a sample of 208 listed companies in Japan. The results of the study show that firms in environmentally sensitive industries can significantly improve their recognition by publishing CSR reports; and firms with better environmental legitimacy in the early stage will be more active in environmental disclosure and build better environmental legitimacy in the next stage.

(3) Green organizational identity

Chang and Chen (2013) used Taiwan manufacturing firms as the research object to explore the relationship between green organizational identity and green innovation performance and found that environmental legitimacy has a mediating effect between green organizational identity and green innovation performance. This implies that green organizational identity is an influencing factor of environmental legitimacy. Soewarno et al. (2019) continued Chang and Chen's (2013) view and shifted the research object to Indonesia to further verify the facilitating effect of green organizational identity on environmental legitimacy.

Table 2.7 Summary of influencing factors of green legitimacy

Influencing Factor				**Source**
Environmental pro-activity	**Green innovation**	**Environmental disclosure**	**Green organizationa identity**	
√				Alrazi et al. (2015)
√				Berrone et al. (2017)
	√			Yu et al. (2020)
		√		Kuo & Yi-Ju Chen (2013)
			√	Chang & Chen (2013)
			√	Soewarno et al. (2019)

2.6.3.2 Research on the Effect of Green Legitimacy

Research into the consequences of green legitimacy is also constrained, primarily concentrating on the institutional viewpoint within the framework of new institutional theory. The current literature predominantly examines four outcome variables (refer to Table 2.8) as outlined below:

(1) Green innovation.

Li et al. (2017) subdivided green innovation into green product innovation and green process innovation and regarded environmental legitimacy as an external factor for green product innovation and process innovation. In Li et al.'s (2018) study, legitimacy is regarded as an external informal mechanism pressure that promotes firms' green product innovation and green process innovation. Zhou et al. (2021) expand the research perspective on environmental legitimacy by distinguishing between formal institutional pressure and informal institutional pressure. They argue that environmental legitimacy helps to promote green innovation and further validate the mediating effect that senior management's perceptions as well as green strategic orientation play between environmental legitimacy and green innovation.

(2) Green innovation performance

Chang and Chen (2013) explored the relationship between environmental legitimacy and green innovation performance based on the performance perspective. They argued that the main goal of firms is not always to maximize profits but to comply with the external pressure of legitimacy. Legitimacy is crucial for firms' survival and development, especially for long-term outcomes. The study points out that those firms with higher environmental legitimacy tend to have access to more resources and stakeholder support, and thus perform more favorably in terms of green innovation performance.

(3) Carbon Disclosure

Li et al. (2018) shew that those firms with poor environmental performance face triple pressures from government regulation, consumer norms, and competitor perceptions, and are therefore expected to disclose more information to demonstrate their efforts in resource conservation and environmental protection. In contrast, companies with good environmental performance are under less pressure for legitimacy and may not prioritize carbon disclosure on their agenda. Thus, carbon disclosure can be viewed as an outcome variable of environmental legitimacy pressure.

(4) Government support

Considering the context of Chinese economic transformation, Yu et al. (2021) emphasized the government's dominant position in the allocation of key resources, such as land, taxes, policy loans, and market access, based on the legitimacy "can-do" view of the New Institutional Theory, which has led to a high degree of firms' institutional and resource dependence on the government. Given that governments do not treat every firm in the market equally, some firms prefer to establish their legitimacy by adopting green innovations to win government support. This has led to government support being seen as an outcome variable of firms' pursuit of environmental legitimacy.

Table 2.8 Summary of the effects of green legitimacy

Green innovation	**Green innovation performance**	**Carbon disclosure**	**Government support**	**Source**
√				Li et al. (2017)
√				Li et al. (2018)
√				Zhou et al. (2021)
		√		Li et al. (2018)
	√			Chang & Chen (2013)
			√	Yu et al. (2020)

In summary, previous studies have examined the green legitimacy of enterprises mainly based on the institutional and strategic perspectives of the new institutional theory. Based on the institutional perspective of the new institutional theory, most scholars interpret green legitimacy as a kind of pressure and believe that enterprises are forced to carry out passive green innovation under such pressure (Li et al., 2017; Zhou et al., 2021).

There are limited scholars studying green legitimacy from the strategic perspective of the new institutional theory. Such scholars interpret green legitimacy as a resource and believe that green legitimacy can provide a resource guarantee for enterprises' green innovation. The higher the green legitimacy of enterprises among stakeholders, the higher the resources and support enterprises will obtain from stakeholders, and the better the green innovation enterprises can carry out (Yu et al., 2021; Fu et al., 2022).

Some scholars also try to explore the incentive role of green legitimacy in the transformation of green innovation into enterprise performance from a strategic perspective. They believe that enterprises need to invest high capital and time costs in the process of green innovation. If an enterprise's green innovation is recognized by the outside world, it can easily be converted into performance; if it is not recognized by the outside world, the investment of capital and time cannot be converted into performance, threatening the survival and development of enterprises (Wang & Huang, 2022). However, it does not deeply analyze the connotation of green legitimacy, nor does it fully explain why green legitimacy will promote the transformation of green innovation into enterprise performance.

2.7 Hypotheses Development

2.7.1 The Influence of Green Supply Chain Integration on Enterprise Performance

As an important measure for enterprises to achieve their pollution reduction and emission reduction goals, GSCI has a certain improvement effect on their environmental performance (Zhou et al., 2020). The green strategic cooperation between enterprises and external suppliers and customers plays a crucial role in reducing the negative environmental impact caused by various types of pollution (Yu et al., 2019).

GSCI emphasizes energy saving and emission reduction and reduces costs by optimizing the resource structure and operational processes (Li et al., 2020). Enterprises implement GSCI to green the product production process, reduce the cost of waste recycling and treatment, significantly reduce the generation of waste from the source, and improve the economic efficiency of enterprises (Li et al., 2020). With the improvement of national environmental protection laws and regulations, environmental protection supervision has increased. The implementation of GSCI can reduce the fines caused by environmental incidents, reduce expenditure, and improve economic efficiency (Rao & Holt, 2005).

From empirical research, Jabbour found that green supply chain practices "collaborate with customers" in Brazilian companies and found that environmental supply chain management helps achieve GSCI, which can improve the company's environmental and economic performance (de Sousa Jabbour et al., 2015). With the increasing maturity of green supply chain management, more and more empirical studies support the integration of internal enterprises, suppliers, and green customers, which ultimately leads to the growth of economic profits (Kong et al., 2021; Han & Huo, 2020).

GSCI also has an impact on the social performance of enterprises. First, it reduces environmental burdens and resource wastage, improves the ecological environment, and enhances air and water quality, thereby protecting the health of residents; Secondly, optimizing resource utilization contributes to sustainable development and pushes society towards a greener, low-carbon direction; In addition, improving employee welfare and supporting local community development helps to enhance social harmony (Geng et al., 2017). At the same time, GSCI enhances corporate image, builds a socially responsible image, attracts more consumer support, reduces legal and reputational risks, and provides a solid foundation for long-term corporate development (Shekari & Rajabzadeh, 2013). Based on the above analysis, this article proposes the following hypothesis:

H1: GSCI has a positive impact on enterprise performance.

2.7.2 The Mediation Effect of Ambidextrous Green Innovation

To analyze the mediating role of ambidextrous green innovation, we proceed in three stages. Firstly, we elaborate on the effect of ambidextrous green innovation on firm performance, and then we elaborate on the effect of GSCI on ambidextrous green innovation. Finally, we elaborate on its mediating role.

2.7.2.1 The Influence of Ambidextrous Green Innovation on Enterprise Performance.

The unique capabilities and behaviors of enterprises are key driving forces for competitive advantage (Porter & Van, 1995). Green innovation, as a firm-specific behavior, aims to achieve resource conservation and environmental improvement, emphasizing green market orientation, prioritizing resource productivity, process improvement, and product innovation issues, enabling firms to use raw materials more efficiently, save energy and labor inputs, reduce costs, or offer differentiated products, thereby establishing a competitive advantage over competitors and contributing to the improvement of firm performance (Chang, 2011; Chen, 2011).

Recent literature suggests that China is a technological latecomer and is in the early stages of green transformation, requiring not only the adoption of exploitative green innovation to integrate existing knowledge and technologies and expand existing product categories and functions to meet the green legitimacy requirements for corporate survival today but also the adoption of exploratory green innovation to adopt new green knowledge and technologies and develop green products to meet the needs of emerging green markets (Yang et al. 2016; Wang et al.,2020; Zhang, 2022). Ambidextrous green innovation becomes a necessary means to achieve green technology upgrading and develop green markets for enterprises (Zhang, 2022; Jia et al., 2022). The ambidextrous green innovation emphasizes that enterprises can effectively control the risk of green innovation activities by reasonably carrying out exploitative green innovation and exploratory green innovation, while simultaneously achieving the upgrading of existing green technologies and the breakthrough of new green technologies, which can balance short-term performance and long-term development, and thus achieve sustainable development of enterprises.

Specifically, exploratory green innovation can fundamentally change the trajectory of technology, promote breakthroughs and changes in green technology for enterprises, help them form green technology barriers, produce differentiated green products, seize new markets, and gain a first-mover advantage (Wang et al.,2020; Wang & Liu,2020). At the same time, through the application of new green technologies and the effective sharing of implicit green knowledge, green products aimed at potential customers can be obtained, which can quickly respond to customer green needs when the market suddenly changes, maintain predictable customer advantages (Wang & Liu,2020), and to some extent reduce the risk of exploratory green innovation. Exploratory green innovation emphasizes the exploration and development of new green technology knowledge and capabilities, and continuously improves the quality of products and services for enterprises in the process of green design, green production, and green operation, thereby forming rich premium benefits (Jian et al., 2008), buffering or even significantly exceeding the costs incurred due to environmental protection actions, occupying a leading position in the market for enterprises, and becoming a leader in industry green standards, has a position that is difficult to imitate and surpass in the short term, forming the first mover advantage and green competitive advantage of the enterprise, and ultimately improving the long-term performance of enterprise (Wang & Liu,2020; Jia et al.,2022).

Wang and Liu (2020) argue that exploitative green innovation can consolidate and expand existing market share, achieve stable performance for the firm, and obtain a higher return on investment by introducing advanced green technologies and production processes and greening existing products to make them more suitable for the green needs of existing customers. Jia et al. (2022) argue that exploitative green innovation can reduce the cost and increase the efficiency of R&D for new green products. Therefore, exploitative green innovation emphasizes the continuous extension of existing knowledge and technology to improve product quality, the efficiency of sales policies, and usage purchase rates of existing products and services, which can reduce R&D risks, shorten R&D cycles, meet the green needs of existing customers, and thus achieve low-risk and high-efficiency short-term benefits (Wang & Liu, 2020; Yang et al., 2022).

Both exploratory green innovation and exploitative green innovation can gain competitive advantages in terms of technology, finance and customers, among which exploratory green innovation is more conducive to the acquisition of long-term competitive advantages and performance, but due to its large investment and high risk characteristics, exploratory green innovation is less effective in terms of short-term financial revenue, while exploitative green innovation, with its stable return on investment, has excellent effectiveness in terms of short-term financial advantage due to their stable return on investment (Wang & Liu, 2020; Jia et al., 2022). The theory of "ambidextrous innovation equilibrium" suggests that ambidextrous firms that engage in both exploitative and exploratory green innovation can not only effectively control green innovation risks, but also balance the short-term performance and long-term growth of the firm (March 1996; Asiaei et al., 2023). Sun and Sun (2021) also argue that in order to better reconcile economic development with environmental pollution problems, firms must engage in both exploitative and exploratory green innovation. Based on the above analysis, this article proposes the following hypothesis:

H2: Ambidextrous green innovation has a positive impact on enterprise performance.

2.7.2.2 The Influence of Green Supply Chain Integration on Ambidextrous Green Innovation

Ambidextrous innovation theory suggests that the future development of enterprises is ambiguous and uncertain and that enterprises need to combine and co-exist two types of innovation activities, namely exploratory green innovation and exploitative green innovation, to not only combine the advantages of the two types of innovation activities but also to form a collaborative and complementary effect, just like running, where the forward movement of one side will drive the other side (Wang et al., 2012; Han et al., 2023).

However, any innovation faces uncertainty and dynamics, and the uncertainty and dynamics of ambidextrous green innovation are mainly reflected in (1) the difficulty for firms to decide which type of green innovation behavior to adopt (Wong et al., 2020); (2) the risk of innovation failure due to technological and commercial uncertainties after identifying an ambidextrous green innovation project (Eslami & Melander, 2019); (3) ambidextrous green innovation will compete for the limited resources of the company, and the company will be unable to ensure the sustainability of ambidextrous green innovation due to limited resources (March 1996; Yang et al., 2023). Ambidextrous green innovation is challenging, and we argue that the GSCI provides the prerequisites for the development of ambidextrous green innovation in enterprises.

First, GSI and GCI, as external integration capability, can also be considered as dynamic capability (Huo et al., 2012; Ji et al., 2020). This capability can address the uncertainty of ambidextrous green innovation. We illustrate it in three ways:

(1) The inspiration for ambidextrous green innovation behavior mostly relies on knowledge external to the firm (Dai et al., 2015). Ji et al., (2020) argue that GSCI is a dynamic process. In the process of interaction with GCI and GSI, firms break the original innovation boundaries in the collision of knowledge and technology regarding customers' green needs and green technology antecedents, gain inspiration for ambidextrous green innovation, and decide what type of ambidextrous green innovation behavior to carry out based on customers' green preferences, the nature of the target market and suppliers' green technology (Dai et al.,2015; Wong et al. 2020; Jia et al., 2022).

(2) The technological and commercial uncertainties faced by the green innovation process require firms to make adjustments from a dynamic perspective (Powell, 1996; Eslami & Melander, 2019). By interacting and collaborating with green customers, companies can gain feedback and insights into consumer expectations and opinions on green products, thus continuously optimizing the direction and strategy of ambidextrous green innovation. Green integration with suppliers allows for the rapid adaptation of ambidextrous green innovation directions and strategies (Huo, 2012).

(3) Even with the inspiration of ambidextrous green innovation, it is difficult for individual enterprises to quickly transform innovative ideas into innovations due to their limited resources (Zhang et al., 2020). One of the main functions of GSCI is to help enterprises collaborate and deploy resources across organizational boundaries (Huo, 2012; Ji et al., 2020). Specifically, integration with green suppliers and green customers can lead to financial support and collaboration opportunities for firms. Green suppliers may be interested in ambidextrous green innovation projects and be willing to provide financial support or co-invest. Collaboration with green customers can lead to broader market channels and sales opportunities, generating greater market demand and sales for ambidextrous green product innovations and solutions. These resources and cooperation opportunities can provide financial and market security for ambidextrous green innovations and ensure the sustainable development of ambidextrous green innovation projects.

Secondly, GII as an absorptive capacity for learning from partners helps to creatively apply new knowledge gained from suppliers and customers (Huo, 2012; Ji et al., 2020). Dai et al. (2015) argue that green innovation requires new skills, new levels of market understanding, and better information processing capabilities and systems. GII provides a platform for improving information sharing and collaboration within firms, facilitating communication and coordination within firms and among supply chain partners, helping firms to disseminate, interpret, utilize, and evaluate information and resources provided by external suppliers and customers, thus facilitating the development of green innovation projects that match market conditions (Xie & Chen, 2022). Chen (2019) argued that GII is an important factor in promoting innovation in firms. The integration between different functions not only helps inter-departmental knowledge sharing but also promotes the generation of new knowledge through the collision of different modes of thinking, thus facilitating ambidextrous green innovation behavior in the firm (Song & Chen, 2019; Xie & Chen, 2022). Based on the above analysis, this article proposes the following hypothesis:

H3: GSCI has a positive impact on ambidextrous green innovation.

Although the positive impact of GSCI on enterprise performance has been confirmed by some studies, from the perspective of organization capabilities, GSCI is essentially a resource base and dynamic capability of the enterprise, and its corresponding positive impact on enterprise performance still needs to be realized through the implementation of corresponding innovation activities (Wu,2013; Wong et al.,2020). This study argues that ambidextrous green innovation provides an indirect transmission pathway in the process of GSCI affecting firm performance.

From the perspective of dynamic capabilities, enterprises with high GSCI capabilities can fully co-ordinate the synergy of various departments within the company and its partners to quickly integrate and reallocate internal and external resources to meet the demand for resources in the process of commercializing ambidextrous green innovation in a shorter period and at a lower cost, thus helping the company to gain the first mover advantage of green innovation and reduce the cost of green innovation, and ultimately to obtain quality performance (Huo 2012; Zhou et al.2020).

From the perspective of innovation risk, a higher level of GCI and GSI means that companies can proactively obtain information about green frontier knowledge, potential green customer demand, and market response, and then identify corresponding green products and technologies and their market value, filter and absorb the new knowledge and information explored through GII, ensure the speed and content of ambidextrous green innovation is consistent with changes in the external environment, reduces the risk of ambidextrous green innovation, and thus improves corporate performance more effectively (Huo,2012; Ouyang et al., 2020). Based on the above analysis, this study proposes the following hypotheses based on the "capability-behavior-performance" mechanism and pathway:

H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.

2.7.3 The Moderation Effect of Green Legitimacy

Enterprises are part of a social system with many social relationships and therefore different stakeholders. Due to differences in interests and perceptions, different stakeholders have different evaluations of enterprises, and legitimacy reflects the common expectations of different stakeholder groups for enterprises. Green legitimacy focuses on the extent to which an enterprise's green activities and behaviors are accepted, supported, and recognized by the outside world (Wang & Huang, 2023).

Green legitimacy is the result of the greening of organizational legitimacy, which is an extension of organizational legitimacy in the environmental field and belongs to a branch of organizational legitimacy (Zhou et al., 2021). Some scholars focus on the role of legitimacy from a strategic perspective, arguing that the green legitimacy process is often a proactive process that can be achieved through effective management control (Yu et al., 2021). Therefore, companies can actively pursue green legitimacy through green innovation (Fu et al., 2022). As a company's green innovation activities become more recognized by the outside world, the more green legitimacy it will gain, the easier it will be to obtain financial support from investors and government agencies and attract potential customers (Suchman, 1995; Chang & Chen, 2013; Fu et al., 2022). This means of enhancing organizational competitiveness and performance by shaping and maintaining green legitimacy is known as the green legitimacy strategy (Pei et al., 2013; Yu et al., 2021).

Legitimacy is a key factor influencing firms' performance improvement through innovative behavior (Zhang et al., 2023). It is a major challenge for firms to capture the benefits of green innovation (especially exploratory green innovation) (Chiesa & Frattini, 2011; Pei et al., 2013). Only by capturing the benefits of ambidextrous green innovations can enterprises transform ambidextrous green innovations into enterprise performance and form sustainable competitive advantages, which requires the recognition of governmental departments, business groups, and the public (Pei et al., 2013; Morgan et al., 2015).

First, in the primary stage of the Chinese green transition, the government plays a crucial role in industrial development (Tzeng et al, 2011; Guo et al., 2018), and obtaining governmental recognition may help firms' innovative behaviors to be recognized by the general public. Second, firms that are highly recognized by upstream and downstream firms may replace to gain higher visibility (Wang & Bansal, 2012), a more stable supply of raw materials, and a more fluid distribution channel, which provides strong channel support for firms to commercialize their bi-dimensional green innovations (Pei et al., 2013). Finally, firms that are highly recognized by customers and the public can promote their green innovations more effectively, reap the benefits of their green innovations more quickly, and build competitive advantage (Wang & Huang, 2022).

In conclusion, in the context of the relatively weak legal protection of green intellectual property rights in China, the legitimacy of green organizations plays an informal role as a mechanism for securing innovation benefits, helping firms to face multiple challenges in the commercialization of ambidextrous green innovation, enhancing their ability to capture the benefits of ambidextrous green innovation, and thus expanding the contribution of ambidextrous green innovation to firm performance. Therefore, the following hypothesis can be formulated.

H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.

2.8 Chapter Summary

In summary, We examined the economic situation and development characteristics of Chinese pharmaceutical manufacturing firms to illustrate the appropriateness of selecting these firms for the study.

Chapter 2 also undertook a systematic review of existing literature and clarified the definitions and dimensions of relevant concepts such as GSCI, enterprise performance, ambidextrous green innovation, and green legitimacy (see Table 2.9).

After that, this chapter developed the research hypotheses (see Table 2.10) and formulated a conceptual framework (see Figure 1.1), assessing the impact of GSCI on enterprise performance based on organizational capability theory, ambidextrous innovation theory, and new institutional theory, incorporating ambidextrous green innovation as the mediating variable and green legitimacy as the moderating variable.

Table 2.9 Summary of definitions and dimensions of variables in this study

Variable	Dimension	Definition	Source
Green supply chain integration (GSCI)	Green internal integration (GII)	The ability of different departments within an enterprise to share information and collaborate to jointly address environmental problems.	Teece et al. (1997); Song and Zhang (2018); Huo (2012); Wong et al. (2015); Zhou et al. (2020); Lo et al. (2018); Kong et al. (2020); Han and Huo (2020)
	Green supplier integration (GSI)	The ability of an enterprises to work closely with its core customers to understand environmental risks and liabilities, to share information, and to set common goals in order to jointly solve environmental problems.	
	Green customer integration (GCI)	The ability of a company to work closely with its core suppliers to understand environmental risks and responsibilities, share information, and set common goals in order to jointly address environmental issues.	

Table 2.9 Summary of definitions and dimensions of variables in this study (Cont.)

Variable	Dimension	Definition	Source
Ambidextrous green innovation (AGI)	Exploratory Green Innovation (ERGI)	The enterprises utilize new environmental knowledge, information, and capabilities to develop new green products, processes, and services.	Benner and Tushman (2003); Lubatkin et al. (2006); Wang et al. (2020); Sun and Sun (2021); Asiaei et al (2023); Meiting et al (2023)
	Exploitative Green Innovation (EIGI)	The enterprises utilize existing environmental knowledge, information, and capabilities to make incremental, small changes to existing green products, processes, and services.	
Green legitimacy (GL)	Coercive legitimacy (CL)	Enterprise is recognized by governments and regulators for green innovation.	Colwell et al. (2013); Chang and Chen (2013); Zhou et al. (2021); Yu et al. (2021)
	Normative legitimacy (NL)	Enterprise is recognized by stakeholders such as the market, industry, environmental organizations, and customers for green innovation.	
	Mimetic legitimacy (ML)	Enterprise is recognized by imitating other enterprises that have succeeded with green innovations	
Enterprise performance (EP)	Economic performance (ECOP)	The enhancement of enterprise profitability, as demonstrated in its financial statements, is accompanied by market share and customer satisfaction.	Geng et al. (2017); Agyabeng-Mensah et al. (2020); Han and Huo (2020)
	Environmental performance (ENVP)	The enhancement of a company's environmental impact level is typically linked with energy conservation, waste reduction, pollution control, and emission mitigation.	
	Social performance (SOCP)	The enhancement of enterprise social responsibility and impact, encompassing its dedication to areas like health and safety, education and training, as well as quality management.	

Table 2.10 Summary of the hypothesis

Hypothesis	Source
H1: GSCI has a positive impact on enterprise performance.	Rao & Holt (2005); Shekari &Rajabzadeh (2013); de Sousa Jabbour et al. (2015); Geng et al. (2017); Yu et al. (2019); Li et al. (2020); Zhou et al. (2020); Han & Huo (2020).
H2: Ambidextrous green innovation has a positive impact on enterprise performance.	Porter & Van (1995); March (1996); Jian et al. (2008); Chang, (2011); Chen (2011); Yang et al. (2016); Sun & Sun (2021); Wang et al. (2020); Wang & Liu (2020); Zhang (2022); Jia et al. (2022); Yang et al. (2022); Asiaei et al. (2023)
H3: GSCI has a positive impact on ambidextrous green innovation.	Powell (1996); March (1996); Wang et al. (2012); Huo et al. (2012); Yang et al. (2015); Dai et al. (2015); Ji et al. (2019); Chen (2019); Song & Chen (2019) ;Eslami & Melander, (2019); Wong et al. (2020); Xie & Chen, (2022); Yang et al. (2022); Jia et al.(2022); Feng et al. (2023); Han et al. (20203)
H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.	Huo (2012); Wu (2013); Wong et al. (2020); Zhou et al. (2020); Ouyang et al. (2020)
H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.	Teece (1986); Suchman(1995); Chang & Chen (2013); Pei et al. (2013); Zhou et al.(2021); Yu et al. (2021); Fu et al.(2022); Wang & Huang (2022)

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presented the research methodology used to prove the conceptual framework and test the hypotheses derived from Chapter 2.

In Section 3.2, the research procedures were described. Section 3.3 outlined the overall population and sampling. Section 3.4 primarily detailed the data collection methods. Section 3.5 described the instrument design, including initial items for each construct, as well as content validity analysis and reliability analysis. Section 3.6 focused on data analysis methods, which include data preparation, descriptive analysis, confirmatory factor analysis (CFA), structural equation modeling (SEM), and PROCESS.

3.2 Research Procedures

Drawing on previous research, this paper established the direct and indirect mechanisms regarding the impact of GSCI on enterprise performance and formulated the hypotheses of this study. To test these hypotheses, the study employed quantitative research methodology. Figure 3.1 illustrates the process followed in this study, which is divided into four stages: exploratory study of literature review, data collection, data analysis, and thesis writing.

The first stage involved conducting an exploratory study, which relied on an extensive literature review. Information was gathered from a substantial body of prior literature covering GSCI, ambidextrous green innovation, green legitimacy, and enterprise performance. This was done to elucidate the definitions and dimensions of these variables, thereby informing the development of the research instrument. Additionally, this process highlighted deficiencies in existing studies, identified the research problem, and facilitated the development of research hypotheses and the construction of the conceptual framework.

The second stage involved data collection. To ensure the optimal use of the research measures, we conducted two activities in sequence before conducting the large-scale survey: content validity, and a pilot study. We used the results of these activities to improve the measurement items used in the questionnaire, with a particular focus on content validity and reliability aspects. The large-scale survey consisted of distributing the questionnaire to identified respondents. The required sample size was determined based on what was needed to conduct structural equation modeling (SEM). The method of questionnaire distribution is based on the characteristics of the study population as well as factors such as time and economic costs.

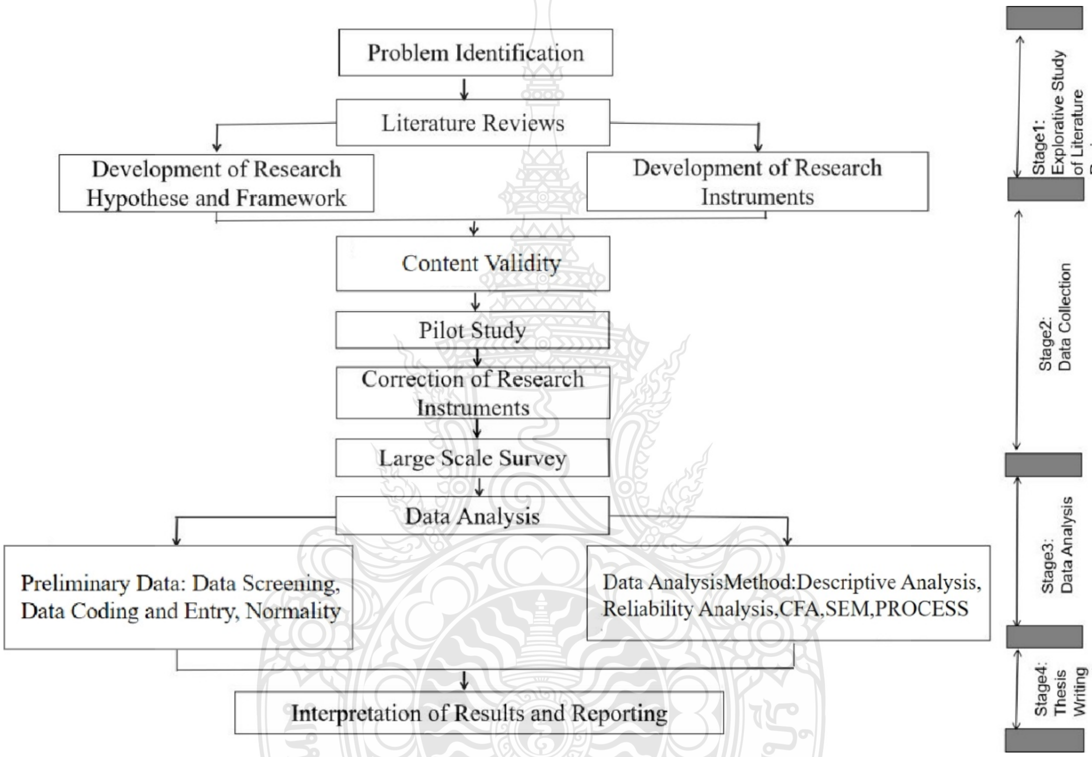

Figure 3.1 Research procedures

The third stage is the data analysis stage. To ensure the validity and accuracy of data analysis, the missing values and outliers of the data need to be analyzed and processed first (Fidell & Tabachnick, 2003). Then, the data is tested for compliance with the assumption of normality, which is a prerequisite for SEM analysis (Byrne, 2010). It is only at the end that the collected data can be analyzed, including descriptive analysis, CFA, SEM, and PROCESS.

The fourth stage is the dissertation writing stage. Based on the results of the data analysis, the findings are reported and discussed, and the theoretical and practical contributions of the study are pointed out, as well as the shortcomings of the study.

3.3 Population and Sampling

3.3.1 Population

This study was interested in the pharmaceutical manufacturing industry of China. The corresponding population is all pharmaceutical manufacturing enterprises in China, which are 28,421 in total (see Table 3.1). To more precisely investigate the relationship between GSCI and performance and its mechanism of action in pharmaceutical manufacturing companies in China, this study will survey middle and senior managers. These respondents need to have an in-depth understanding of business operations such as GSCI and ambidextrous green innovation, and their positions may include CEOs, general managers, supply chain managers, purchasing managers, marketing managers, etc. of the companies.

Based on the data in Table 3.1, it can be learned that the total number of pharmaceutical manufacturing companies involved in this study is 28,421 and these companies are widely distributed in different provinces.

Table 3.1 The distribution of pharmaceutical manufacturing enterprises

Province	Number of Pharmaceutical Manufacturing Enterprises	Percent
Guangdong Province	2,854	10.04%
Shandong Province	2,369	8.34%
Jiangsu Province	2,096	7.37%
Anhui Province	1,932	6.80%
Henan Province	1,568	5.52%
Liaoning Province	1,360	4.79%
Hebei Province	1,264	4.45%
Hubei province	1,244	4.38%
Jilin Province	1,242	4.37%
Sichuan Province	1,213	4.27%

Table 3.1 The distribution of pharmaceutical manufacturing enterprises (Cont.)

Province	Number of Pharmaceutical Manufacturing Enterprises	Percent
Jiangxi Province	1,073	3.78%
Zhejiang Province	991	3.49%
Shanxi Province	924	3.25%
Hunan Province	759	2.67%
Guizhou Province	718	2.53%
Guangxi Province	700	2.46%
Yunnan Province	592	2.08%
Beijing	580	2.04%
Heilongjiang Province	548	1.93%
Fujian Province	544	1.91%
Inner Mongolia	541	1.90%
Gansu Province	519	1.83%
Hainan	494	1.74%
Shanghai City	483	1.70%
Shanxi Province	470	1.65%
Chongqing City	444	1.56%
Tianjing City	300	1.06%
Xinjiang	229	0.81%
Qinghai Province	129	0.45%
Tibet	121	0.43%
Ningxia	120	0.42%
Total	28,421	100%

3.3.2 Sample Size

SEM is based on covariance and correlations that are unstable when evaluated from a small sample size. Since this study will employ SEM as the main analytical method, it is important to take into account that the Maximum Likelihood Estimation (MLE) method in SEM requires a sufficient sample size.

Different views exist regarding the minimum sample size in SEM analysis. According to the rules of thumb, the sample size should be 5 to 10 times the number of measurement items (Nunnally & Bernstein, 1967; Gorsuch, 1983). Since the questionnaire for this study contained 53 measurement items, the sample size could range from 265 to 530.

Larger sample sizes lead to more accurate SEM estimates due to improved model estimation accuracy. However, considering the actual data collection process, a larger sample size can result in higher research costs, including economic and time costs (Singh & Masuku, 2014).

Meanwhile, Jackson (2001) suggests that a sample size of 200-400 is acceptable for maximum likelihood estimation. To minimize research costs (both economic and time-related) while meeting the accuracy requirements of estimation, this study set the sample size at 400.

3.3.3 Sampling Technique

Considering the requirement for approximately 400 samples from pharmaceutical manufacturing enterprises in China, purposive sampling and proportional sampling methods were selected for data collection in this study. The details of each sampling method are described as follows:

The purposive sampling method was used to identify the study area. The 2023 edition of the Chinese pharmaceutical industry in-depth research and development trend analysis report highlighted that Chinese pharmaceutical manufacturing enterprises exhibit characteristics of industrial clusters, with the current spatial pattern dominated by eastern regions such as the Yangtze River Delta, the Bohai Rim, and the Pearl River Delta. As early as 2018, pharmaceutical manufacturing enterprises in the Yangtze River Delta region accounted for 23.68% of the total nationwide (China High-Tech Statistics Yearbook, 2019). According to China Economic Net, as of October 2022, there were a total of 3368 companies related to biotechnology and pharmaceuticals domestically, with nearly half of them located in the Yangtze River Delta region.

Moreover, as China's primary economic powerhouse, the Yangtze River Delta (YRD) region stands out as one of the nation's most economically developed and robustly comprehensive areas. It is also recognized as one of the world's most vibrant and promising economic regions. Encompassing Shanghai, Zhejiang, Jiangsu, and Anhui, this region hosts prominent industrial clusters and has established an extensive logistics supply chain penetrating the international market (Ding et al., 2022). Simultaneously, the Yangtze River Delta is at the forefront of sustainable development, characterized by reduced environmental pollution and minimal ecological degradation (Zeng et al., 2021). Enterprises in the region demonstrate strong awareness and capability for green innovation. We believe that pharmaceutical manufacturing enterprises in the Yangtze

River Delta region can represent the developmental trends of the Chinese pharmaceutical industry. Hence, pharmaceutical manufacturing enterprises from the Yangtze River Delta (YRD) region were included in this study. There are a total of 5,502 pharmaceutical manufacturers in the YRD, as illustrated in Table 3.2.

A proportional sampling method was used to allocate the number of sampled enterprises which were selected to be distributed the questionnaires. The calculated samples were counted based on the ratio of the number of enterprises in different regions to the total number of enterprises in the YRD region. For example, Jiangsu Province has the largest number of pharmaceutical manufacturing firms compared to other regions, so more firms need to be selected. Ultimately, the 400 firms selected are shown in Table 3.2.

Table 3.2 Selected area and samples

Selected Area	Enterprises	Percent	Sampled Enterprises
Shanghai Autonomous Region	483	8.78%	35
Zhejiang Province	991	18.01%	72
Jiangsu Province	2096	38.10%	152
Anhui Province	1932	35.11%	141
Total	5502	100%	400

Note: Autonomous Region is similar to the province

3.4 Data Collection Method

Three channels were used to collect data for this study.

(1) Direct face-to-face distribution. The pharmaceutical industry regularly organizes exhibitions, trade fairs, and talent exchange conferences, and the pharmaceutical industrial park regularly organizes training sessions for production and management unit principals and safety managers. The researcher used social connections to attend these sessions and distributed questionnaires to the managers of the participating companies, explaining our study and collecting them.

(2) Indirect distribution. Pharmaceutical manufacturing companies are usually located in pharmaceutical industrial parks, so the researcher commissioned the management organization of pharmaceutical industrial parks to distribute the

questionnaires. Additionally, the researcher also entrusted friends to distribute the questionnaires to the respondents through their personal networks.

(3) E-mail distribution. The questionnaire was distributed by e-mail through the available directory of companies in the pharmaceutical manufacturing industry and their e-mail addresses.

To enhance the quality of the research data, the criteria for invalid questionnaires are predefined as follows: (1) Questionnaires from participants who do not meet the eligibility criteria, such as those outside the targeted positions and regions of this study. (2) Questionnaires that contain unreasonable or illogical responses. (3) Questionnaires that are incomplete. (4) Questionnaires that contain outliers.

We collected questionnaires in two stages. First, data collection primarily took place at various conference venues, supplemented by email and indirect distribution methods. After three months of the survey (September 2023 - November 2023), a total of 379 valid questionnaires were collected, falling short of the target of 400 valid questionnaires. To address this issue, we sought additional questionnaires in December 2023, primarily through personal connections (indirect distribution) and supplemented by follow-up emails. During this phase, the researchers monitored the number of valid questionnaires in real time until an additional 21 valid questionnaires were collected.

3.5 Instrument Design and Development

3.5.1 Instrument Design Procedures

This study used survey questionnaires as a key instrument. To obtain high quality questionnaires and measurement items, the researcher used the following process to design the questionnaire:

Step 1: Prepare the initial questionnaire. By collecting and organizing mature scales from authoritative literature in related fields such as GSCI, ambidextrous green innovation, enterprise performance, and green legitimacy, further reviewing mature scales in related fields in the context of an emerging economy and combining with the practice of green transformation of Chinese enterprises and the characteristics of the research subjects, the initial scale is compiled.

Step 2: Refinement of questionnaire design. Two experts working in the fields of GSCI, green innovation, and performance and three senior managers with practical experience were selected to seek suggestions for questionnaire refinement and to adjust the measurement items of the questionnaire through consultation and interviews, to make it more in line with the management operation of the Chinese pharmaceutical manufacturing enterprises' practices, to ensure that the interviewees can accurately understand the connotation of each item, and to improve the effectiveness of the questionnaire research.

Step 3: Pre-survey. Select 30 enterprises from Suzhou Pharmaceutical Industrial Park as the research object, distribute the questionnaires face-to-face way, and conduct the pre-survey, on the one hand, can obtain the respondents' understanding of the questionnaire, language expression and other aspects of the proposal, on the other hand, can obtain the preliminary test questionnaire credibility of the data, to realize the early discovery of problems in the questionnaire design, to reduce the possibility of errors in the formal research process.

Step 4: Questionnaire re-correction. After recovering 30 questionnaires, the authors first tested the reliability of the questionnaires by calculating Cronbach's coefficient alpha using SPSS22.0. Each dimension should have a Cronbach Alpha Coefficient surpassing .70 (Hajiar, 2018). Based on the results of the test the questionnaire was revised again to form the final questionnaire.

Step 5: Formal distribution of the questionnaire. After the questionnaire reliability and validity tests, final questionnaires were distributed to the intended study area.

3.5.2Instrument Development

In this study, instruments sourced from distinguished prior researchers were devised and utilized to encompass the necessary information for testing the research hypotheses. The questionnaire survey was executed with expert guidance following a thorough literature review.

The questionnaire was organized into two modules: respondents' basic information (Part 1) and the main body of the questionnaire (Part 2-Part 5). In the respondents' basic information part, it mainly involves the basic information such as the industry and type of enterprise, the education level of the respondents, and the position level of the respondents. In the main part of the questionnaire, the GSCI, ambidextrous green innovation, green legitimacy, and enterprise performance of the enterprises are investigated, representing the independent, mediating, moderating, and dependent variables in the conceptual framework in that order. The details are as follows:

Part 1: Basic Information

This section involves the investigation of demographic information and background characteristics of the enterprises, including basic information such as position, length of service, education level, number of employees in the enterprise, industry to which the enterprise belongs, and type of enterprise. This basic information not only identifies whether the respondents are eligible for the study, but also can be used to analyze the characteristics of the surveyed enterprises.

Part 2: Green Supply Chain Integration

This study draws on the GSCI scale developed by Kong et al. (2021) to measure GSCI from three dimensions: GII, GSI, and GCI. Each dimension of GSCI contains six items. This scale contains a total of 18 measurement items (see Table 3.3). The items on the scales were rated on a 5-point Likert scale from "strongly disagree (1)" to "strongly agree (5)".

Table 3.3 Items of green supply chain integration scale

Dimension	Code	Items
Green Internal Integration	GII1	In our company, all departments work together to achieve environmental goals.
	GII2	In our company, each department has a common understanding of its responsibility for environmental performance.
	GII3	In our company, all departments work together to reduce the environmental impact of our activities.
	GII4	In our company, all departments work together to plan, anticipate, and solve problems related to the environment.
	GII5	In our company, all departments work together to determine how to reduce the environmental impact of our products/services.
	GII6	In our company, all departments emphasize the accumulation and sharing of environmental knowledge.

Table 3.3 Items of green supply chain integration scale (Cont.)

Dimension	Code	Items
Green Supplier Integration	GSI1	Our company works together with major suppliers to achieve environmental goals.
	GSI2	Our company agrees with major suppliers on environmental performance responsibilities.
	GSI3	Our company works together with major suppliers to reduce the environmental impact of our activities.
	GSI4	Our company works together with major suppliers to plan, anticipate, and solve problems related to the environment.
	GSI5	Our company works together with major suppliers to determine how to reduce the environmental impact of our products/services.
	GSI6	Our company works together with our major suppliers to accumulate and share environmental knowledge.
Green Customer Integration	GCI1	Our company works together with major customers to achieve environmental goals.
	GCI2	Our company agrees with major customers on environmental performance responsibilities.
	GCI3	Our company works together with major customers to reduce the environmental impact of our activities.
	GCI4	Our company works together with major customers to plan, anticipate, and solve problems related to the environment.
	GCI5	Our company works together with major customers to determine how to reduce the environmental impact of our products/services.
	GCI6	Our company works together with our major customers to accumulate and share environmental knowledge.

Part 3: Enterprise Performance

In this study, we refer to Fauzi et al. (2010), Geng et al. (2017) and Agyabeng-Mensah et al. (2020) to measure enterprise performance in terms of three dimensions: economic performance, environmental performance, and social performance.

The environmental performance metrics refer to the studies of Han and Huo (2020) and Zhou et al. (2020). The economic performance assessment adopted the findings of Kong et al. (2021). The social performance metrics were drawn from the study of De Giovanni (2012) and Agyabeng-Mensah et al. (2020). The final scale of enterprise performance consists of 13 measures (see Table 3.4). The items on the scales were rated on a 5-point Likert scale from “strongly disagree (1)” to “strongly agree (5)”.

Table 3.4 Items of enterprise performance scale

Dimension	Code	Items
Environmental Performance	ENVP1	In the past two years, the emissions of our company's "three wastes" have significantly decreased.
	ENVP2	In the past two years, hazardous/harmful/toxic materials consumption of our company has been significantly decreased.
	ENVP3	In the past two years, the energy consumption of our company has been significantly decreased.
	ENVP4	In the past two years, the number of times companies have been regulated for environmental issues has decreased significantly.
Economic performance	ECOP1	In the past two years, our company's sales revenue has significantly increased.
	ECOP2	In the past two years, the market share of our company's products has significantly increased.
	ECOP3	In the past two years, our company's net profits have significantly increased.
	ECOP4	In the past two years, our company's return on investment have significantly increased.
	ECOP5	In the past two years, our company's return on sales have significantly increased.
Social Performance	SOCP1	In the past two years, our company has improved employees’ health and safety.
	SOCP2	In the past two years, our company has improved community health and safety.
	SOCP3	In the past two years, our company has improved job satisfaction levels of employees.
	SOCP4	In the past two years, our company has increased incentives and engagement for local employment.

Part 4: Ambidextrous Green Innovation

This study draws on existing research results and divides ambidextrous innovation into two dimensions: exploratory innovation and exploitative innovation. This study uses the research scales of Jansen et al. (2006) and Wang et al. (2020) to measure exploratory innovation and exploitative innovation, using a total of 13 items. Among them, exploratory innovation measures 7 items (ERI1-ERI7) and exploratory innovation measures 6 items (EII1-EII6) (see Table 3.5). The items on the scales were rated on a 5-point Likert scale from “strongly disagree (1)” to “strongly agree (5)”.

Table 3.5 Items of ambidextrous green innovation scale

Dimension	Code	Items
Exploratory Green Innovation	ERGI1	Our company actively embraces demand beyond existing green products, processes and services.
	ERGI2	Our company actively adopts new green products, processes, and services.
	ERGI3	Our company actively develops new green products, processes, and services.
	ERGI4	Our company is actively experimenting with new green products and services in the market.
	ERGI5	Our company actively promotes the commercialization of new green products and services.
	ERGI6	Our company actively uses new green distribution channels.
	ERGI7	Our company actively explores new opportunities in green markets.
Exploitative Green Innovation	EIGI1	Our company actively improves existing green products, processes, and services.
	EIGI2	Our company actively adjusts existing green product offerings, processes, and services.
	EIGI3	Our company actively introduces improved green products and services to the market.
	EIGI4	Our company actively strives to improve the efficiency of our existing green products and services.
	EIGI5	Our company actively increases economies of scale in existing green markets.
	EIGI6	Our company actively expands the scope of green services for existing customers.
	EIGI7	Our company aims to lower the costs of internal processes.

Part 5: Green Legitimacy

Based on the research of Yu et al. (2021) and Colwell, S. R., & Joshi (2013), this study measures green legitimacy from three dimensions: coercive legitimacy, normative legitimacy, and mimetic legitimacy. This scale contains a total of 9 measurement items (see Table 3.6). The items on the scales were rated on a 5-point Likert scale from “strongly disagree (1)” to “strongly agree (5)”.

Table 3.6 Items of green legitimacy scale

Dimension	Code	Items
Coercive Legitimacy	GCL1	In the past two years, green innovation activities have enabled our company's production and operation to meet the requirements of relevant laws and regulations.
	GCL2	In the past two years, the government has highly evaluated the green innovation activities of our company.
	GCL3	In the past two years, green innovation activities have shielded our company from regulatory penalties.
Normative Legitimacy	GNL1	In the past two years, our company's green innovation activities have been widely understood and accepted by consumers and the public.
	GNL2	In the past two years, our company has established a good social and market image through green innovation activities.
	GNL3	In the past two years, our company has received high praise from environmental organizations for its green innovation activities.
Mimetic Legitimacy	GML1	In the past two years, our company has obtained various green environmental quality certifications or production standard certifications in the industry.
	GML2	In the past two years, our company has increased its visibility in the industry due to green innovation activities.
	GML3	In the past two years, our company has set a good example for other enterprises in the industry due to its green innovation activities.

3.5.3 Instrument Content Validity and Reliability

3.5.3.1 Content validity. Content validity refers to the degree of agreement between what is measured by the item and what is intended to be measured (Turner & Carlson, 2003).

This study applied item-objective congruence (IOC) to the questionnaire content validity assessment. Five experts in related fields were invited to examine and comment on the proposed instrument. These experts were provided with a validity questionnaire to assess whether the written questions were consistent with the definitions identified from theory and previous research. Three levels were used in the assessment process, namely "congruent" (+1), "not sure (0), and "not congruent" (-1). "Congruent" means that the question corresponds to the meaning of the topic and its dimensions. "Not sure" means that the question does not correspond exactly to the meaning of the item and its dimensions. "Not congruent" means that the question does not correspond to the meaning of the item and its dimensions. If experts categorize a problem as "not sure" or "not congruent" in the evaluation, they will be asked to make recommendations on how to correct the problem. After receiving the experts' suggestions, the researcher will modify the research instrument accordingly.

The formula for calculating the content validity index is as follows (Rovinelli & Hambleton, 1976).

$$IOC = \frac{\sum R}{N}$$

$\sum R = \text{Sum } of\ \ scores\ \ for\ each$ item checked by $specialists$

$N = Number\ of\ \ specialist$

Items with IOC scores lower than .5 were omitted from the ultimate questionnaire. The evaluation by experts confirmed that the content validity of the questionnaire scored .6 or higher. This affirmation signifies that the questionnaire items align well with the research objectives, exhibit contextual accuracy, and maintain linguistic appropriateness.

Two academic researchers and three senior managers with practical experience evaluate the IOC of this instrument and the details are as follows:

(1) Prof. Dr. Xuemei Zhang, Lecturer at Anhui Provincial Key Laboratory of Regional Logistics Planning and Modern Logistics Engineering, Fuyang Normal University Business School.

(2) Dr. Wang Yuan, Lecturer at School of Economics and Management, Shanghai University of Political Science and Law.

(3) Mr. Fan Zhang, Purchasing Manager, Jiangsu Hengrui Medicine Co., Ltd.

(4) Mr. Ensheng Li, Marketing Manager, Beijing Fuller Technology Development Co.

(5) Mr. Jun Wang， Marketing Manager， Northeast Pharmaceutical Group Ltd.

Based on the IOC results, the IOC score of the EIGI7 item was .4, which was lower than .5. So, this item was deleted. The remaining measurement items are acceptable with IOC ranging between .60 to 1.00 (See the IOC summary in Appendix II).

3.5.3.2 Pilot Study and Reliability Analysis. A pilot study is a preliminary, small-scale investigation designed to evaluate various aspects of the methods intended for a larger, more rigorous, or confirmatory research endeavor (Arain et al., 2010).

The primary objective of a pilot study is not to address specific research inquiries but rather to safeguard against embarking on an extensive study without a thorough understanding of the proposed methods. In essence, a pilot study serves as a preventive measure, averting the occurrence of critical flaws in a study that could be costly in terms of both time and resources (Polit & Beck, 2008). The pilot phase plays a pivotal role in assessing the reliability of the questionnaire, rectifying any imperfections such as confusing language or instructions, ensuring data are analyzable, and allowing the researcher to refine the questionnaire (Jackson & Furnham, 2000).

Furthermore, pilot studies can serve as an early warning system, highlighting potential areas of vulnerability in the main research project. They may reveal instances where research protocols might not be adhered to or where proposed methods or instruments are unsuitable or overly complex (Van Teijlingen & Hundley, 2002). Pilot studies can also bring to light practical challenges that may arise during the research process. Additionally, they may uncover local dynamics or issues that could impact the research procedure (Polit & Beck, 2008).

In this study, 30 pharmaceutical manufacturing companies were selected from Suzhou Pharmaceutical Industrial Park for a pilot study. For the collected pre-survey questionnaire data, this study will use Cronbach’s Alpha coefficient to determine the reliability of each scale for four scales. If the Cronbach’s Alpha coefficient is higher than .70, it indicates that the design of the questionnaire is acceptable and can be used for general academic research (Taherdoost, 2016).

The reliability test results of the pilot study are shown in Table 3.7. From Table 3.7, it can be seen that the GCI scale contains a total of 6 measurement items, and its Cronbach's Alpha coefficient is .911, which is greater than the critical value of .70. It is concluded that the reliability of the GCI scale data meets the standard. Similarly, the reliability of the remaining variable scales also meets the required standards. Therefore, these results indicate that the reliability of the instruments analyzed in this study is acceptable.

Table 3.7 Reliability testing of pilot study

Variable	Cronbach's Alpha	Number of Items
GCI	.897	6
GSI	.903	6
GII	.890	6
ENVP	.878	4
ECOP	.874	5
SOCP	.843	4
ERGI	.903	7
EIGI	.899	6
GCL	.821	3
GNL	.849	3
GML	.861	3

3.6 Data Analysis

3.6.1 Preliminary Data Analysis

Before conducting SEM, preliminary data analysis is a crucial step. This process enhances the quality of the model and ensures the reliability and validity of the analysis results. The validity and accuracy of SEM rely on the completeness and accuracy of the input data. Missing values, outliers, or inconsistent measurement scales in the data can lead to inaccurate model estimates and even incorrect conclusions. Therefore, the first crucial step before SEM is to check and clean the data to ensure its quality. This study re-examines missing data and outliers based on the valid sample.

Researchers and data analysts often exclude cases with missing data, as they may skew the results (Marczyk et al., 2010). Outliers can also bias SEM parameter estimates, affecting the model's fit and interpretability. Therefore, we handle surveys with missing data or outliers by deleting those cases.

In addition, almost all commonly used statistical methods in social sciences are based on the assumption that the collected data are normally distributed. Normality can be diagnosed through two multivariate indexes: skewness and kurtosis. According to Hair et al. (2006), skewness and kurtosis must not be more than + or – 3 standard deviations from the mean. In this study, we set the maximum acceptable limit of observation values up to ±3 for the skewness and kurtosis.

3.6.2 Descriptive Analysis

The objective of descriptive analysis is to understand the characteristics of GSCI, ambidextrous green innovation, green legitimacy and performance of the sample enterprises. This study analyzes the mean, standard deviation, skewness coefficient, and kurtosis coefficient of the above variables. Among them, the mean value can reflect the general state of each of the above indicators of the sample enterprises, whether the standard deviation can reflect the degree of difference of each of the above indicators of the sample firms, while the kurtosis coefficient and skewness coefficient can portray the shape of the distribution of each of the above indicators of the sample enterprises, which in turn can help us to determine the distribution of the sample enterprises in the distribution of each of the indicators, i.e., symmetric situation and flat situation (Larson, 2006).

3.6.3 Factor Analysis

Factor analysis is indeed a statistical method used for data reduction, particularly to reduce a large set of variables or measures into a smaller number of underlying factors. In business research, it's frequently employed to uncover the latent dimensions or factors behind a set of measurements or survey questions. There are two main types of factor analysis: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Among them， EFA is used when researchers don't have a pr-defined theory or model, and they want to explore and uncover the underlying structure within their data. EFA helps identify the number of factors and how variables are loaded onto those factors. CFA is used when researchers have a specific theoretical framework or hypothesis about the factor structure. It tests whether the collected data fits the prspecified model and evaluates how well the data supports the proposed relationships among variables.

In this study, CFA was applied to align with the structure of relationships observed in previous research literature. The research instrument was translated into the Chinese, and data were collected from Chinese pharmaceutical manufacturing enterprises where the unique context might have an impact on the structure of each factor. Hence, CFA was chosen as the appropriate analytical approach for this study.

CFA is a crucial component of SEM analysis, as highlighted by Edwards (2010). It primarily concentrates on the examination of measurement models. Arnau and Thompson (2000) emphasized that, before delving into the analysis of structural equation models, it is essential to first analyze the measurement model. The interrelation analysis of these latent variables holds significance only when the measurement model accurately portrays the latent variables under investigation.

Measurement model analysis primarily considers two crucial validity factors: convergent validity and discriminant validity. In this study, the assessment of the measurement model is based on three indicators as proposed by Hair et al. (2010):

Factor Loading: These assess whether each factor loading is statistically significant and should exceed .7.

Composite Reliability (CR): CR represents the reliability component of the measurement items, indicating the internal consistency of each indicator within the latent variable. A CR value of greater than .7 is generally expected.

Average Variance Extracted (AVE): AVE reflects the explanatory power of each measurement item within the latent variable on the variance of that latent variable. A higher AVE value indicates greater convergent validity, with a typical threshold of greater than .5.

Discriminant validity involves analyzing the relationships between measurement models. In this article, discriminant validity is assessed by comparing the AVE values and the squares of the correlation coefficients between latent variables.

3.6.4 Structure Equation Model (SEM)

This article employs an SEM to validate the proposed hypotheses (H1-H4). SEM is a robust multivariate statistical modeling technique commonly utilized for testing theoretical models and hypotheses, as outlined by Kline (2023). In contrast to other statistical methods such as regression analysis, SEM offers several notable advantages, including: measuring potential (difficult to observe) constructs that cannot be directly observed; Simultaneously analyzing multiple sets of causal relationships, i.e. allowing multiple dependent variables to be included in the structural equation model simultaneously; Simultaneously testing the direct and indirect influence relationships between different constructs; Allow independent and dependent variables to include measurement errors; Able to provide more accurate and flexible measurement results (Kline, 2023). SEM can be employed for various analyses, including regression analysis, confirmatory factor analysis, and correlation analysis, among others. They offer a comprehensive means of illustrating the mutual influences and correlations between variables.

Software packages such as AMOS, EQS, lavaan, LISREL, Mx, and Mplus are utilized to complete the computational aspects of the overall SEM process. This article uses AMOS software to establish a structural equation model and conduct statistical analysis.

3.6.4.1 The Modeling Process of Structural Equation Modeling. There are five steps in SEM analysis: (1) setting; (2) model recognition; (3) model estimation and fitting; (4) model evaluation; and (5) model correction.

1）Model Setting

The SEM cannot be set based on experience or perception but must be based on a fixed theoretical foundation. Before constructing a structural equation model, it is necessary to carefully study the relevant theories and gain a deep understanding of the actual situation of the research object. Therefore, while conducting extensive literature research to understand the relevant theories, it is also necessary to conduct in-depth research on the characteristics of the research object to identify the correlation between various influencing factors. In this way, the model constructed by combining theory and practice can better solve the corresponding problems.

This article proposes hypotheses through the examination of relevant theories and research, and then constructs a confirmatory factor model. Based on this, it analyzes the impact mechanism of GSCI on corporate performance, by considering the impact of ambidextrous green innovation and green legitimacy.

(2) Model Recognition

Model recognition evaluates the feasibility of achieving successful data fitting upon introduction and execution. In mathematical terms, it ascertains the solvability of the specified structural equations. Recognition outcomes encompass three possibilities: unrecognizable, exact recognition, and over-recognition. Effective model fitting is achievable solely when exact recognition or over-recognition is attained. In cases where model fitting falls short, it becomes imperative to increase the count of known parameters within the model to satisfy recognition criteria. The absence of model recognition renders the software incapable of displaying fitting result values and analyzing the research problem.

(3) Estimation and Fitting of Models

Two main methods are commonly used to solve structural equation models: Partial Least Squares (PLS) and Linear Structural Relationship (LISREL). PLS minimizes the sum of squares of errors at each step but falls short of overall error requirements. LISREL encompasses five methods in AMOS: maximum likelihood estimation, generalized least squares, unweighted least squares, free metric least squares, and asymptotic arbitrary step method. Maximum likelihood estimation is preferred for its unbiasedness, effectiveness, consistency, and approximation to a normal distribution. In this paper, maximum likelihood estimation is employed for parameter estimation.

(4) Model Evaluation

Model evaluation hinges on test results and numerical evaluation metrics to gauge the model's fit quality. Within the confines of existing evidence and theoretical frameworks, evaluate the degree of alignment between all models and the sample data.

Following guidelines suggested by Bentler & Bonett (1980), Bentler (1990), Baumgartner & Homburg (1996), Doll et al. (1994), Bagozzi et al. (1991), and Hair et al. (2010), this study evaluates model fit based on specific fit measures as outlined in Table 3.8.

Table 3.8 Model fit analysis of the moderated structural model

Fitting Indicators	Threshold	Source
χ^2	-	
df	-	
χ^2 / df	≤ 5	Bagozzi et al. (1991); Hair et al. (2010)
RMSEA	$\leq .08$	Hair et al. (2010)
GFI	$\geq .9$ good $\geq .8$ acceptable	Baumgartner & Homburg (1996);
AGFI	$\geq .9$ good $\geq .8$ acceptable	Doll et al. (1994)
NFI	$\geq .90$	Bentler & Bonett (1980)
CFI	$\geq .90$	Bentler (1990)
TCL	$\geq .90$	Bentler & Bonett (1980)

(5) Model Correction

Upon successful model fitting, the initial step involves evaluating if the path coefficients in the output pass significant tests. If so, consider potential model corrections. Next, verify if widely accepted fit indices align with reporting standards and assess if the model's goodness of fit meets expectations. In cases of unsatisfactory goodness of fit, corrective actions involve adjustments to free parameter settings within the model, including modifications, increases, or decreases. Parameters failing significance tests can be fixed at 0 or 1, reducing free parameters. Alternatively, for models with poor fit, contemplate the introduction of additional free parameters as a corrective measure.

3.6.4.2 Analysis of the Direct and Indirect Effects of SEM. The conceptual model of this study includes one mediation variable: ambidextrous green innovation. One of the chief advantages of the counterfactual approach to mediation analysis is allowing for effect decomposition of a total effect into a natural direct and indirect effect even in models with interactions and nonlinearities (Robins & Greenland, 1992). Usually, the influence effects in SEM can be divided into two types: direct effects and indirect effects.

Direct effects refer to the direct impact from the causal variable (exogenous or endogenous) to the outcome variable (endogenous), measured by the path coefficient from the causal variable to the outcome variable; Indirect effect refers to the indirect impact of the causal variable on the outcome variable by influencing one or more mediating variables. When there is only one mediating variable, the magnitude of the indirect effect is the product of the two path coefficients; The total effect is equal to the sum of indirect effects and direct effects.

This article examines the relevant latent variables from both direct and indirect effects, in order to make the research more accurate and to make the measurement results more consistent with the content to be examined. In addition, this study will test whether ambidextrous green innovation plays a significant mediating role between GSCI and enterprise performance through the P-value of the standardized path coefficient of indirect effects. When the P-value is less than .05, the mediating effect is significant, while on the contrary, the mediating effect is not significant.

3.6.5 Analysis of the Moderating Effect of Process Macro

Process Macro model 1 by Hayes (2017) is employed to test the moderating effect of green legitimacy (GL) between ambidextrous green innovation (AGI) and enterprise performance (EP) (H5). As shown in Figure 3.2, according to model 1 in PROCESS, ambidextrous green innovation (AGI) is the independent variable, green legitimacy is the moderator variable, and enterprise performance is the dependent variable. It can be implemented through the use of an SPSS statistical software package to test the hypotheses. The output results of the SPSS statistical software will be discussed in detail in Section 4.7.2.

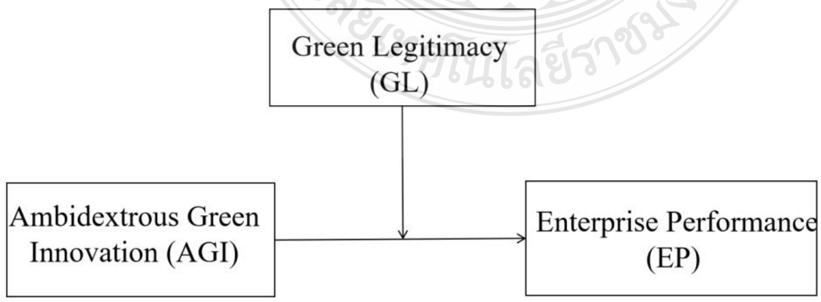

Figure 3.2 Analysis of the moderation effect of green legitimacy on the relationship between ambidextrous green innovation and enterprise performance

3.7 Chapter Summary

This chapter focused on the research methodology of this study. It began by outlining the procedures of the study and then detailed the design and development of the instrument, population and sampling, data collection methods, and data analysis methods. The next chapter will present the specific findings of this study.

CHAPTER 4
RESEARCH RESULT

4.1 Introduction

The literature review guides researchers in constructing conceptual models and developing research tools, providing a theoretical framework for the study.

This chapter analyzes the survey results based on the research questions posed. This chapter is composed of eight sections. Following this introduction, Section 4.2 illustrates the process of data preparation. Section 4.3 analyzes demographic characteristics. Subsequently, descriptive analysis is performed in Section 4.4. Reliability and validity analyses are performed on the data in Sections 4.5 and 4.6 respectively, ensuring the construct validity, including convergent validity and discriminant validity, of all model constructs. Subsequently, the research model and hypothesis testing are conducted in Sections 4.7 and 4.8 respectively.

4.2 Data Preparation

This section involved the direct work of data organization, including data screening, data coding, and entry. The details are set out below.

4.2.1 Data Screening

To ensure a reasonable response rate, the survey employed three methods: face-to-face surveys, indirect distribution, and email surveys targeting pharmaceutical manufacturing companies in four provinces: Shanghai, Anhui, Zhejiang, and Jiangsu. Respondents covered positions including CEO, general manager, supply chain manager, purchasing manager, and marketing manager within these enterprises. From September to December 2023, data collection primarily occurred at various conference venues, supplemented by email and indirect distribution methods. In December, email and indirect distribution methods were primarily utilized. Participants who hadn't responded were reminded through follow-up emails and WeChat messages. Table 4.1 illustrates that out of 647 questionnaires distributed, 472 were collected. After excluding 72 invalid questionnaires, 400 questionnaires remained valid, resulting in an effective recovery rate of 61.82%.

Table 4.1 Distribution and return of questionnaires

Method of distribution of questionnaires	Number of Distributed Questionnaire	Number of Effective Returned Questionnaire	Effective Returned Rate
Direct face-to-face	159	151	94.97%
Indirect distribution	203	182	89.66%
E-mail distribution.	285	67	23.51%
Total	647	400	61.82%

4.2.2 Data Coding and Entry

To facilitate data processing and interpretation, the variables in this study were coded and abbreviated as shown in table 4.2.

Table 4.2 Abbreviation of constructs and observed variables

Construct Group	Observed variable	Variable types
Green Supply Chain Integration (GSCI)	Green internal integration (GII) Green supply integration (GSI) Green customer integration (GCI)	Independent Variable
Ambidextrous Green Innovation （AGI)）	Exploratory green innovation (ERGI) Exploitative green innovation (EIGI)	Mediating Variable
Enterprise Performance (EP)	Environmental performance (ENVP) Economic performance (ECOP) Social performance (SOCP)	Independent Variable
Green Legitimacy (GL)	Green coercive legitimacy (GCL) Green normative legitimacy (GNL) Green mimetic legitimacy (GML)	Moderating variable

4.2.3 Normality Test

One of the necessary prerequisites for conducting SEM analysis is that the data must not deviate significantly from a normal distribution. The purpose of the normality test is to assess whether the data are normally distributed and to ensure that the scores of individual respondents are not too high or too low to affect the overall results (Hair et al., 2010).

Normality can be diagnosed through skewness and kurtosis. Skewness is a statistic that describes the degree of skewness of a data distribution. kurtosis quantifies the degree of peakedness or flatness of a distribution relative to the normal distribution. According to Hair et al. (2006), skewness and kurtosis should not exceed ±3 standard deviations from the mean to avoid issues of non-normality in the data set.

Table 4.3 shows the results of the normality test. From Table 4.3, it can be seen that the absolute values of kurtosis and skewness for all measurement items are less than 3, indicating that there is no non-normality issue in the data (Hair et al.,2006).

Table 4.3 Results of normality distribution test results

Item	N	Skewness	Kurtosis	Item	N	Skewness	Kurtosis
GCI1	400	-0.238	-0.930	SOCP1	400	-0.067	-0.848
GCI2	400	-0.075	-0.952	SOCP2	400	-0.041	-0.788
GCI3	400	-0.058	-0.906	SOCP3	400	-0.177	-0.763
GCI4	400	-0.091	-0.950	SOCP4	400	-0.189	-0.751
GCI5	400	-0.271	-0.791	ERGI1	400	-0.043	-0.754
GCI6	400	-0.384	-0.433	ERGI2	400	-0.147	-0.659
GSI1	400	-0.136	-0.529	ERGI3	400	-0.056	-0.728
GSI2	400	-0.226	-0.600	ERGI4	400	-0.017	-0.536
GSI3	400	-0.108	-0.759	ERGI5	400	-0.168	-0.688
GSI4	400	-0.130	-0.600	ERGI6	400	-0.089	-0.540

Table 4.3 Results of normality distribution test results (Cont.)

Item	N	Skewness	Kurtosis	Item	N	Skewness	Kurtosis
GSI5	400	-0.216	-0.647	ERGI7	400	-0.041	-0.668
GSI6	400	-0.335	-0.422	EIGI1	400	-0.024	-0.598
GII1	400	-0.117	-0.724	EIGI2	400	-0.088	-0.712
GII2	400	-0.196	-0.817	EIGI3	400	-0.009	-0.601
GII3	400	-0.271	-0.799	EIGI4	400	-0.046	-0.592
GII4	400	-0.116	-0.791	EIGI5	400	-0.073	-0.547
GII5	400	-0.288	-0.721	EIGI6	400	0.011	-0.600
GII6	400	-0.311	-0.516	GNL1	400	-0.082	-0.947
ENVP1	400	-0.141	-0.823	GNL2	400	-0.131	-0.913
ENVP2	400	-0.204	-0.977	GNL3	400	-0.024	-0.992
ENVP3	400	-0.108	-0.825	GML1	400	0.102	-0.758
ENVP4	400	-0.231	-0.833	GML2	400	0.172	-0.696
ECOP1	400	0.083	-0.836	GML3	400	0.092	-0.884
ECOP2	400	-0.234	-0.733	GCL1	400	0.116	-0.577
ECOP3	400	-0.085	-0.812	GCL2	400	0.090	-0.833
ECOP4	400	-0.092	-0.785	GCL3	400	0.035	-0.820
ECOP5	400	-0.188	-0.671	—		—	—

4.3 Demographic Data

Questionnaires were distributed to individuals holding positions such as CEO, general manager, supply chain manager, purchasing manager, and marketing manager within pharmaceutical manufacturing enterprises in China. The questionnaire consisted of six questions with demographic information including the industry code of the pharmaceutical manufacturing enterprises, current position, gender, age, highest education level, and period working in the current enterprise. The summarized demographic data is presented in Table 4.4.

(1) Gender: Regarding the gender distribution of respondents, 64.3% were male, while 35.7% were female.

(2) Age: Among the respondents, the majority fall within the 41-45 age bracket, accounting for 30.3%, followed by 46-50 at 25.8%. The smallest group is in the 30-35 range, comprising 12.0%.

(3) Position: The highest proportion is for supply chain managers at 26.0%, followed by marketing managers at 24.3%, and the smallest proportion is for presidents, accounting for 3.3%.

(4) Education: Among the respondents, the highest proportion holds a Master's degree at 35.3%, followed by those with a Bachelor's degree at 31.0%, while the lowest proportion holds a doctor’s degree at 12.0%.

(5) Period working: Among all respondents, the highest proportion falls within the 5–10-year tenure at the current company, accounting for 34.0%, followed by 3-5 years at 32.5%, while those with less than three years of experience constitute the smallest group at 14.0%.

(6) Sub-industries: Manufacturing of Chemical Pharmaceutical Preparations has the highest proportion at 30.3%, followed by manufacturing of Chemical Raw Materials at 21.5%. The lowest proportion is for manufacturing of Veterinary Drugs, accounting for 4.5%.

Table 4.4 Demographic characteristics of the sample

Demographic	Category	Frequency	Percentage (%)
Gender	Male	257	64.3
	Female	143	35.7
Age	30 - 35	48	12.0
	36 - 40	65	16.3
	41 - 45	121	30.3
	46 - 50	103	25.8
	51 – 55	63	15.8

Table 4.4 Demographic Characteristics of The Sample (Cont.)

Demographic	Category	Frequency	Percentage (%)
Current position	General Manager	85	21.3
	Supply Chain Manager	104	26.0
	Purchasing Manager	83	20.8
	Marketing Manager	97	24.3
	CEO/Vice president	18	4.5
	President	13	3.3
Highest Education	Below Bachelor's degree	87	21.8
	Bachelor's degree	124	31.0
	Master's degree	141	35.3
	Doctor's degree	48	12.0
Period working in the current enterprise	Less than 3 years	56	14.0
	Between 3 to 5 years	130	32.5
	Between 5 to 10 years	136	34.0
	More than 10 years	78	19.5
Industry code of pharmaceutical manufacturing enterprises	2710	86	21.5
	2720	121	30.3
	2730	40	10.0
	2740	82	20.5
	2750	18	4.5
	2760	53	13.3

Note:2710: Chemical Raw Materials, 2720: Chemical Pharmaceutical Preparations, 2730: Chinese Herbal Pieces, 2740: Chinese Patent Medicines, 2750: Veterinary Drugs, 2760: Bio-pharmaceuticals.

4.4 Descriptive Statistics

The following section summarizes the characteristics of the data collected for this study and is presented in a quantitative and comparable manner.

4.4.1 Green Supply Chain Integration

The attribute of green supply chain integration construct was measured by three observed variables, which were green supplier integration, green internal integration and green customer integration. The statistical analysis of the minimum and maximum score, mean value, and standard deviation value is shown in Table 4.5.

The item with the highest mean value was “GII6” (Mean=3.48, SD=1.06) under the green internal integration variable. The item with the lowest mean value was “GCI4” (Mean=3.10, SD=1.23) under the green customer integration variable.

Table 4.5 Descriptive statistics for green supply chain integration

Variable	Min	Max	Mean	SD
Green internal integration				
GII1	1	5	3.30	1.04
GII2	1	5	3.21	1.12
GII3	1	5	3.22	1.14
GII4	1	5	3.33	1.08
GII5	1	5	3.30	1.13
GII6	1	5	3.48	1.06
Green supplier integration				
GSI1	1	5	3.14	1.13
GSI2	1	5	3.19	1.18
GSI3	1	5	3.28	1.16
GSI4	1	5	3.23	1.14
GSI5	1	5	3.40	1.13
GSI6	1	5	3.41	1.06
Green customer integration				
GCI1	1	5	3.25	1.25
GCI2	1	5	3.18	1.24
GCI3	1	5	3.16	1.22
GCI4	1	5	3.10	1.23
GCI5	1	5	3.31	1.19
GCI6	1	5	3.47	1.08

4.4.2 Ambidextrous Green Innovation

The attribute of ambidextrous green innovation construct was measured by two observed variables, which were exploratory green innovation and exploitative green innovation. The statistical analysis of the minimum and maximum score, mean value and standard deviation value is shown in Table 4.6.

The item with the highest mean value was “ERGI6” (Mean=3.23, SD=0.98) within the exploratory green innovation variable. The item with the lowest mean value was “ERGI7” (M=2.90, SD=1.08) within the exploratory green innovation as well.

Table 4.6 Descriptive statistics for ambidextrous green innovation

Variable	Min	Max	Mean	SD
Exploratory green innovation				
ERGI1	1	5	3.10	1.13
ERGI2	1	5	3.07	1.12
ERGI3	1	5	3.06	1.14
ERGI4	1	5	3.07	0.99
ERGI5	1	5	3.12	1.13
ERGI6	1	5	3.23	0.98
ERGI7	1	5	2.90	1.08
Exploitative green innovation				
EIGI1	1	5	3.05	1.04
EIGI2	1	5	3.05	1.07
EIGI3	1	5	3.07	1.08
EIGI4	1	5	3.06	1.08
EIGI5	1	5	3.08	1.03
EIGI6	1	5	3.20	1.03

4.4.3 Enterprise Performance

The attribute of the enterprise performance construct was measured by three observed variables, which were environmental performance, economic performance, and social performance. The statistical analysis of the minimum and maximum score, mean value and standard deviation value is shown in Table 4.7.

The item with the lowest mean value was "ECOP1" (Mean=2.92, SD=1.19) within the economic performance variable. The item with the highest mean value was "ECOP2" (Mean=3.33, SD=1.17) within the economic performance variable as well.

Table 4.7 Descriptive statistics for enterprise performance

Variable	Min	Max	Mean	SD
Environmental Performance				
ENVP1	1	5	3.18	1.17
ENVP2	1	5	3.22	1.27
ENVP3	1	5	3.17	1.19
ENVP4	1	5	3.27	1.19
Economic performance				
ECOP1	1	5	2.92	1.19
ECOP2	1	5	3.33	1.17
ECOP3	1	5	3.14	1.16
ECOP4	1	5	3.13	1.13
ECOP5	1	5	3.22	1.12
Social Performance				
SOCP1	1	5	3.11	1.17
SOCP2	1	5	3.15	1.20
SOCP3	1	5	3.19	1.18
SOCP4	1	5	3.29	1.16

4.4.4 Green Legitimacy

The attribute of green legitimacy construct was measured by three observed variables, which were green coercive legitimacy, green normative legitimacy and green mimetic legitimacy. The statistical analysis of the minimum and maximum score, mean value and standard deviation value is shown in Table 4.8.

The item with the highest mean value was “GNL1” (Mean=3.18, SD=1.25) within the green normative legitimacy variable. The item with the lowest mean value was “GML2” (Mean=2.70, SD=1.12) within the green mimetic legitimacy.

Table 4.8 Descriptive statistics for green legitimacy

Variable	Min	Max	Mean	SD
Green Normative Legitimacy				
GNL1	1	5	3.18	1.25
GNL2	1	5	3.11	1.27
GNL3	1	5	3.13	1.25
Green Mimetic Legitimacy				
GML1	1	5	2.79	1.13
GML2	1	5	2.70	1.12
GML3	1	5	2.72	1.17
Green Coercive Legitimacy				
GCL1	1	5	2.88	1.10
GCL2	1	5	2.88	1.16
GCL3	1	5	2.97	1.18

4.5 Reliability Test

This study uses Cronbach's Alpha coefficient to test the reliability of all constructs. The reliability test results are shown in Table 4.9. From Table 4.9, it can be seen that the GCI scale contains a total of 6 measurement items, and its Cronbach's Alpha coefficient is .910, which is greater than the critical value of .70. It is concluded that the reliability of the GCI scale data meets the standard (Straub et al. 2004). Similarly, it can be concluded that the reliability of the scales for all the remaining constructs meets the standards.

Table 4.9 Results of reliability testing

Variable	Cronbach's Alpha	Number of Items
GCI	.910	6
GSI	.906	6
GII	.910	6
ENVP	.884	4
ECOP	.891	5
SOCP	.879	4
ERGI	.919	7
EIGI	.902	6
GCL	.845	3
GNL	.857	3
GML	.824	3

4.6 Construct Validity Test through CFA

Construct validity assessment seeks to determine the extent to which a set of measurement items reflects the underlying factor model (Hair et al. 2010). This involves the measurement of individual constructs and requires that each factor model be tested first and then the higher-order models (Lewis et al., 2005). According to Segars & Grover (1998), this procedure 'provides the fullest evidence of measurement efficacy and also reduces the likelihood of confounds in full structural equation modeling which may arise due to excessive error in measurement'. All of the variables in this study were second-order latent variables, and next, we analyzed these latent variables in turn with one-factor and second-order factor analyses.

4.6.1 Convergent Validity

4.6.1.1 One-factor Con-generic Model Analysis. The study includes four second-order variables: GSCI, ambidextrous green innovation, enterprise performance, and green legitimacy. In line with the perspectives of (Lewis et al., 2005) and Segars & Grover (1998), we initially conducted one-factor con-generic model analysis on these variables first.

(1) One-factor Con-generic Model for Green Supply Chain Integration

GSCI contains three dimensions: GII, GCI, and GSI. In this section, a one-factor analysis was conducted on each of these three dimensions. The GII model theoretically has six items (GII1, GII2, GII3, GII4, GII5, GII6). The CFA results of the proposed one-factor con-generic model for GII in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.1 and Table 4.10, respectively. The factor loading for each item are all above .7 and squared multiple correlation (SMC) is all above .5 (Hair et al. 2010). The fitting indicators of the proposed model all meet the thresholds. Therefore, the proposed one-factor con-generic model for GII is deemed acceptable.

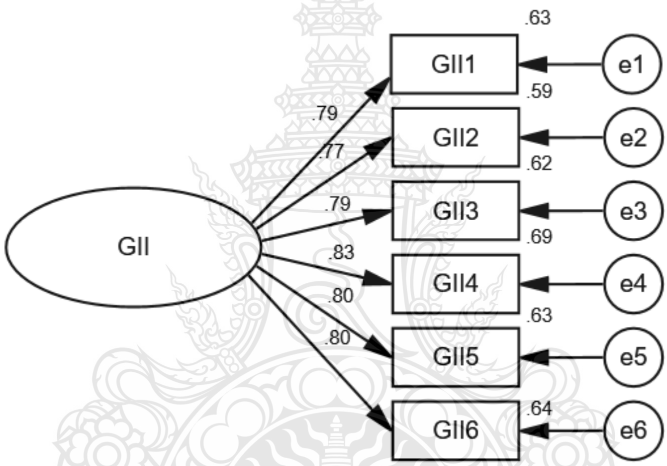

Figure 4.1 Proposed One-factor Con-generic model of GII

The GSI model theoretically has six items (GSI1, GSI2, GSI3, GSI4, GSI5, GSI6). The CFA results of the proposed one-factor con-generic model for GSI in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.2 and Table 4.10, respectively. The factor loading for each item are all above .7 and SMC are all above .5 (Hair et al. 2010). The fitting indicators of the proposed model all meet the thresholds. Thus, the proposed measurement model for GSI is accepted.

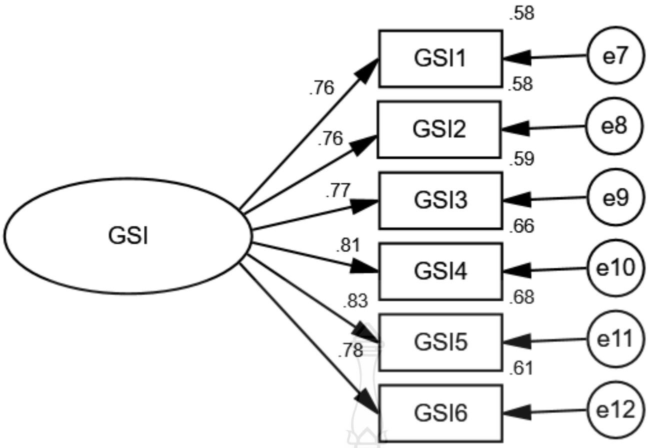

Figure 4.2 Proposed One-factor Con-generic model of GSI

The GCI model theoretically has six items (GCI1, GCI2, GCI3, GCI4, GCI5, GCI6). The CFA results of the proposed one-factor con-generic model for GCI in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.3 and Table 4.10, respectively. The factor loading for each item are all above .7 and SMC are all above .5 (Hair et al. 2010). All fitting indicators of the proposed model meet the specified thresholds, indicating strong support for the adequacy of the proposed measurement model for the GCI. As a result, the proposed one-factor con-generic model for GCI is considered acceptable.

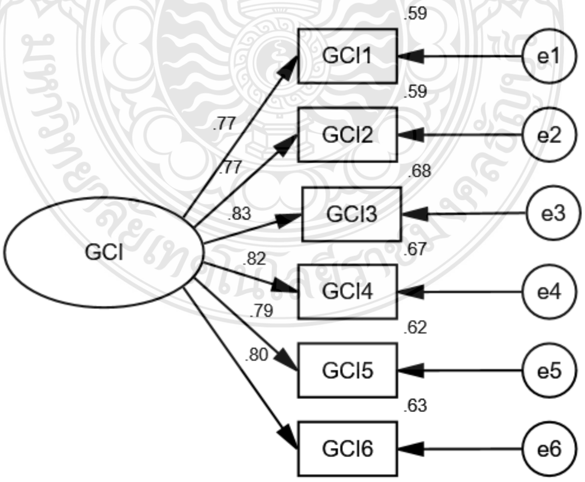

Figure 4.3 Proposed One-factor Con-generic model of GCI

Table 4.10 Proposed GSCI One-factor Con-generic model fit analysis

Fitting Indicators	Estimate Value			Threshold
	GII	GSI	GCI	
χ^2	18.187	12.455	36.077	-
df	9	9	9	-
χ^2/df	2.021	1.384	4.009	≤ 5
RMSEA	.051	.031	.079	≤ .08
GFI	.985	.990	.970	≥ .9 good ≥.8 acceptable
AGFI	.965	.977	.930	≥ .9 good ≥ .8 acceptable
NFI	.987	.991	.973	≥ .90
CFI	.990	.997	.979	≥ .90
TLI	.989	.996	.965	≥ .90

(2) One-factor Con-generic Model for Ambidextrous Green Innovation

AGI contains two dimensions: ERGI and EIGI. In this section, a one-factor analysis was conducted on each of these two dimensions.

The ERGI model theoretically has seven items (ERGI1, ERGI2, ERGI3, ERGI4, ERGI5, ERGI6). The CFA results of the proposed one-factor con-generic model for ERGI in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.4 and Table 4.11, respectively. The factor loading for each item are all above .7 and SMC are all above .5 (Hair et al. 2010). All fitting indicators of the proposed model meet the specified thresholds, indicating strong support for the adequacy of the proposed measurement model for the ERGI. As a result, the proposed one-factor con-generic model for ERGI is accepted.

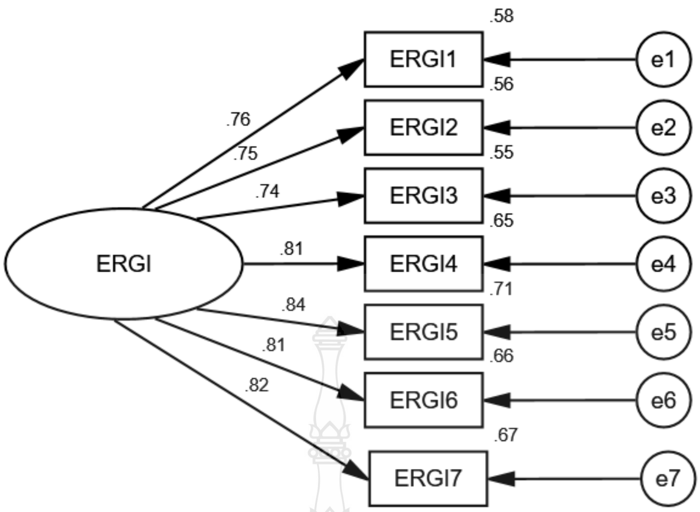

Figure 4.4 Proposed One-Factor Con-generic Model of ERGI

Table 4.11 Proposed AGI One-factor Con-generic model fit analysis

Fitting Indicators	Estimate Value		Threshold
	ERGI	EIGI	
χ^2	69.464	21.436	-
df	14	9	-
χ^2/df	4.96	2.382	≤ 5
RMSEA	.064	.059	$\leq .08$
GFI	.959	.983	$\geq .9$ good $\geq .8$ acceptable
AGFI	.918	.961	$\geq .9$ good $\geq .8$ acceptable
NFI	.959	.984	$\geq .90$
CFI	.966	.991	$\geq .90$
TLI	.949	.984	$\geq .90$

The EIGI model theoretically has six items (EIGI1, EIGI2, EIGI3, EIGI4, EIGI5, EIGI6). The CFA results of the proposed one-factor con-generic model for EIGI in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.5 and Table 4.11, respectively. The factor loading for each item are all above .7 and SMC are all above .5 (Hair et al. 2010). The fitting indicators of the proposed model have met the thresholds, indicating support for the suitability of the proposed measurement model for EIGI. Consequently, it can be inferred that the proposed single-factor con-generic model for EIGI is accepted.

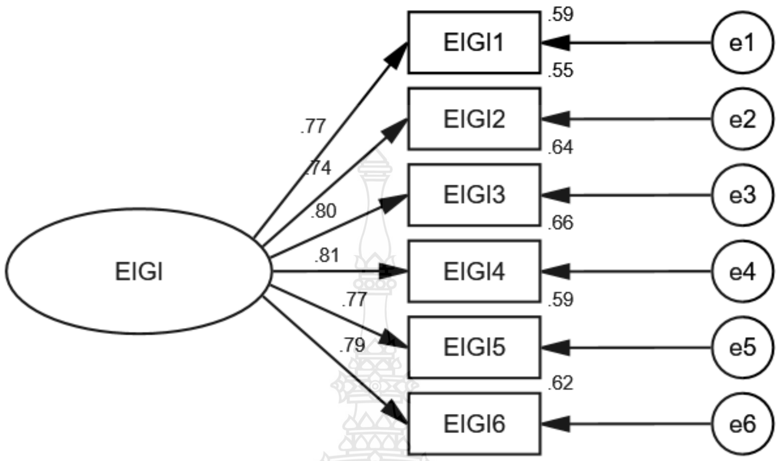

Figure 4.5 Proposed One-factor Con-generic model of EIGI

(3) One-factor Con-generic Model for Enterprise Performance

EP contains three dimensions: ENVP, ECOP, and SOCP. In this section, a one- factor analysis was conducted on each of these three dimensions.

The ENVP model theoretically has four items (ENVP1, ENVP2, ENVP3, ENVP4). The CFA results of the proposed one-factor model for ENVP in corresponding with its model fitting indicators and factor loading are revealed in Figure 4.6 and Table 4.12, respectively. The factor loading for each item are all above .7, the minimum SMC equals to .6, reaching the threshold (Hair et al. 2010). The fitting indicators of the proposed model have met the thresholds, indicating support for the suitability of the proposed measurement model for ENVP. Consequently, the proposed single-factor con-generic model for ENVP is accepted.

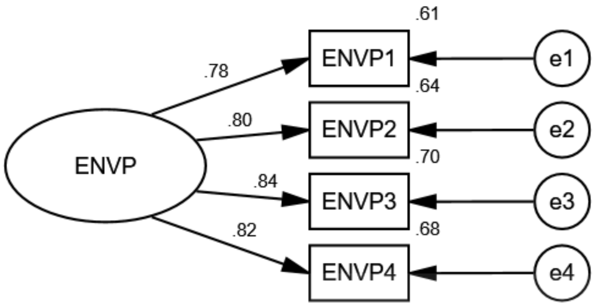

Figure 4.6 Proposed One-Factor Con-generic Model of ENVP

Table 4.14 Proposed EP One-Factor Con-generic Model fit analysis

Fitting Indicators	**Estimate Value**			**Threshold**
	ENVP	**ECOP**	**SOCP**	
χ^2	1.557	14.093	5.545	-
df	2	5	2	-
χ^2/df	.779	2.819	2.772	≤ 5
RMSEA	.000	.068	.067	$\leq .08$
GFI	.998	.987	.993	$\geq$ .9 good $\geq$ .8 acceptable
AGFI	.990	.960	.967	$\geq$ .9 good $\geq$ .8 acceptable
NFI	.998	.987	.993	$\geq .90$
CFI	1.000	.991	.996	$\geq .90$
TLI	1.000	.983	.987	$\geq .90$

The ECOP model theoretically has five items (ECOP1, ECOP2, ECOP3, ECOP4, ECOP5). The CFA results of the proposed one-factor model for ECOP corresponding with its model fitting indicators and factor loading are revealed in Figure 4.7 and Table 4.12, respectively. The factor loading for each item all above .7 and SMC are all above .5 (Hair et al. 2010). The fitting indicators of the proposed model have met the thresholds, indicating support for the suitability of the proposed measurement model for ECOP. Consequently, the proposed single-factor con-generic model for ECOP is accepted.

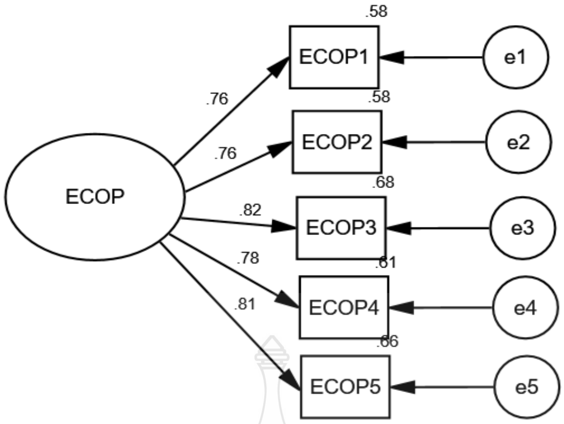

Figure 4.7 Proposed One-factor Con-generic model of ECOP

The SOCP model theoretically has five items (SOCP1, SOCP 2, SOCP 3, SOCP 4). The CFA results of the proposed one-factor model for ECOP corresponding with its model fitting indicators and factor loading are revealed in Figure 4.7 and Table 4.12, respectively. The factor loading for each item all above .7 and SMC are all above .5 (Hair et al. 2010). The fitting indicators of the proposed model have met the thresholds, indicating support for the suitability of the proposed measurement model for ECOP. Consequently, the proposed single-factor con-generic model for ECOP is accepted.

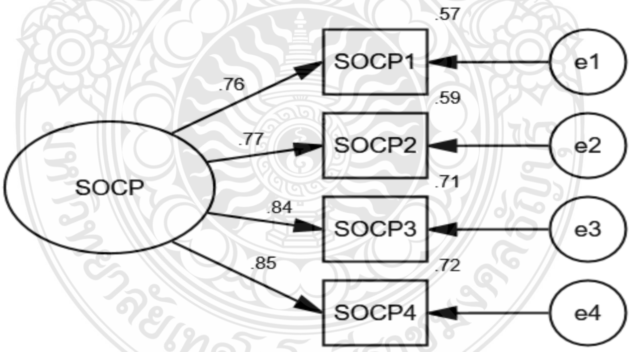

Figure 4.8 Proposed One-factor Con-generic model of SOCP

(4) One-factor Con-generic Model for Green Legitimacy

GL contains three dimensions: GCL, GNL, and GML. In this section, a one- factor analysis was conducted on each of these three dimensions.
GCL, GNL, and GML all contain three items only. In the absence of error correlation, a one-factor CFA model with three observed variables is a just-identified model (df = 0).

When df = 0, the model cannot provide data to refute the likelihood of the model. Therefore, the fit statistic is 0 because the fit is perfect in the just-identified model (Brown,2015). So, we only focus on the factor loading, ignoring the model fit index. One-factor CFA models for CL, NL, and ML are presented in Figure 9- Figure 11, respectively. These figures reveal that all of the one-factor CFA models for CL, NL, and ML have good factor loading, these models are admissible.

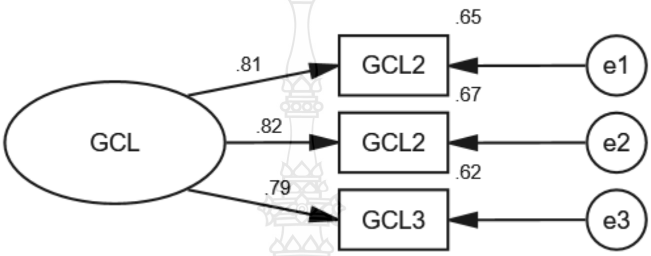

Figure 4.9 Proposed one-factor Con-generic model of GCL

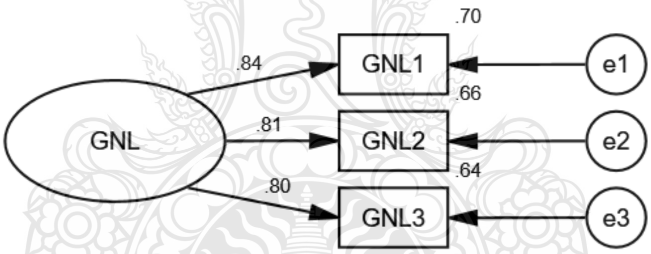

Figure 4.10 Proposed one-factor Con-generic model of GNL

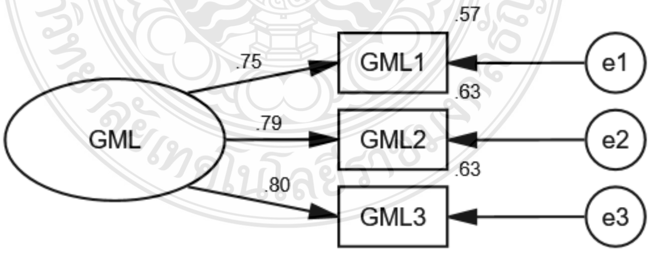

Figure 4.11 Proposed one-factor Con-generic model of GML

4.6.1.2 Higher Order Measurement Model Analysis. Through the theoretical review, the GSCI, AGI, EP, and GL concerned in this study are all at the second-order level. In this section, second-order CFA was employed. After assessing model fit, construct validity tests for AVE and CR are conducted.

(1) The Second-Order Factor Model of Green Supply Chain Integration

In the preceding sections, we individually tested and validated the one-factor con-generic models of the three factors comprising the GSCI. This section validates all three factors together, forming the GSCI construct. The research hypothesis of this study is based on the GSCI construct, which is a second-order construct.

Figure 4.12 illustrates the proposed second-order measurement model of the GSCI based on the GII, GCI, and GSI one-factor con-generic models. The fit indicators of the proposed model, as displayed in Table 4.13, demonstrate that the model fit indices are within the recommended thresholds. The results of the convergence validity test are shown in Table 4.14. All factor loading are all greater than .7. The CR is greater than .7, and the AVE is greater than .5, which indicates that the model has good convergence validity.

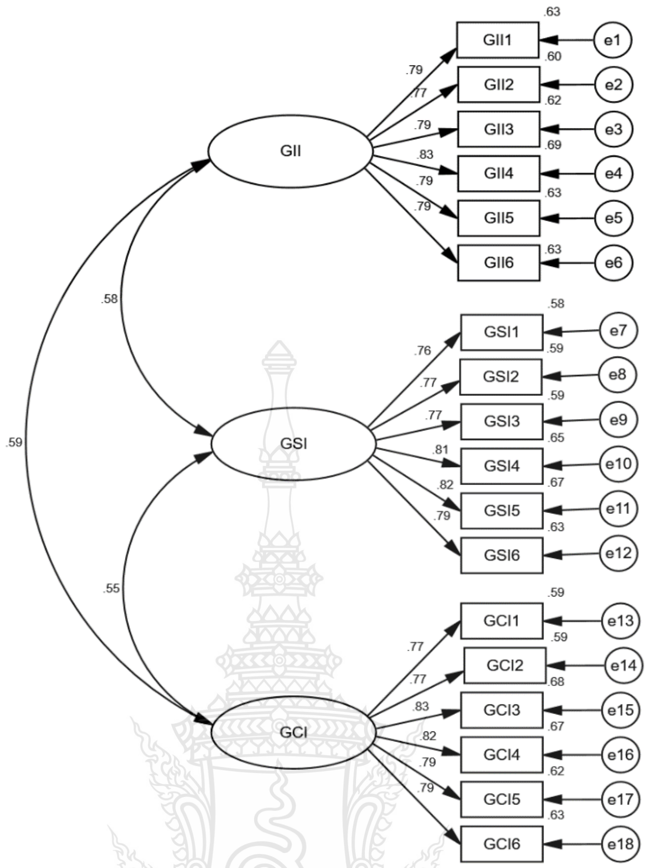

Figure 4.12 Proposed second-order measurement model of GSCI

Table 4.13 Analysis of fit for proposed second-order measurement model of GSCI

Fitting Indicators	Estimate Value	Threshold
χ^2	279.790	-
df	132	-
χ^2/df	2.120	≤ 5
RMSEA	.053	$\leq .08$
GFI	.930	$\geq .9$good $\geq .8$ acceptable
AGFI	.909	$\geq .9$good $\geq .8$ acceptable
NFI	.942	$\geq .90$
CFI	.968	$\geq .90$
TLI	.963	$\geq .90$

Table 4.14 Convergent validity for proposed second-order measurement of GSCI

Variable	Item	Standardized factor loading	CR	AVE
GII	GII1	.792	.911	.632
	GII2	.772		
	GII3	.788		
	GII4	.829		
	GII5	.793		
	GII6	.793		
GSI	GSI1	.762	.906	.617
	GSI2	.765		
	GSI3	.768		
	GSI4	.806		
	GSI5	.819		
	GSI6	.792		
GCI	GCI1	.771	.911	.630
	GCI2	.769		
	GCI3	.825		
	GCI4	.819		
	GCI5	.785		
	GCI6	.792		

(2) The Second-Order Factor Model of Ambidextrous Green Innovation

The one-factor con-generic CFA models of the two components comprising the AGI were individually tested and validated. This section validates all the two factors together, forming the AGI construct. The research hypothesis of this study is based on the AGI construct, which is a second-order construct.

Figure 4.13 illustrates the proposed second-order measurement model of the AGI based on the ERGI and EIGI one-factor con-generic models. The fit indicators of the proposed model, as displayed in Table 4.15, demonstrate that the model fit indices are within the recommended thresholds. The results of the convergence validity test are shown in Table 4.16. All factor loadings are all greater than .7. The CR is greater than .7, and the AVE is greater than .5, which indicates that the model has good convergence validity.

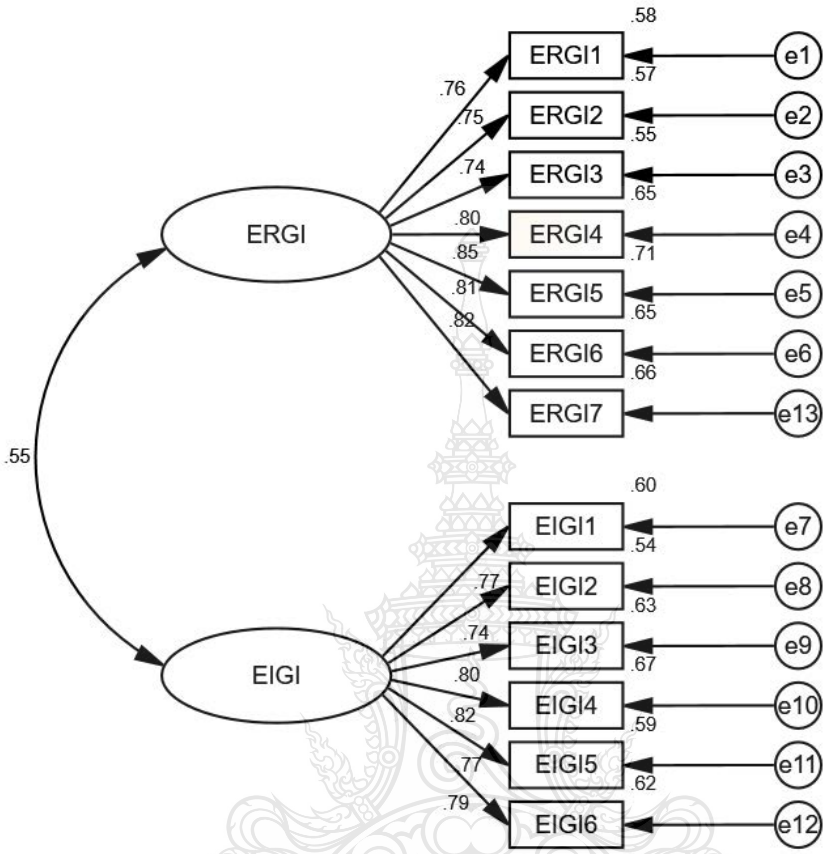

Figure 4.13 Proposed second-order measurement model of AGI

Table 4.15 Analysis of fit for proposed second-order measurement model of AGI

Fitting Indicators	Estimate Value	Threshold
χ^2	139.291	-
df	64	-
χ^2/df	2.176	≤ 5
RMSEA	.054	$\leq .08$
GFI	.954	$\geq .9$good $\geq .8$ acceptable
AGFI	.934	$\geq .9$good $\geq .8$ acceptable
NFI	.958	$\geq .90$
CFI	.977	$\geq .90$
TLI	.972	$\geq .90$

Table 4.16 Convergent validity for proposed second-order measurement of AGI

Variable	Item	Standardized factor loading	CR	AVE
ERGI	ERGI1	.762	.921	.625
	ERGI2	.752		
	ERGI3	.743		
	ERGI4	.804		
	ERGI5	.845		
	ERGI6	.809		
	ERGI7	.815		
EIGI	EIGI1	.772	.903	.609
	EIGI2	.735		
	EIGI3	.795		
	EIGI4	.821		
	EIGI5	.767		
	EIGI6	.788		

(3) The Second-Order Factor Model of Enterprise Performance

Our research hypothesis is based on the concept of EP, which is a second-order concept. This section will validate the overall structure of three factors that form the EP.

Figure 4.14 illustrates the proposed second-order measurement model of the EP based on the ENVP, ECOP, and SOCP one-factor con-generic models. The fit indicators of the proposed model, as displayed in Table 4.17, demonstrate that the model fit indices are within the recommended thresholds. The results of the convergence validity test are shown in Table 4.18. All factor loadings are all greater than .7. The CR is greater than .7, and the AVE is greater than .5, which indicates that the model has good convergence validity.

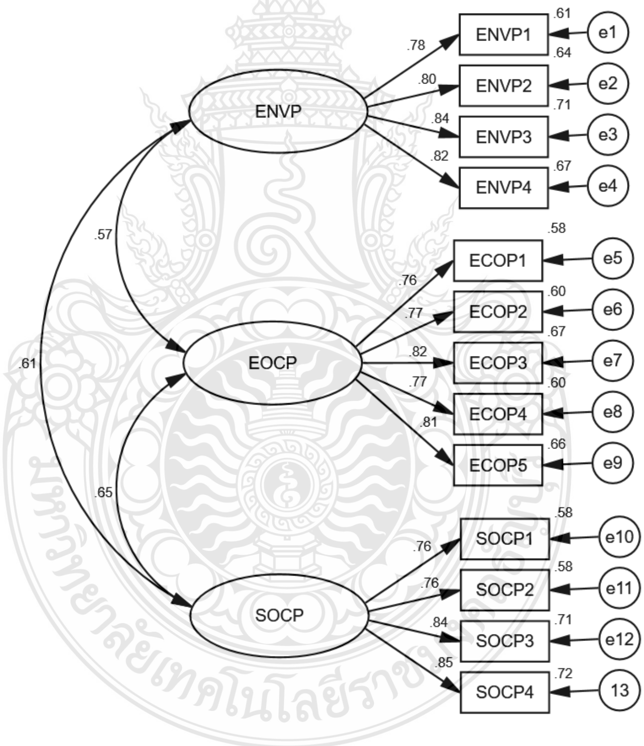

Figure 4.14 Proposed second-order measurement model of EP

Table 4.17 Analysis of fit for proposed second-order measurement model of EP

Fitting Indicators	Estimate Value	Threshold
χ^2	66.712	-
df	62	-
χ^2/df	1.076	≤ 5
RMSEA	.014	$\le .08$
GFI	.975	$\ge .9$ good $\ge .8$ acceptable
AGFI	.963	$\ge .9$good $\ge .8$ acceptable
NFI	.979	$\ge .90$
CFI	.998	$\ge .90$
TLI	.998	$\ge .90$

Table 4.18 Convergent validity for proposed second-order measurement of EP

Variable	Item	Standardized factor loading	CR	AVE
ENVP	ENVP1	.781	.884	.657
	ENVP2	.800		
	ENVP3	.842		
	ENVP4	.818		
ECOP	ECOP1	.758	.892	.622
	ECOP2	.775		
	ECOP3	.820		
	ECOP4	.775		
	ECOP5	.814		
SOCP	SOCP1	.762	.880	.647
	SOCP2	.763		
	SOCP3	.842		
	SOCP4	.847		

(4) The Second-Order Factor Model of Green Legitimacy

Our research hypothesis is based on the concept of GL, which is a second-order concept. This section will validate the overall structure of three factors that form the GL.

Figure 4.15 illustrates the proposed second-order measurement model of the GL based on the GNL, GCL, and GML one-factor con-generic models. The fit indicators of the proposed model, as displayed in Table 4.19, demonstrate that the model fit indices are within the recommended thresholds. The results of the convergence validity test are shown in Table 4.20. All factor loadings are greater than .7. The CR is greater than .7, and the AVE is greater than .5, which indicates that the model has good convergence validity.

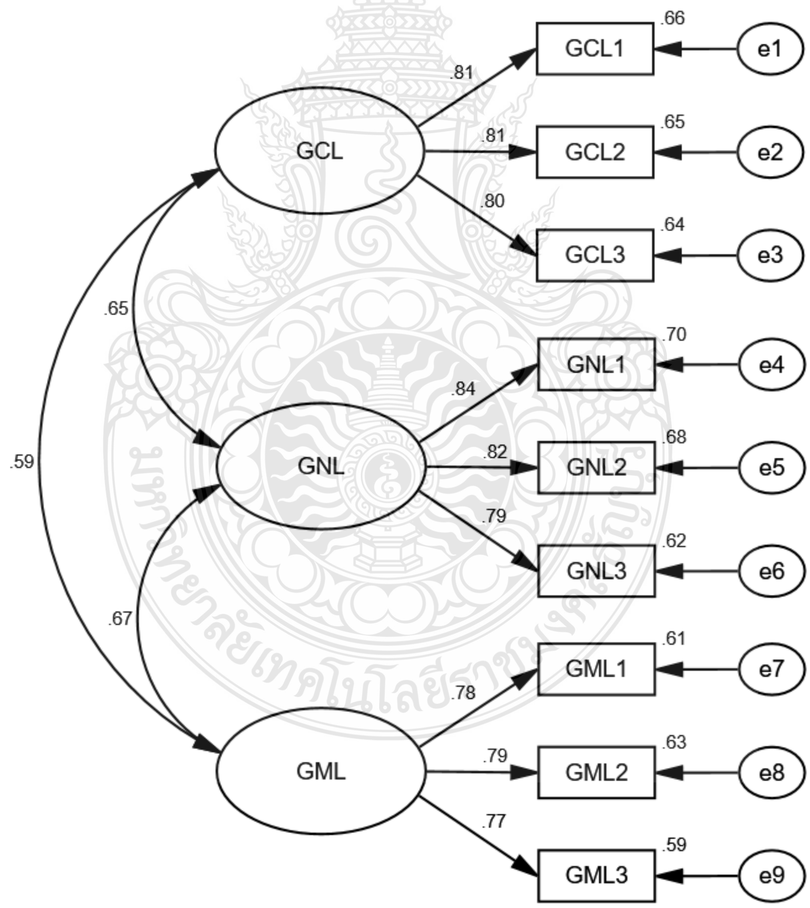

Figure 4.15 Proposed second-order measurement model of GL

Table 4.19 Analysis of fit for proposed second-order measurement model of GL

Fitting Indicators	Estimate Value	Threshold
χ^2	35.097	-
df	24	-
χ^2/df	1.426	≤ 5
RMSEA	.034	$\leq .08$
GFI	.981	$\geq .9$ good $\geq .8$ acceptable
AGFI	.965	$\geq .9$good $\geq .8$ acceptable
NFI	.981	$\geq .90$
CFI	.994	$\geq .90$
TLI	.991	$\geq .90$

Table 4.20 Convergent validity for proposed second-order measurement of GL

Variable	**Item**	**Standardized factor loading**	**CR**	**AVE**
GCL	GCL1	.810	.846	.647
	GCL2	.806		
	GCL3	.797		
GNL	GNL1	.838	.857	.666
	GNL2	.823		
	GNL3	.787		
GML	GML1	.782	.823	.608
	GML2	.791		
	GML3	.767		

4.6.2 Discriminant Validity

Table 4.21 presents the results of discriminant validity testing for each dimension of each latent variable mentioned above. As shown in Table 4.21, the AVE values for each dimension of each latent variable are greater than 0.5. Furthermore, Table 4.22 demonstrates that the square root of the AVE values exceeds the absolute values of the correlation coefficients among each dimension of each latent variable indicating that this study has good discriminative validity (Hair et al., 2006; Straub et al., 2004).

Table 4.21 Discriminant validity testing results

	GCI	GSI	GII	ERGI	EIGI	ENVP	ECOP	SOCP	GCL	GNL	GML
GCI	**.794**										
GSI	.540**	**.785**									
GII	.504**	.531**	**.795**								
ERGI	.366**	.390**	.387**	**.791**							
EIGI	.359**	.335**	.340**	.585**	**.780**						
ENVP	.339**	.285**	.393**	.330**	.285**	**.811**					
ECOP	.334**	.285**	.349**	.389**	.290**	.511**	**.789**				
SOCP	.424**	.410**	.368**	.382**	.344**	.534**	.578**	**.804**			
GCL	.130**	.122*	.169**	.186**	.161**	.230**	.245**	.296**	**.804**		
GNL	.164**	.117*	.162**	.100*	0.092	.150**	.234**	.233**	.549**	**.816**	
GML	.104*	0.066	0.097	0.084	0.033	.122*	.138**	.139**	.492**	.566**	**.780**

Note: (1) The bold value in the upper right corner is the square root of AVE, and other values are the correlation coefficients between variables

(1) * $p < 0.01$,** $p < 0.05$

4.7 Research model

4.7.1 Model 1

Model 1 was employed to investigate the direct and indirect effects among the variables, as depicted in Figure 4.16.

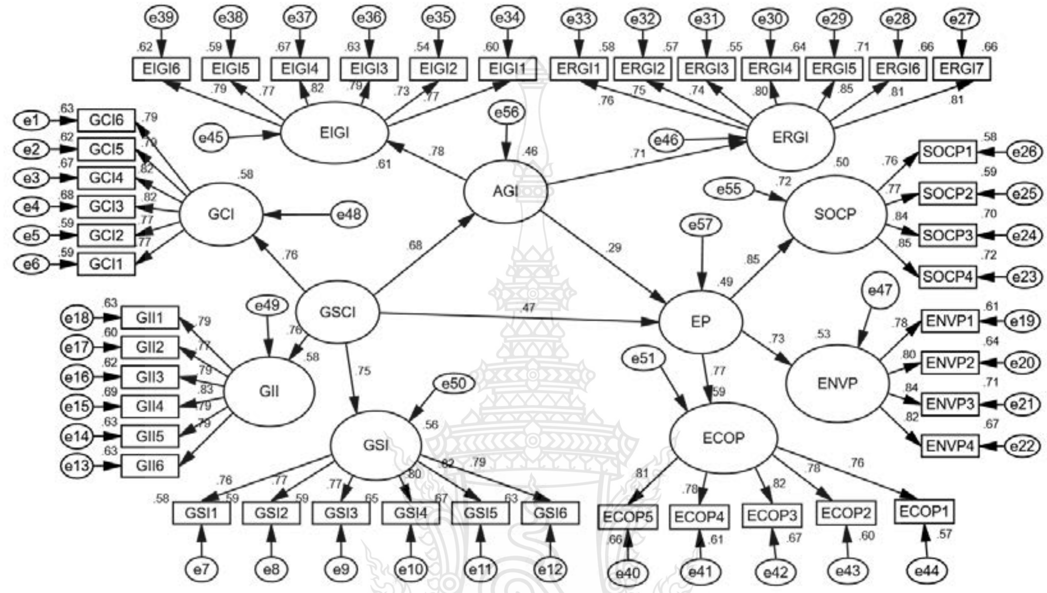

Figure 4.16 Model 1

The model fit indices for model one is shown in Table 4.22. From Table 4.22, it was found that all fit indices for model one as followed: $\chi^2 = 1126.540$, df $= 891$, $\chi^2/df = 1.264$, RMSEA = .026, GFI = .891, AGFI = .897, NFI = .907, CFI= .979, TLI=.978. All fitting indicators fell within acceptable ranges. Therefore, model one was validated and can delineate which variables directly or indirectly influence the other variables within the model (Anderson & Gerbing, 1988; Hair et al., 2010).

Table 4.22 Model fit analysis of model 1

Fitting Indicators	Estimate Value	Threshold
χ^2	1126.540	-
df	891	-
χ^2 / df	1.264	≤ 5
RMSEA	.026	$\leq .08$
GFI	.891	$\geq .9$ good $\geq .8$ acceptable
AGFI	.879	$\geq .9$ good $\geq .8$ acceptable
NFI	.907	$\geq .90$
CFI	.979	$\geq .90$
TLI	.978	$\geq .90$

Table 4.23 presents the results for Model 1. From the direct effects, it was found that the confidential interval for the relationship between green supply chain integration (GSCI) and enterprise performance (EP) fell within the 95% confidence interval, with a standardized coefficient of influence of .468 ($p < .01$). This suggested that there was a significant direct relationship between green supply chain integration (GSCI) and enterprise performance (EP), indicating green supply chain integration had (GSCI) a significant positive impact on enterprise performance (EP).

Table 4.23 Hypothesis testing of Model 1

Effect Analysis	Estimate	β	S.E.	C.R.	*p*-value	95% Confidence Interval	
						Lower	Upper
EP ← GSCI	.553	.468	.099	4.727	**	.266	.661
EP ← AGI	.364	.291	.113	2.575	*	.065	.508
AGI ← GSCI	.644	.681	.052	13.096	***	.575	.781
EP ← AGI ← GSCI	.234	.198	.079	2.506	**	.048	.363

* $p < .05$, ** $p < .01$, *** $p < .001$

The confidence interval for ambidextrous green innovation (AGI) and enterprise performance (EP) fell within the 95% confidence interval, with a standardized coefficient of influence of .291 (p < .05). This indicates a notable direct relationship between ambidextrous green innovation (AGI) and enterprise performance (EP), signifying a significant positive effect of ambidextrous green innovation (AGI) on enterprise performance (EP).

The confidence interval for green supply chain integration (GSCI) and ambidextrous green innovation (AGI) fell within the 95% confidence interval, with a standardized coefficient of influence of .681 (p < .001). This indicated a notable direct relationship between green supply chain integration (GSCI) and ambidextrous green innovation (AGI), signifying a significant positive effect of green supply chain integration (GSCI) on ambidextrous green innovation (AGI).

From the indirect effect, it was found that the indirect confidence interval for the influence of green supply chain integration (GSCI) on enterprise performance (EP) through ambidextrous green innovation (AGI) fell within the 95% confidence interval, with a standardized path coefficient of .198 (p < .01). This indicated that there was a significant indirect effect of green supply chain integration (GSCI) on enterprise performance (EP) through ambidextrous green innovation (AGI)

Table 4.24 shows the result of direct effects, indirect effects, and the total effect of model 1. Ambidextrous green innovation (AGI) had direct effects on enterprise performance (EP) at β=.291 (p < .01).

Table 4.24 Standardized direct, indirect, and total effects among variables

Independent Variable	**Effect**	**Dependent Variable**	
		AGI	**EP**
AGI	Standardized Direct Effect	-	.291*
	Standardized Indirect Effect	-	-
	Standardized Total Effects	-	.291*
GSCI	Standardized Direct Effect	.681***	.468**
	Standardized Indirect Effect	-	.198**
	Standardized Total Effects	.681***	.666***

* p < .05, ** p < .01, *** p < .001

Green supply chain integration (GSCI) had a significant direct effect on enterprise performance (EP) with a coefficient of β=.468 ($p<.01$) and a significant indirect effect through ambidextrous green innovation (AGI) with a coefficient of β=.198 ($p<.01$). The total effect of green supply chain integration (GSCI) on enterprise performance (EP) (β=.666, $p<.001$) exceeded the direct effects (β=.468, $p<.01$). This suggested that ambidextrous green innovation (AGI) partially mediates the relationship between green supply chain integration (GSCI) and enterprise performance (EP).

Examining the R-squared coefficient of the structural equation with internal variables as dependent variables and mediating variables—namely, enterprise performance (EP) ($R^2 = .49$) and ambidextrous green innovation (AGI) ($R^2 = .46$). It was observed that ambidextrous green innovation (AGI) explains 49.00% of the variance in enterprise performance (EP)， while green supply chain integration (GSCI) explains 46.00% of the variance in ambidextrous green innovation (AGI).

4.7.2 Model 2

H5 proposed that green legitimacy (GL) moderates the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP). This study employed Process Macro Model 1 to test H5. The conceptual diagram and statistical diagram analysis framework for the hypothesis, depicted in Figure 4.17 and Figure 4.18, respectively, are presented below, along with the summarized results of the moderated analysis, are presented below.

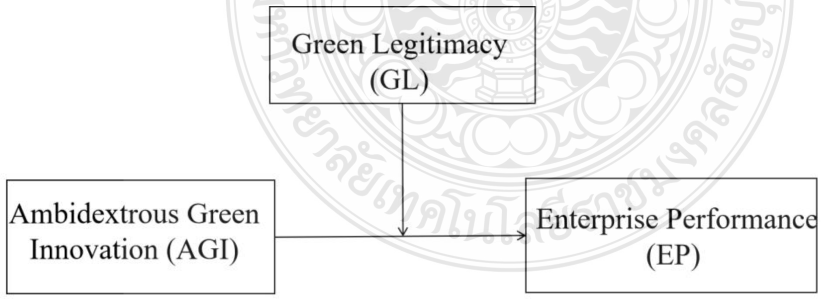

Figure 4.17 Model 2 **(**Conceptual diagram of moderated analysis for GL)

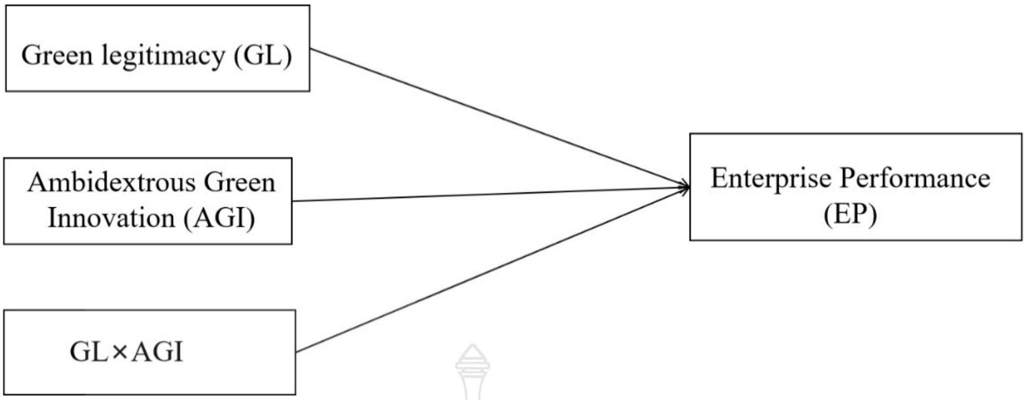

Figure 4.18 Model 2 **(**Statistical diagram of moderated analysis for GL)

Table 4.25 revealed that the interaction model was significant, explaining 29.60% of the variance in enterprise performance (EP) ($R^2 = .296$; F = 55.46; $p < .001$). Ambidextrous green innovation (AGI) significantly positively impacted enterprise performance (EP), as indicated by a β coefficient of .481 (C.R. = 10.522, $p < .001$). Meanwhile, there was a significant positive association between the interaction term (AGIxGL) and enterprise performance (EP), with a β coefficient of .251 (C.R. = 4.767; $p < .001$). Moreover, the 95% confidence interval for the lower limit (LLCI) of .147 and the upper limit (ULCI) of .354 yielded significant values (as zero is not included within the lower and upper limits). These meant a significant positive moderating effect of green legitimacy (GL) on the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP). In other words, the effect is stronger when enterprises have high green legitimacy.

Table 4.25 Result for model 2 summary of outcome variable of EP

Process Macro model 1							
	R	R^2	MSE	F	*df1*	*df2*	*p*
EP	.544	.296	.49	55.46	3	396	***
			Model				
	Coeff	S.E.	C.R.	*P-value*	LLCI	ULCI	
Constant	3.153	.036	88.879	***	3.084	3.223	
EP←AGI	.481	.046	10.522	***	.391	.570	
EP←GL	.227	.042	5.464	***	.145	.308	
EP←AGI×GL	.251	.053	4.767	***	.147	.354	
Tests of highest order unconditional interactions, X=AGI by W=GL interaction							
	R^2-chng	F	*df*1	*df2*	*P-value*		
X*W	.040	22.73	1	396	***		
Conditional effect of the focal predictor at value of the moderator (GL value in conditional in graph are the mean and +/- SD from the mean.)							
	GL	Effect	S.E.	C.R.	*P-value*	LLCI	ULCI
LOW	-.857	.266	.059	4.544	***	.151	.381
MEDIUM	.000	.481	.046	10.522	***	.391	.570
HIGH	.857	.695	.069	10.020	***	.559	.832

* *p* < .05, ** *p* <.01, *** *p* <.001

Tests of highest-order unconditional interactions found that the interaction effect between AGI and GL influence on EP was significant, indicated by $R^2-chng=.04$ (p < .001). The moderating effect contributed 4% to the variance. This also meant there was a significant moderating effect of green legitimacy (GL) on the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP).

To further visually examine the moderating effect of GL, GL levels were divided into three groups: high, medium, and low (±1SD). It was observed that as GL increases, the effect of AGI on EP (β = .695, C.R. = 10.020, p < .001) is higher compared to when GL is lower (β = .266, C.R.= 4.544, *p* < .001). This indicates that when GL is higher, the impact of AGI on EP is greater.

To more intuitively illustrate the moderating effect of GL on the relationship between AGI and EP, this study plotted the impact of AGI on EP under low, medium, and high GL conditions, as depicted in Figure 4.19. It was found that the effect of ambidextrous green innovation (AGI) on enterprise performance (EP) is different across different values of green legitimacy (GL). The line shows a significantly steeper slope under conditions of high green legitimacy (GL), indicating a much stronger influence of ambidextrous green innovation (AGI) on enterprise performance (EP) compared to situations with low green legitimacy (GL). In other words, as the level of green legitimacy (GL) increases, the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP) strengthens.

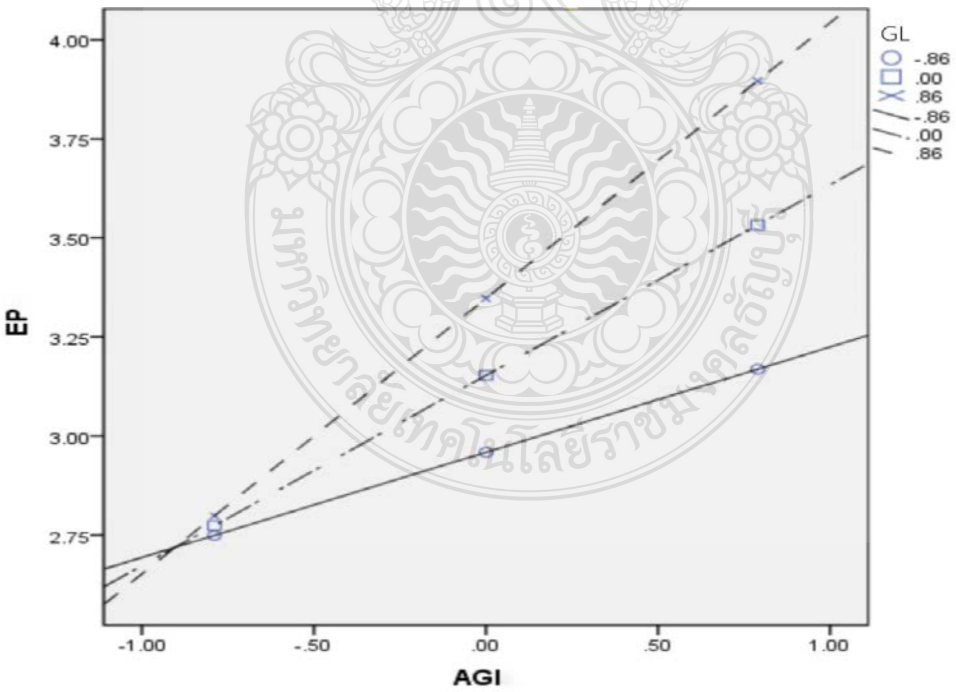

Figure 4.19 The moderating effect of GL between AGI and EP

4.8 Hypothesis Testing

According to the three research questions including 1) How does GSCI have causal relationship to enterprise performance? 2) How does GSCI have causal relationship to enterprise performance through ambidextrous green innovation? and 3) How does ambidextrous green innovation have causal relationship to enterprise performance increase with favorable green legitimacy? The following hypotheses were tested to answer the research questions:

H1: Green Supply Chain Integration has a positive impact on enterprise performance.

H2: Ambidextrous green innovation has an impact on enterprise performance.

H3: Green Supply Chain Integration has a positive impact on ambidextrous green innovation.

H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.

H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.

4.8.1 Hypothesis H1 Testing

H1: GSCI has a positive impact on enterprise performance.

The model 1 results demonstrated a positive relationship between green supply chain integration (GSCI) and enterprise performance (EP). Table 4.23 results showed a standardized path coefficient of .468 between green supply chain integration (GSCI) and enterprise performance (EP), with a standard error of .099, a critical ratio of 4.727, and a *p*-value below .01. The confidence interval for the relationship between green supply chain integration (GSCI) and enterprise performance (EP) is within the 95% confidence interval of (.266, .661). The factor loading values for each item of the observed variables, which were green supply chain integration (GSCI) based on green internal integration (GII), green supplier integration (GSI), and green customer integration (GCI) were .763, .751, and .759 respectively. These values indicated a significant positive relationship between green supply chain integration and enterprise performance (EP), thus supporting hypothesis H1.

4.8.2 Hypothesis H2 Testing

H2: Ambidextrous green innovation has a positive impact on enterprise performance.

The model 1 results demonstrated a positive relationship between ambidextrous green innovation (AGI) and enterprise performance (EP). Table 4.23 results showed a standardized path coefficient of .291 between AGI and EP, with a standard error of .113, a critical ratio of 2.575, and a *p*-value below .05. The confidence interval for the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP) is within the 95% confidence interval of (.065, .508). The factor loading values for each item of the observed variables, which were ambidextrous green innovation (AGI) based for exploratory green innovation (ERGI) and exploitative green innovation (EIGI) were .710 and .778 respectively. These values indicated a significant positive relationship between ambidextrous green innovation (AGI) and enterprise performance (EP), thus supporting hypothesis H2.

4.8.3 Hypothesis H3 Testing

H3: GSCI has a positive impact on ambidextrous green innovation.

The model 1 results demonstrated a positive relationship between green supply chain integration (GSCI) and ambidextrous green innovation (AGI). Table 4.23 results showed a standardized path coefficient of .681 between GSCI and AGI, with a standard error of .052, a critical ratio of 13.096, and a *p*-value below .001. The confidence interval for the relationship between green supply chain integration (GSCI) and ambidextrous green innovation (AGI) is within the 95% confidence interval of (.575, .781). The factor loading values for each item of the observed variables, which were green internal integration (GII), green supplier integration (GSI), and green customer integration (GCI) were .763, .751, and .759 respectively. These values indicated a significant positive relationship between green supply chain integration (GSCI) and ambidextrous green innovation (AGI), thus supporting hypothesis H3.

4.8.4 Hypothesis H4 Testing

H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.

Table 4.23 presents a comparison between the direct and indirect standardized path coefficients for green supply chain integration (GSCI) on enterprise performance (EP). The directly standardized path coefficient from green supply chain integration (GSCI) to enterprise performance (EP) was .468, with a standard error of .099, a critical ratio of 4.727, and a *p*-value below .01. While, the indirect standardized path coefficient from green supply chain integration (GSCI) to enterprise performance (EP) was .198, with a standard error of .079, critical ratio of 2.506, and a *p*-value below .01. The confidence interval for the indirect standardized path between green supply chain integration (GSCI) and ambidextrous green innovation (AGI) falls within the 95% confidence interval of (.048, .363).

Additionally, Table 4.24 indicates that the total standardized effect of GSCI on EP was .666 ($p < .001$). When AGI is introduced as a mediator variable, the standardized direct effect of GSCI on EP decreases to .468 ($p < .01$). These values indicate a significant positive impact of green supply chain integration on enterprise performance through ambidextrous green innovation, and that ambidextrous green innovation (AGI) plays a partial mediating role in this relationship.Therefore, hypothesis H4 is supported.

4.8.5 Hypothesis H5 Testing

H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.

Table 4.25 shows a significant positive association between the interaction term (AGIxGL) and enterprise performance (EP), with a β coefficient of .251 (C.R. = 4.767; $p<.001$). The 95% confidence interval for the lower limit (LLCI) of .147 and upper limit (ULCI) of .354 also yielded significant values (as zero is not included within the limits). Additionally, the moderating effect contributed 4% to the variance in enterprise performance (EP). These results indicate a significant moderating effect of green legitimacy (GL) on the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP).

Figure 4.19 illustrates that the effect of ambidextrous green innovation (AGI) on enterprise performance (EP) is different across different values of green legitimacy (GL). The line shows a significantly steeper slope under conditions of high green legitimacy (GL), indicating a much stronger influence of ambidextrous green innovation (AGI) on enterprise performance (EP) compared to situations with low green legitimacy (GL). In other words, as the level of green legitimacy (GL) increases, the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP) strengthens. Therefore, hypothesis H5 is supported. The summary of hypothesis testing is shown in Table 4.26.

Table 4.26 Summary of hypotheses testing

Hypothesis	Result
H1: GSCI has a positive effect on enterprise performance.	Supported
H2: Ambidextrous green innovation has a positive effect on enterprise performance.	Supported
H3: GSCI has a positive effect on ambidextrous green innovation.	Supported
H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.	Supported
H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.	Supported

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

In this chapter, conclusions are drawn from the findings of the study regarding the effect of GSCI on enterprise performance. These conclusions stem from the study's objectives, research questions, and outcomes. Additionally, the implications of these findings are discussed, and corresponding recommendations are provided. Recommendations were derived from the conclusions and purpose of the study.

5.1 Conclusions

The aim of this study was to investigate the impact of GSCI on enterprise performance from the perspective of organizational capabilities. Ambidextrous green innovation will serve as a mediator and green legitimacy as a moderator. The specific research objectives are as follows: (1) To redefine GSCI from the perspective of organizational capabilities and analyze its relationship with enterprise performance. (2) To assess the impact of GSCI on enterprise performance through ambidextrous green innovation. (3) To determine whether green legitimacy moderates the relationship between ambidextrous green innovation and enterprise performance.

To achieve the above objectives, this study constructed a conceptual model of the effects of GSCI on enterprise performance, considering green innovation as a mediating variable and green legitimacy as a moderating variable based on organizational capabilities theory, ambidextrous innovation theory, and new institutional theory. Within this conceptual framework, five hypotheses were formulated: H1: GSCI has a positive impact on enterprise performance. H2: Ambidextrous green innovation has a positive impact on enterprise performance. H3: GSCI has a positive impact on ambidextrous green innovation. H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance. H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.

A questionnaire survey was conducted to collect data for testing the five research hypotheses above. The survey targeted 400 pharmaceutical manufacturing companies in the Yangtze River Delta region. The sample size for each province was determined based on its proportion of the total. To ensure a high data collection rate, the researcher used three distribution methods: direct face-to-face distribution, indirect distribution using network relationships, and e-mail distribution. A total of 647 questionnaires were distributed. Ultimately, 400 valid questionnaires were analyzed, which corresponds to a response rate of 61.82%. In the analysis phase, structural equation modeling (SEM) was used to investigate the direct and indirect relationships between GSCI, ambidextrous green innovation, and enterprise performance (H1-H4). In addition, Process Macro model 1 was used to confirm the moderating effect of green legitimacy (H5). The results of the hypotheses testing are presented in Table 5.1.

Table 5.1 The results of testing the research hypotheses

Research Question	**Hypothesis**	**Statistic Technique**	**Result**
RQ1: How does GSCI have a causal relationship with enterprise performance?	H1: GSCI has a positive impact on enterprise performance.	SEM	Supported
RQ2: How does GSCI have a causal relationship with enterprise performance through ambidextrous green innovation?	H2: Ambidextrous green innovation has a positive impact on enterprise performance.	SEM	Supported
	H3: GSCI has a positive impact on ambidextrous green innovation.	SEM	Supported
	H4: Ambidextrous green innovation mediates the effect between GSCI and enterprise performance.	SEM	Supported
RQ3: How does ambidextrous green innovation have a causal relationship to increased enterprise performance with favorable green legitimacy?	H5: Green legitimacy has a moderating effect on the relationship between ambidextrous green innovation and enterprise performance.	Process Macro	Supported

This paper mainly draws the following conclusions:

First, this study views GSCI as a dynamic capability, offering a new definition from the perspective of organizational capability. Unlike traditional static definitions, this new interpretation presents an innovative approach to green supply chain management. It emphasizes that focal companies, along with their supply chain partners, sense and seize green development opportunities through green information sharing, green process collaboration, and green strategy collaboration, thereby flexibly responding to uncertainties in the green development phase and driving innovation and operations more effectively. These enhancements enable the realization of sustainable performance in complex and evolving environments, addressing the requisites of the lean, agile, resilient, and green era (Sahu et al., 2023), responding to Sahu et al.'s (2018) call for researchers to devise more effective approaches for achieving sustainability in green supply chain management.

Secondly, this study demonstrates that GSCI has a significantly positive impact on firm performance through the lens of dynamic capability, representing an innovative academic exploration. This research sheds new light on the value of GSCI by examining its role in opportunity sensing, opportunity seizing, and resource reconstruction during the pursuit of sustainable development.

Thirdly, the research results further show that ambidextrous green innovation has a partial mediating effect between GSCI and firm performance. The improvement of GSCI (dynamic capability) not only directly improves firm performance but also indirectly fosters the development of firm performance through ambidextrous green innovation (green innovation behavior). Our study advances green practice effectiveness research by highlighting the critical role of integrating two green practices for enterprises to secure high-quality enterprise performance along their sustainable development trajectory. This further confirms that the development of firm capabilities and strategic behaviors are interrelated, and the combination of capabilities and behaviors yields better performance.

Fourthly, we find that green legitimacy plays a positive moderating role between ambidextrous green innovation and enterprise performance. To the best of our knowledge, To the best of our knowledge, this is a unique and unexplored area that provides a new perspective for facilitating the conversion of ambidextrous green innovation behavior into enterprise performance.

5.2 Discussion

This section presents discussions on the research questions.

5.2.1 Discussion of Research Question 1

Research question 1 is: How does GSCI have a causal relationship to enterprise performance? The results of hypothesis testing for H1 indicated that GSCI has a positive impact on enterprise performance, including improvements in economic, environmental, and social performance. This finding is aligned with the empirical results of Huo (2012), who demonstrated that supply chain integration was a critical dynamic capability enabling enterprises to absorb external knowledge and update information. This enables them to conduct business more flexibly and enhance supplier-oriented performance, customer-oriented performance, and financial performance in the Chinese manufacturing industry.

Lo et al. (2018) also confirmed that GSCI means that enterprises exchange green information with supply chain partners, and mutually understand environmental risks and responsibilities, making environmental maintenance activities more effective, and environmental performance better.

Moreover, Zhou et al. (2020) affirmed that enterprises can better understand customer needs, identify design issues in the early stages of product development, and accelerate product development by integrating with customers. Integration with suppliers tends to focus on developing specific technologies and collaborative practices, thereby reducing transaction costs.

5.2.2 Discussion of Research Question 2

Research question 2 is: How does GSCI have a causal relationship with enterprise performance through ambidextrous green innovation?. Three hypotheses (H2, H3, and H4) were developed to investigate the direct and indirect relationships between GSCI, ambidextrous green innovation, and enterprise performance. This analysis focused on examining the mediating effect of ambidextrous green innovation.

The results of hypothesis testing for H2 indicated that enterprise performance was directly affected by ambidextrous green innovation. Regarding the relationship between GSCI and ambidextrous green innovation, the results of hypothesis testing for H3 showed a positive direct relationship, indicating that GSCI influenced ambidextrous green innovation. Furthermore, the results of the H4 hypothesis revealed that ambidextrous green innovation played a partial mediating role between GSCI and enterprise performance.

The conclusion of a positive relationship between ambidextrous green innovation and enterprise performance (H2) is consistent with the "ambidextrous balance" theory, which suggests that ambidextrous enterprises that simultaneously engage in exploratory and exploitative innovation are more likely to achieve good performance. This finding is also supported by the empirical study of Jia et al. (2022), which found that both exploratory green innovation and exploitative green innovation are positively correlated with enterprise performance in manufacturing. However, this conclusion is inconsistent with the viewpoint of Ebben and Johnson (2005), who argue that not all firms are suitable for ambidexterity. They suggest that for small firms, choosing one of the two paradoxical elements is more beneficial to firm performance.

Studies on ambidextrous innovation may explain the differences in research results. While both exploratory and exploitative innovation behaviors aim to enhance enterprise performance, their effectiveness is influenced by industrial factors and firm size (Sorescu et al., 2003; Jansen et al.,2006). These insights offer a plausible reason for the differences observed between this study's outcomes and those of prior research, as well as highlighting the necessity to examine the ambidextrous green innovation–enterprise performance relationship across varied research settings. Thus, this study represents an academic endeavor to reveal the significance of this association within China's pharmaceutical manufacturing industry. It also enriches the current academic discourse through offering a viewpoint that acknowledges the intricate and context-dependent nature of the link between ambidextrous green innovation and enterprise performance.

The result of a positive relationship between GSCI and ambidextrous green innovation (H3) is consistent with Cohen & Levinthal's (1990) argument. They suggested that timely acquisition and effective utilization of knowledge from external sources such as markets, technology, and competitors can help enterprises better understand market demands, technological trends, and competitive dynamics, laying the foundation for innovation. This finding is supported by the empirical study of Gumusluoğlu and Ilsev's (2009), who found that the implementation of innovations requires support from external knowledge and resources, as well as a supportive internal environment for innovation. Teece et al. (1997) also emphasized the importance of identifying new opportunities and efficiently organizing them, implying that enterprises must possess keen insight to promptly identify new opportunities in the market and be flexible in organizing resources and capabilities to leverage these opportunities for innovation and growth.

The finding of ambidextrous green innovation plays a partial mediating role between GSCI and enterprise performance supported the resource-behavior-performance theoretical framework. The resource-behavior-performance framework provides scholars with a robust methodology for empirically examining the links among the capabilities, behaviors, and performance of enterprises (Garousi Mokhtarzadeh et al., 2020). The resource-behavior-performance framework differentiates between owning and using resources, asserting that while possessing resources is essential, it alone is inadequate (Zott,2003; Ketchen et al.,2007; Garousi Mokhtarzadeh et al., 2020). The enterprise must actualize the value of its resources through specific behaviors. Ketchen et al. (2007) argued that resource is the basis of behavior but, without putting effective and efficient behaviors into practice, it is difficult to transform the resource into performance. By highlighting mediating behaviors, the framework elucidates why enterprises with similar resources and backgrounds exhibit performance disparities.

Wei & Wang (2011) argued that enterprises need to understand the interrelationship between the development of their resources and capabilities and the implementation of behaviors: behaviors require the acquisition of the necessary resources and capabilities, while the development of resources and capabilities requires appropriate behaviors. Garousi Mokhtarzadeh et al. (2020) regarded networking capability as a resource, classified inter-organizational knowledge mechanisms and inter-organizational learning as actions, and developed a resource-action-performance framework to verify that networking capability influences corporate innovation performance through these mechanisms and learning processes.

5.2.3 Discussion of Research Question 3

Research question 3 is: How does ambidextrous green innovation have a causal relationship to increased enterprise performance with favorable green legitimacy?. The results of the hypothesis testing of H5 showed that, as the level of green legitimacy (GL) increases, the relationship between ambidextrous green innovation (AGI) and enterprise performance (EP) strengthens. This indicated that green legitimacy plays a motivating role between ambidextrous green innovation and firm performance in the context of the relatively weak legal protection of green intellectual property rights.

This finding was consistent with the new institutional theory that when an enterprise has legitimacy, its actions, products, and services are more likely to be recognized and accepted by the public, which benefits the enterprise in acquiring innovation returns (Zimmerman & Zeitz, 2002). Janssen and Nonnenmann (2017) confirmed that organizational legitimacy affects enterprise innovation. Additionally, Liu and Wang (2022) categorized legitimacy into policy legitimacy and market legitimacy. They found that legitimacy plays a positive moderating role between new product development and firm financial performance in high-tech small and medium-sized enterprises.

This finding was different from Teece's (1986) argument that in environments with imperfect property rights protection, innovative firms often struggle to capture innovation benefits due to malicious imitation by competitors. Drawing on the perspective of new institutional theory, we pointed out that green legitimacy can also provide a certain guarantee for the acquisition of green innovation benefits. This implies to some extent that legitimacy mechanisms serve as a supplement to formal legal mechanisms in cases where they are inadequate. In other words, in the wave of green development, even when the green intellectual property rights system in emerging economies is not yet sound, green legitimacy can still offer a certain degree of assurance for firms' ambidextrous green innovation benefits.

5.3 Theoretical Contribution

The study makes a contribution to research and theory. First, this study makes an important contribution to the literature on green supply chain management and corporate sustainable development. This study considers GSCI as a dynamic capability of enterprises and proposes a new definition from the perspective of organizational capability. In contrast to the traditional static definition, this new interpretation offers a new approach to green supply chain management. It fosters a deeper collaboration between supply chain partners, stimulates the development of innovative business strategies for environmental protection, and at the same time enables companies to absorb external knowledge, update information, and conduct flexible operations more effectively. This helps enterprises to better understand the value of GSCI.

Our results show the direct and positive impact of GSCI on enterprise performance. This underscores the importance of extending organizational capabilities from the firm level to the supply chain level and provides a new perspective for understanding the relationship between GSCI and enterprise performance in emerging economies.

Second, this study makes a significant contribution to the integration of organizational capabilities theory and ambidextrous innovation theory. This study does not simply assume that GSCI alone can provide significant performance for firms. Instead, it proposes that GSCI enhances performance through the enterprise's ambidextrous green innovation behavior.

Organizational capabilities theory states that capabilities are resources for firms and that the potential value of resources must be realized through actions (Ketchen et al., 2007). Actions are constrained by resources and can take place in different areas (Newbert, 2007). The theory of ambidextrous innovation states that adopting ambidextrous actions can lead to better performance, but this behavior is constrained by resources (March, 1996). Actions describe what organizations do, and capabilities determine how well organizations perform these actions (Kauppila, 2015). Based on previous literature (Wong et al., 2015; Zhao et al., 2020), this study hypothesized that GSCI as a resource determines how well firms can perform ambidextrous green innovation.

The empirical results of this study have shown that GSCI improves enterprise performance through ambidextrous green innovation. This conclusion extends the existing knowledge base and suggests that there is a self-reinforcing cycle of interaction between GSCI and ambidextrous green innovation that affects corporate sustainability performance.

Third, by examining the moderating role of green legitimacy between ambidextrous green innovation and firm performance, this study contributes to the literature on green innovation. Despite existing research pointing to the longer investment cycle and capital commitment associated with green innovation, as well as its potential to affect profit margins (Ma et al., 2019; Gohoungodji et al., 2020), there are also concerns about the weak green intellectual property rights system in China, which challenges the notion that one should rely on formal property rights protection to reap the benefits of ambidextrous green innovation (Yang & Wang, 2020).

However, from the perspective of green legitimacy, as global environmental degradation progresses and public awareness of environmental protection and health increases, companies will be recognized and respected by the public for their green, innovative behavior (Yu et al., 2021) and thus gain a higher level of green legitimacy. This conveys a positive green image to the external environment, which facilitates the acceptance of companies' products or services in the market and enables the faster translation of green innovations into business performance.

Based on the strategic perspective of new institutional theory, this study empirically investigated the role of green legitimacy in transforming green innovations into enterprise performance from the perspective of innovation benefits. In particular, it confirmed that green legitimacy plays a motivating role in promoting green innovation and creating enterprise performance. This conclusion may encourage pharmaceutical companies to focus on the motivational role of green legitimacy in the process of green innovation.

5.4 Managerial Implications

This study makes several practical contributions. First, it has shown how GSCI influences enterprise performance through ambidextrous green innovation and the positive moderating role that green legitimacy plays in this relationship. Understanding these mechanisms enables practitioners to be successful. The study offers recommendations for practitioners in the Chinese pharmaceutical industry who want to overcome the current environmental challenges and achieve sustainable development:

(1) Management in pharmaceutical companies should realize that relying only on internal resources and capabilities is not enough. They must respond to the current demands of the green market and the environmental pressures through GSCI to overcome environmental challenges and achieve sustainable development.

GSCI includes green internal integration, green supplier integration, and green customer integration. Green supplier integration and green customer integration belong to external integration, while the capability of green internal integration (such as the capability of green information sharing and collaborative planning) can enhance the capability of external integration. Therefore, pharmaceutical companies should first focus on improving green internal integration among functional departments and then actively engage in external green integration with key suppliers and customers.

(2) Our research results have revealed an important fact: While GSCI capabilities help improve business performance, they are not enough to achieve the most desirable outcomes. Companies need to take ambidextrous green innovation behaviors to maximize the use of GSCI and translate it into desired performance.

Being a highly polluting industry, the green transformation of pharmaceutical manufacturing companies is not a short-term affair. To comply with environmental regulations, companies need to involve the resources and capabilities of supply chain partners to implement beneficial exploitative green innovation, such as actively improving and adapting existing green products, processes, and services to reduce pollution in the short term and meet the basic requirements of environmental regulations, otherwise, companies will face heavy environmental penalties. In the face of increasing public awareness of environmental protection and increasingly stringent environmental regulations, only by actively exploring new market opportunities, developing new green processes, green products and green services, and other exploration green innovation activities can pharmaceutical companies develop new green markets, take a leading position and achieve long-term sustainable development.

However, companies may encounter various challenges during the process of beneficial exploitative and exploratory green innovation, such as dilemmas in the selection of green innovation projects, risks of innovation failure, and resource constraints. Pharmaceutical companies should make full use of the various components of GSCI, use green customers to integrate and adjust the direction and content of exploitative and exploratory green innovation (ambidextrous green innovation) in real time to reduce business uncertainty, integrate green suppliers to reduce technical uncertainty in dual green innovation, and timely adjust and allocate internal and external resources for dual green innovation through green internal and external integration. This not only promotes green innovation but also improves the overall performance level.

(3) Pharmaceutical industry enterprises must pay attention to obtaining green coercive legitimacy, normative legitimacy, and mimetic legitimacy in the process of exploratory green innovation and exploitative green innovation. Obtaining coercive legitimacy is the basis for the survival and development of an enterprise. Enterprises can meet the basic requirements of the government and regulators by making small green improvements to their existing products, production processes, and services in order to be recognized by the government and regulators and avoid penalties.

However, when most enterprises have coercive legitimacy, green normative legitimacy, and imitative legitimacy will replace the coercive system as the key area for enterprises to play with green legitimacy. Therefore, enterprises should also actively face the need to go beyond the existing green products, processes, and services, learn and utilize new green knowledge, develop new green products, processes, and services, promote the commercialization of brand-new green products and services, win the recognition of upstream and downstream enterprises in the industry and the public, and increase their visibility, to gain normative legitimacy and find a strong support channel for the commercialization of green innovation. In addition, companies in the pharmaceutical industry should actively enhance their legitimacy and competitive advantage by imitating and learning from the exploitative and exploratory behavior of green innovations of reference companies in the industry during the operation process.

This study also has some implications and recommendations for other stakeholders：

(1) Pharmaceutical associations can organize training and workshops on GSCI to help companies understand the importance and operational methods. This would counter the misconception prevalent among many companies that certain green practices (such as green procurement, production, and consumption) constitute green supply chain management. Such a view lacks awareness of holistic management practices (Ricardianto et al., 2022; Siddiquee et al., 2024). It is crucial to sensitize them to the integrative nature of green supply chain management, which requires strategic collaboration between multiple actors and levels.

(2) Governments and pharmaceutical associations can establish a GSCI rating system that includes three dimensions: green internal integration, green customer integration and green supplier integration. This system can be used to assess and rank companies' GSCI, identify areas for improvement, and provide additional policy support to outstanding companies. This approach aims to motivate more companies in the pharmaceutical industry to take active measures to integrate the green supply chain.

(3) The Chinese pharmaceutical industry lags behind developed countries in terms of green innovation practices. The government needs to create appropriate incentive mechanisms to close this gap. On the one hand, it should encourage companies in the pharmaceutical industry to actively utilize various green technologies and services from developed countries. On the other hand, it should focus on promoting competitive, research-based behavior in green innovation. The government could set up a dedicated green innovation fund for the pharmaceutical industry to incentivize collaboration between pharmaceutical companies and supply chain partners in the implementation of ambitious green innovation projects. Initiatives could include, for example, the development of new biodegradable packaging materials, the promotion of green synthesis of pharmaceuticals, or research into efficient and environmentally friendly techniques for the recycling and disposal of pharmaceutical waste. To encourage the active participation

of pharmaceutical companies and supply chain partners, the government could introduce reward mechanisms, such as financial subsidies, tax incentives, or honorary titles based on performance in these efforts.

(4) The government and pharmaceutical industry associations can coordinate the resources and intentions of all stakeholders to establish a green innovation collaboration platform that focuses on pharmaceutical companies and supports suppliers and customers to participate in green innovation in pharmaceutical companies. This platform provides opportunities for online communication and collaboration and facilitates the sharing of experiences, resources and best practices between stakeholders. It enables pharmaceutical companies to efficiently access, share and leverage resources from supply chain partners to promote green innovation.

(5) It is important for policymakers to create an environment and culture that supports pharmaceutical manufacturing companies in implementing green innovation. The government and other authoritative institutions play a crucial role in the formulation of environmental laws and regulations and influence public perceptions of legitimacy in the realm of informal institutions such as social norms and culture (Wang & Yang, 2020). Therefore, policymakers can utilize green legitimacy to drive the implementation of green innovation in pharmaceutical manufacturing companies by enacting regulations and systems that are conducive to two-way green innovation. This will create a larger space for green legitimacy, shaping public perceptions of regulations, norms, and cognitive legitimacy, thus helping pharmaceutical manufacturing companies to achieve higher levels of green legitimacy.

5.5 Research Limitations and Recommendations for Further

5.5.1 Limitations of the Research

Although our study has made some contribution in the above aspects, it must still be acknowledged that it has some shortcomings. We should be aware of some of the limitations of the study and actively address them to advance future research.

(1) The research data is from Chinese pharmaceutical companies, which only reflects the situation of this industry in China, and the conclusions of the study are limited

by region and industry. Therefore, the conclusions of this study have limited applicability to other industries or regions.

(2) This study uses cross-sectional data. These cannot adequately capture the dynamic longitudinal changes of companies as they only represent a snapshot at a specific point in time. To address this limitation and enable a more comprehensive investigation, it is recommended to include longitudinal data to track the progress of the study over time. This approach will provide deeper insights into the evolving nature of enterprise dynamics and allow for a more nuanced understanding of the factors influencing performance over time.

5.5.2 Recommendations for Further Research

Given the limitations highlighted above and the conclusions drawn from the current research, this study suggests that future research should prioritize the following areas:

(1) The research data is from Chinese pharmaceutical companies, which only reflects the situation of this industry in China, and the conclusions of the study are limited by region and industry. Future research can expand the sample to other regions and industries and try to obtain data from different members of the supply chain (e.g., suppliers, distributors, customers, etc.) to further improve the results of this study.

(2) The cross-sectional data may not capture the longitudinal dynamic changes of enterprises, and future research data will be used to follow up the study for a more in-depth investigation.

(3) Due to the complexity of the study, only green legitimacy was considered as a boundary condition in this study. Future research could investigate the mechanisms of other factors that influence GSCI and firm performance to extend the findings of this study. For example, the impact of government environmental protection policies and corporate managers' echo-consciousness on GSCI outcomes should be investigated.

(4) Traditional studies of supply chain integration have revealed the existence of certain "dark sides" within integration relationships. These aspects include conflict and power dependencies in collaboration that have the potential to deteriorate and even break bilateral relationships, affecting the prediction of supply chain integration outcomes. The relationship between GSCI and enterprise performance is therefore multi-faceted, with

GSCI potentially exerting both facilitating and inhibiting influences on performance. Future research could focus on describing the various pathways through which GSCI produces positive and negative effects, while also examining the cumulative effects of these different pathways. This comprehensive approach is essential to fully understand how GSCI affects business performance and can provide practical guidance to companies seeking to enhance positive impacts and mitigate negative impacts in a targeted manner, ultimately advancing the sustainable development goals associated with GSCI.

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APPENDICES

APPENDIX A

Questionnaire

Green Supply Chain Integration for Enterprise Performance: The Mediating Role of Ambidextrous Green Innovation and the Moderating Effect of Green Legitimacy in China's Pharmaceutical Manufacturing Industry

[Date]___________

Dear respondent, I am a student of ________________ University, Faculty of _____________________, in the _____ year.

In our effort to investigate the green supply chain integration for enterprise performance: the mediating role of ambidextrous green innovation and the moderating effect of green legitimacy in China's pharmaceutical manufacturing industry, I would like to kindly invite you to participate in a quick survey and answer to the best of your knowledge.

Your participation is voluntary, and your answer is anonymous; please do not sigh your name on this document. The answers will be analyzed as a group and not individually. Be assured, the answers will be kept confidential.

This survey will take approximately 10-15 minutes. Please answer the questions the best you can.

I really appreciate your time and genuine feedback.

Thank you!

Yours sincerely,

[Name]

Directions: *Please indicate your answer for each of the following statements by placing the "√" mark in the box of your answer.*

Part 1: Basic Information

1. Are you currently working in a Pharmaceutical manufacturing enterprises in China?
   - ☐ Yes
   - ☐ No
2. Industry code of your enterprise's in the pharmaceutical manufacturing industry:
   - ☐ 2710
   - ☐ 2720
   - ☐ 2730
   - ☐ 2740
   - ☐ 2750
   - ☐ 2760
3. Location of the enterprise:__________ province_________city
4. Are you currently working in a middle or senior management position?For example, supply chain manager, purchasing manager, marketing manager, general manager, CEO, etc.
   - ☐ Yes
   - ☐ No
5. What is your current position?
   - ☐ General manager
   - ☐ Supply chain manager
   - ☐ Purchasing manager
   - ☐ Marketing manager
   - ☐ CEO/Vice president
   - ☐ President
6. Gender:
   - ☐ Male
   - ☐ Female

7. Age:
   - ☐ 30 - 35
   - ☐ 36 - 40
   - ☐ 41 - 45
   - ☐ 46 - 50
   - ☐ 51 - 55
8. Highest Education:
   - ☐ Below Bachelor’s degree
   - ☐ Bachelor’s degree
   - ☐ Master’s degree
   - ☐ Doctor’s Degree
9. Period working in the current enterprise:
   - ☐ Less than 3 years
   - ☐ Between 3 to 5 years
   - ☐ Between 5 to 10 years
   - ☐ More than 10 years

Part 2: Green Supply Chain Integration

(Please indicate your level of agreement with the below statements)

Factors	Likert Scale				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Green Internal Integration (How does your company handle green internal integration?)					
1. In our company, all departments work together to achieve environmental goals.					
2. In our company, each department has a common understanding of its responsibility for environmental performance.					
3. In our company, all departments work together to reduce the environmental impact of our activities.					
4. In our company, all departments work together to plan, anticipate, and solve problems related to the environment.					
5. In our company, all departments work together to determine how to reduce the environmental impact of our products/services.					
6. In our company, all departments emphasize the accumulation and sharing of environmental knowledge.					

Green Supplier Integration (How does your company handle green supplier integration?)					
7. Our company works together with major suppliers to achieve environmental goals.					
8. Our company agrees with major suppliers on environmental performance responsibilities.					
9. Our company works together with major suppliers to reduce the environmental impact of our activities.					
10.Our company works together with major suppliers to plan, anticipate, and solve problems related to the environment.					
11.Our company works together with major suppliers to determine how to reduce the environmental impact of our products/services.					
12.Our company works together with our major suppliers to accumulate and share environmental knowledge.					
Green Customer Integration (How does your company handle green customer integration?)					
13. Our company works together with major customers to achieve environmental goals.					
14. Our company agrees with major customers on environmental performance responsibilities.					

15. Our company works together with major customers to reduce the environmental impact of our activities.					
16. Our company works together with major customers to plan, anticipate and solve problems related to the environment.					
17. Our company works together with major customers to determine how to reduce the environmental impact of our products/services.					
18. Our company works together with our major customers to accumulate and share environmental knowledge.					

Part 3: Ambidextrous Green Innovation
(Please indicate your level of agreement with the below statements)

Factors	**Likert Scale**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Exploratory Green Innovation (How does your company carry out exploratory green innovation?)					
19. Our company actively embraces demand beyond existing green products, processes and services.					
20.Our company actively adopts new green products, processes and services.					

21.Our company actively develops new green products, processes and services.					
22.Our company is actively experimenting with new green products and services in the market.					
23. Our company actively promotes the commercialization of new green products and services.					
24.Our company actively uses new green distribution channels.					
25.Our company actively explores new opportunities in green markets.					
Exploitative Green Innovation (How does your company carry out exploitative green innovation?)					
26.Our company actively improves existing green products, processes and services.					
27.Our company actively adjusts existing green product offerings, processes and services.					
28.Our company actively introduces improved green products and services to the market.					
29.Our company actively strives to improve the efficiency of our existing green products and services.					
30.Our company actively increases economies of scale in existing green markets.					

31.Our company actively expands the scope of green services for existing customers.					

Part 4: Enterprise Performance
(Please indicate your level of agreement with the below statements)

Factors	Likert Scale				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Environmental performance (How is your company performing in terms of environmental performance?)					
32. In the past two years, the emissions of our company's "three wastes" have significantly decreased.					
33. In the past two years, thehazardous/harmful/toxic materials consumption of our company has been significantly decreased.					
34. In the past two years, the energy consumption of our company has been significantly decreased.					
35.In the past two years,the number of times companies have been regulated for environmental issues has decreased significantly.					
Economic performance (How is your company performing in terms of economic performance?)					
36.In the past two years, our company's sales revenue has significantly increased.					
37.In the past two years, the market share of our company's products has significantly increased.					
38.In the past two years, our company's net profits have significantly increased.					

39.In the past two years, our company's ROL have significantly increased.					
40.In the past two years, our company's return on sales have significantly increased.					
Social Performance (How is your company performing in terms of social performance?)					
41.In the past two years, our company has improved employees' health and safety.					
42.In the past two years, our company has improved community health and safety.					
43.In the past two years, our company has improved job satisfaction levels of employees.					
44.In the past two years, our company has increased incentives and engagement for local employment.					

Part 5: Green Legitimacy
(Please indicate your level of agreement with the below statements)

Factors	**Likert Scale**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Coercive Legitimacy (How does your company perform in terms of coercive legitimacy?)					
45.In the past two years, green innovation activities have enabled our company's production and operation to meet the requirements of relevant laws and regulations.					

46.In the past two years, the government has highly evaluated the green innovation activities of our company.					
47.In the past two years, green innovation activities have shielded our company from regulatory penalties.					
Normative Legitimacy (How does your company perform in terms of normative legitimacy?)					
48.In the past two years, our company's green innovation activities have been widely understood and accepted by consumers and the public.					
49.In the past two years, our company has established a good social and market image through green innovation activities.					
50.In the past two years, our company has received high praise from environmental organizations for its green innovation activities.					
Mimetic Legitimacy (How does your company perform in terms of mimetic legitimacy?)					
51.In the past two years, our company has obtained various green environmental quality certifications or production standard certifications in the industry.					
52.In the past two years, our company has increased its visibility in the industry due to green innovation activities.					

53.In the past two years, our company has set a good example for other enterprises in the industry due to its green innovation activities.					

Thank you for your time.Have a good day!

APPENDIX B

Summary of the index of consistency (IOC)

Measurement Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average Score	Decision
Green supply chain integration							
Green Internal Integration (How does your company handle green internal integration?)							
1. In our company, all departments work together to achieve environmental goals.	1	1	1	1	1	1	√
2. In our company, each department has a common understanding of its responsibility for environmental performance.	0	1	1	1	1	.8	√
3. In our company, all departments work together to reduce the environmental impact of our activities.	1	1	1	1	0	.8	√
4. In our company, all departments work together to plan, anticipate, and solve problems related to the environment.	1	1	1	1	1	1	√
5.In our company, all departments work together to determine how to reduce the environmental impact of our products/services.	1	1	1	1	1	1	√
6.In our company, all departments emphasize the accumulation and sharing of environmental knowledge.	1	1	1	1	1	1	√
Green Supplier Integration (How does your company handle green supplier integration?)							
7.Our company works together with major suppliers to achieve environmental goals.	1	0	1	1	1	.8	√

8.Our company agrees with major suppliers on environmental performance responsibilities.	1	1	1	1	1	1	√
9. Our company works together with major suppliers to reduce the environmental impact of our activities.	1	1	1	1	1	1	√
10.Our company works together with major suppliers to plan, anticipate, and solve problems related to the environment.	1	1	1	1	1	1	√
11.Our company works together with major suppliers to determine how to reduce the environmental impact of our products/services.	0	1	1	1	1	.8	√
12.Our company works together with our major suppliers to accumulate and share environmental knowledge.	1	0	1	1	1	.8	√
Green Customer Integration (How does your company handle green customer integration?)							
13.Our company works together with major customers to achieve environmental goals.	1	1	1	1	1	1	√
14.Our company agrees with major customers on environmental performance responsibilities.	1	0	1	1	1	.8	√
15.Our company works together with major customers to reduce the environmental impact of our activities.	0	1	1	1	1	.8	√
16.Our company works together with major customers to plan, anticipate and solve problems related to the environment.	1	1	1	1	1	1	√

17.Our company works together with major customers to determine how to reduce the environmental impact of our products/services.	1	1	1	1	1	1	√
18.Our company works together with our major customers to accumulate and share environmental knowledge.	1	1	1	1	1	1	√
Ambidextrous Green Innovation							
Exploratory Green Innovation(How does your company carry out exploratory green innovation?)							
19. Our company actively embraces demand beyond existing green products, processes and services.	1	1	1	1	1	1	√
20.Our company actively adopts new green products, processes and services.	1	1	1	1	1	1	√
21.Our company actively develops new green products, processes and services.	1	0	1	1	1	.8	√
22.Our company is actively experimenting with new green products and services in the market.	1	1	1	1	0	.8	√
23. Our company actively promotes the commercialization of new green products and services.	1	0	1	1	1	.8	√
24.Our company actively uses new green distribution channels.	1	1	1	1	1	1	√
25.Our company actively explores new opportunities in green markets.	1	1	1	1	1	1	√

Exploitative Green Innovation (How does your company carry out exploitative green innovation?)							
26.Our company actively improves existing green products, processes and services.	1	0	1	1	1	.8	√
27.Our company actively adjusts existing green product offerings, processes and services.	1	1	1	1	0	.8	√
28.Our company actively introduces improved green products and services to the market.	1	0	1	1	1	.8	√
29.Our company actively strives to improve the efficiency of our existing green products and services.	0	1	1	1	1	.8	√
30.Our company actively increases economies of scale in existing green markets.	0	1	1	1	1	.8	√
31.Our company actively expands the scope of green services for existing customers.	1	1	1	1	0	.8	√
32. Our company aims to lower the costs of internal processes.	1	0	1	0	0	.4	Drop
Enterprise Performance							
Environmental performance (How is your company performing in terms of environmental performance?)							
33. In the past two years, the emissions of our company's "three wastes" have significantly decreased.	1	1	1	1	1	1	√
34. In the past two years, thehazardous/harmful/toxic materials consumption of our company has been significantly decreased.	1	1	1	1	1	1	√
35. In the past two years, the energy consumption of our company has been significantly decreased.	1	1	1	0	1	.8	√

36.In the past two years,the number of times companies have been regulated for environmental issues has decreased significantly.	1	1	1	0	1	.8	√
Economic performance (How is your company performing in terms of economic performance?)							
37.In the past two years, our company's sales revenue has significantly increased.	1	1	1	0	1	.8	√
38.In the past two years, the market share of our company's products has significantly increased.	1	1	1	1	1	1	√
39.In the past two years, our company's net profits have significantly increased.	1	1	1	1	1	1	√
40.In the past two years, our company's ROL have significantly increased.	1	1	1	0	1	.8	√
41.In the past two years, our company's return on sales have significantly increased.	1	1	1	0	1	.8	√
Social Performance (How is your company performing in terms of social performance?)							
42.In the past two years, our company has improved employees' health and safety.	1	1	1	0	1	.8	√
43.In the past two years, our company has improved community health and safety.	1	1	0	1	1	.8	√
44.In the past two years, our company has improved job satisfaction levels of employees.	1	1	1	1	1	1	√
45.In the past two years, our company has increased incentives and engagement for local employment.	1	0	1	1	1	.8	√

Green Legitimacy							
Coercive Legitimacy (How does your company perform in terms of coercive legitimacy?)							
46.In the past two years, green innovation activities have enabled our company's production and operation to meet the requirements of relevant laws and regulations.	1	1	1	1	1	1	√
47.In the past two years, the government has highly evaluated the green innovation activities of our company.	1	1	1	1	0	.8	√
48. In the past two years, green innovation activities have shielded our company from regulatory penalties.	1	0	1	1	1	.8	√
Normative Legitimacy (How does your company perform in terms of normative legitimacy?)							
49. In the past two years, our company's green innovation activities have been widely understood and accepted by consumers and the public.	1	0	1	1	0	.6	√
50.In the past two years, our company has established a good social and market image through green innovation activities.	1	1	1	1	0	.8	√
51.In the past two years, our company has received high praise from environmental organizations for its green innovation activities.	1	1	1	1	0	.8	√
Mimetic Legitimacy (How does your company perform in terms of mimetic legitimacy?)							

52.In the past two years, our company has obtained various green environmental quality certifications or production standard certifications in the industry.	1	1	1	1	1	1	√
53.In the past two years, our company has increased its visibility in the industry due to green innovation activities.	1	0	1	1	1	.8	√
54.In the past two years, our company has set a good example for other enterprises in the industry due to its green innovation activities.	1	1	0	1	1	.8	√

Biography

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