

**THE INFLUENCE OF INSTITUTIONAL
PRESSURE, GREEN SUPPLY CHAIN
MANAGEMENT PRACTICES AND GREEN
INNOVATION ON FIRM SUSTAINABLE
PERFORMANCE**

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by

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LIST OF ABBREVIATIONS

AVE	Average variance extracted
CB-SEM	Covariance-based SEM
CMB	Common method bias
CNIPA	China National Intellectual Property Administration
CR	Composite Reliability
ECP	Economic performance
ENP	Environmental performance
EU	Environmental uncertainty
GI	Green innovation
GSCM	Green supply chain management
HTMT	Heterotrait-monotrait ratio
MEE	Ministry of Ecology and Environment
MIIT	Ministry of Industry and Information Technology
PBV	Practice-based view theory
PLS-SEM	Partial Least Squares Structural Equation Modeling
SCT	Supply chain traceability
SP	Social performance
VIF	Variance inflation factor

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**PENGARUH TEKANAN INSTITUSI, PENGURUSAN RANTAIAN
BEKALAN DAN INOVASI HIJAU DI ATAS KELESTARIAN PRESTASI
FIRMA**

ABSTRAK

Kemampuan telah menjadi isu utama bagi syarikat. Penyelidikan ini mengkaji kesan tekanan institusi, amalan GSCM, dan inovasi hijau terhadap prestasi mampan syarikat, dengan mempertimbangkan kesan modulator ketidakpastian alam sekitar dan kebolehesanan rantai bekalan. Penyelidikan ini berdasarkan kaji selidik ke atas 1,500 kilang dari senarai Kilang Hijau 2021 dan 2022 yang diterbitkan oleh Kementerian Perindustrian dan Teknologi Maklumat China. Penemuan menunjukkan terdapat korelasi positif yang signifikan antara tekanan institusi dan GSCM practices serta inovasi hijau. Ketidakpastian alam sekitar memoderasi hubungan antara tekanan regulatori dan pelanggan dengan GSCM practices, tetapi tiada kesan modulator yang signifikan diperhatikan untuk tekanan persaingan. Begitu juga, ketidakpastian alam sekitar memoderasi hubungan antara tekanan regulatori dan inovasi hijau. Selain itu, GSCM practices dan inovasi hijau memberi pengaruh positif terhadap inovasi hijau dan prestasi mampan syarikat. Kebolehesanan rantai bekalan selanjutnya memperkuat kesan positif GSCM practices terhadap prestasi ekonomi dan sosial, tetapi tidak menunjukkan kesan modulator yang signifikan terhadap prestasi alam sekitar. Penemuan ini menekankan kepentingan mengintegrasikan amalan hijau dalam strategi korporat, memberikan pandangan baru untuk penyelidikan masa depan dan panduan praktikal untuk meningkatkan prestasi mampan dalam syarikat.

**THE INFLUENCE OF INSTITUTIONAL PRESSURE, GREEN SUPPLY
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ABSTRACT

Sustainability has become a key issue for companies. This study examines the impact of institutional pressure, GSCM practices, and green innovation on firms' sustainable performance, considering the moderating effects of environmental uncertainty and supply chain traceability. The research is based on a survey of 1,500 factories from the 2021 and 2022 Green Factories list published by China's Ministry of Industry and Information Technology. The findings indicate significant positive correlations between institutional pressures and both GSCM practices and green innovation. Environmental uncertainty moderates the relationships between regulatory and customer pressures and GSCM practices, but no significant moderating effect was observed for competitive pressure. Similarly, environmental uncertainty moderates the relationship between regulatory pressure and green innovation. Furthermore, GSCM practices and green innovation positively influence green innovation and firms' sustainable performance. Supply chain traceability further enhances the positive impact of GSCM practices on economic and social performance but does not exhibit a significant moderating effect on environmental performance. These findings underscore the importance of integrating green practices into corporate strategies, providing new insights for future research and practical guidance for improving sustainable performance in firms.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter provides an overview of the research on sustainable performance, green supply chain management practices and green innovation. It begins by introducing the overall background, evolution, and trends of sustainable development and sustainable performance. Subsequently, it discusses the issues pertaining to sustainable performance, green supply chain management practices, and green innovation. The problem statement of this thesis is then presented, along with the introduction of objectives and research questions. The significance of this research is further discussed from both theoretical and practical perspectives. Finally, key structures, terms, and organizations are defined to outline the remaining structure of this thesis.

1.2 Background

With the increasingly prominent environmental problems, sustainable development has become the focus of global attention. This trend is particularly relevant to the manufacturing sector, which is the focus of this study. In many developed countries, the manufacturing industry has shifted from a sole emphasis on economic returns to a holistic approach that balances environmental, economic, and social factors (Wirba, 2023). Despite China's remarkable economic achievements, it continues to face severe environmental challenges. In 2019, China was the global leader in total energy consumption, utilizing 4.86 billion tons of standard coal, accounting for 24% of the world's total energy consumption (IEA, 2020). The

limitations of energy resources and the degradation of the environment have become significant obstacles to China's economic development (Chen et al., 2021; Hao & Fu, 2023).

For China's manufacturing sector, the green transition is still in its infancy. CITI Group's 2015 assessment of the Green Supply Chain Index, combined with data compiled by the Institute of Public and Environmental Affairs (IPE) and the Natural Resources Defense Council (NRDC), shows that green supply chain management is not universal in China, with only 15% of manufacturing firms implementing comprehensive practices (CITI Index, 2015; Li et al., 2019; Li & Yan, 2021). Many manufacturing industries still struggle to shift from short-term economic returns to long-term sustainability thinking, as the costs associated with green transformation and the uncertainty of financial returns remain key concerns.

To remedy the situation, the Chinese government introduced the 14th Five-Year Plan for the Development of Green Industries in 2021, which includes the establishment of environmentally sustainable factories and enterprises, as well as the development of green industrial parks and supply chains (MIIT, 2021). Enterprises are expected to prioritize sustainable performance, with green supply chain management and green innovation playing essential roles in their development strategies (Zaid, 2023). To further incentivize adoption, the government has implemented a green certification system for companies demonstrating significant progress in sustainable practices. Certified companies receive financial aid, green credit, tax breaks, and other policy benefits to encourage the widespread adoption of green production technologies (MIIT, 2024).

These efforts have led to some progress, with reports indicating that China reduced carbon dioxide emissions per unit of GDP by 48.4% by the end of 2020, surpassing the initial target of 40–45% (Li, 2022). However, despite this progress, the transition to green manufacturing remains slow. As of 2024, only approximately 0.09% of China's 4,529,585 manufacturing enterprises—equivalent to 4,271 companies—had been recognized as national green factories (NBSC, 2024). Furthermore, less than 10% of industrial parks had achieved green certification, despite government incentives (MIIT, 2023). For instance, as of 2022, only 7 out of 27 major steel enterprises in China had set carbon neutrality targets, covering merely 28.5% of the country's total steel production that year (China energy, 2024). In the building materials sector, carbon dioxide emissions reached 1.14 billion tons in 2021, accounting for 11% of the national total emissions and 31% of the annual emissions from the industrial sector (Gov, 2024). Although China's energy consumption per unit of GDP in 2024 decreased by 3.8% compared to the previous year, suggesting some improvement in energy efficiency, it remains insufficient to meet the long-term carbon neutrality goals. Overall, while policy initiatives and technological innovations have played a positive role in advancing green manufacturing, the pace of green transformation in certain sectors and regions remains slow, necessitating further policy support and technological investment to achieve sustainable development in the manufacturing industry (Wang, 2022; Antwi, 2022; Hariram, 2023; Wen, 2023; Yu, 2024).

This reluctance is concerning, as the long-term consequences of inaction are severe. Environmentally, failing to implement sustainable practices can exacerbate climate change, resource depletion, and biodiversity loss (Hariram, 2023). Economically, companies that ignore green initiatives may face higher operational

costs due to stricter environmental regulations, reduced market competitiveness, and exclusion from international markets with stringent sustainability requirements (Wang, 2022).

Moreover, China has intensified its environmental regulations, imposing heavy penalties on companies that fail to meet environmental standards. These penalties include substantial fines, production suspensions, and even criminal liability for responsible executives. Additionally, public scrutiny of corporate environmental performance has increased. Companies failing to meet green standards have faced consumer backlash and lost market share, highlighting the risks of neglecting sustainability (Li & Yan, 2021). The Environmental Protection Law of the People's Republic of China stipulates that non-compliant companies may be forced to suspend operations, and responsible individuals could face administrative detention. In severe cases, criminal liability may be imposed, further elevating compliance risks.

Another critical factor influencing firms' sustainable performance is environmental uncertainty. Rapid changes in environmental regulations, market demands, and technological advancements create uncertainty for businesses, affecting their ability to implement green supply chain management (GSCM) practices and green innovation (GI) (Zhao, 2023; Kapoor, 2024). While institutional pressures push firms toward sustainability, environmental uncertainty may either strengthen or weaken the impact of these pressures on corporate green practices. Firms facing high uncertainty must adopt flexible strategies to effectively respond to shifting regulatory requirements and market expectations (Fatimah et al., 2023).

Additionally, supply chain traceability plays a crucial role in ensuring the effectiveness of GSCM practices. As global concerns over product sustainability and

ethical sourcing continue to rise, companies are increasingly required to track and verify the environmental and social impacts of their supply chains (Tao et al., 2023; Wen, 2023). A well-developed traceability system enhances transparency, improves risk management, and strengthens consumer trust, ultimately contributing to better sustainable performance (Asha et al., 2023). However, firms with weak traceability mechanisms may struggle to translate green supply chain practices into tangible sustainability outcomes.

Given these dynamics, this study investigates how GSCM practices and GI influence firms' sustainable performance under institutional pressures, while examining the moderating effects of environmental uncertainty and supply chain traceability. By addressing these factors, the research aims to provide valuable insights into the green transition of China's manufacturing industry, offering practical implications for both policymakers and business leaders.

1.2.1 The Importance of Sustainable performance

Green, low-carbon, and sustainable development has become an international consensus. Currently, the global energy landscape is undergoing rapid transformation, and energy security may face increasingly complex challenges (Caineng et al., 2024). The Green Development White Paper of China states that green development is a development path that conforms to nature, promotes harmonious coexistence between humans and nature (Cui, 2024), achieves maximum economic and social benefits with minimal resource and environmental costs, and represents high-quality and sustainable development (Islam, 2023). It has become a consensus among countries (Guoxin News,

2023). The greening of corporate behavior and the focus on sustainable performance have become focal points for the survival and development of enterprises.

Starting from 2021, a combination of factors has led to a global energy supply crunch and sharp price increases (Lyu et al., 2022), quickly evolving into an "environmental crisis" characterized by soaring energy prices and market volatility (Crnčec et al., 2023; Wang et al., 2024). To address these issues, China has taken major projects and initiatives as drivers, with the construction of green factories, green industrial chains, and green industrial parks as the linkages, aiming to achieve energy conservation, emission reduction, and efficiency improvement (Lyu et al., 2022; Wu and Gao, 2022). Continuous efforts have been made to develop a green manufacturing system. A large number of green factories have achieved energy consumption levels superior to the national energy consumption limit standards, gradually establishing a full-chain supply system of green products, spanning from basic raw materials to end-consumer goods (National Energy Administration, 2023).

This implies that businesses need to start adopting sustainable approaches to manage their supply chains. Seuring and Müller (2008) argue that the supply chains of companies should consider the needs of customers and stakeholders from three dimensions of sustainability, namely economic, environmental, and social. Elkington (1998) refers to these as the triple bottom line, emphasizing the need for businesses to balance sustainability across these three dimensions. Failure to achieve sustainability in any of these pillars renders the supply chain unsustainable (Govindan, 2018).

In the past, manufacturing organizations primarily focused on economic growth while neglecting sustainable performance, resulting in an imbalance among these dimensions (Wan, 2022; Lee, 2024). As a result, governments, customers, competitors,

and the overall environment are exerting pressure on businesses to prioritize environmental protection and adopt more environmentally friendly corporate practices. In the long run, green behavior can help enterprises achieve better sustainable performance and gain a competitive advantage (Ürey, 2020) since customers prefer organizations that promote social well-being and reduce environmental degradation (Martins, 2021).

Sustainable performance is a crucial factor in the sustainable development of businesses and holds significant importance for both the organizations and society at large (Khan, 2021). It demonstrates how effectively a company has integrated its social objectives into actionable practices (Alsayegh, 2020). This includes the company's dedication to environmental protection and ecosystem health, achieved through reduced resource consumption, lowered carbon emissions, and minimized waste production. By adopting environmentally friendly production methods and embracing green technological innovations, businesses can reduce their reliance on natural resources and mitigate their adverse environmental impacts (Khan, 2023; El Ayoubi, 2023). Furthermore, sustainable performance embodies a sense of social responsibility, as it enables companies to create greater value for society while pursuing economic growth, enhancing their social image, and reputation (Yildiz Çankaya and Sezen, 2019). Emphasizing sustainable performance also encourages businesses to engage in green innovation and seek more environmentally friendly and sustainable business models. By consistently enhancing their products and services to meet the increasing demand for eco-friendly options (D'Angelo, 2023), companies can obtain a competitive edge, expand their market share, and achieve sustained economic benefits.

Enterprises should equally prioritize the three dimensions of sustainable performance: economic performance, environmental performance, and social performance. Economic performance (ECP) is typically measured through operational and financial indicators (Afum, 2020; Khan et al., 2023). Environmental performance (ENP) refers to the evaluation of enterprises based on their environmental practices across various aspects (Habib, 2022). Social performance (SP) ensures that enterprises fulfill their societal mission, it has significant implications for a firm's reputation (Brammer & Pavelin, 2006; Pérez-Cornejo et al., 2020). Corporate social responsibility calls for enterprises to focus on employee health and safety, employee training, and the improvement of overall societal well-being, which are also important indicators of social performance (Pérez-Cornejo et al., 2023). Striking a balance among these three dimensions will bring higher profits and a competitive advantage to organizations.

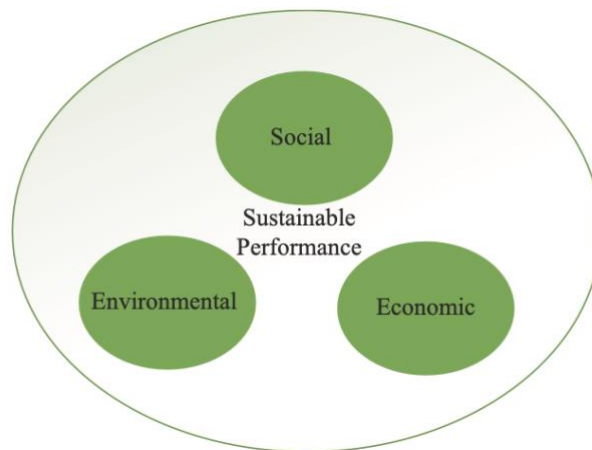


Figure 1.1 Sustainable performance dimensions

Source: Sustainable performance dimensions (Dhiman, 2021)

1.2.2 The Importance of GSCM practices

Supply chain management is regarded as a crucial avenue for facilitating environmental management within organizations, which includes activities related to fulfilling consumer demands through procurement, production, transportation, and distribution (Hart and Milstein, 2003; Chakraborty, 2023). According to Vachon and Klassen (2006), a well-integrated supply chain is becoming a fundamental element for achieving environmental sustainability within organizational networks. Klassen (1993) advocates for the integration of environmental issues into mainstream supply chain management (SCM) and the development of environmentally conscious supply chain management systems (Preuss and Fearne, 2022; Naz, 2024).

Adebanjo (2016) emphasize the environmental pressures that organizations need to consider when formulating sustainability strategies. Sharma et al. (2017) concludes that green supply chain management (GSCM) is imperative for businesses across various industries to gain a competitive edge in the market. The practice of GSCM entails a mutually beneficial relationship between organizations and performance (Zhu and Sarkis, 2004; Chakraborty, 2023). Linton et al. (2007) highlight that organizations can enhance sustainability, operational efficiency, and cost-effectiveness by implementing practical and environmentally friendly management practices throughout their supply chains. Sustainable green development is crucial for the manufacturing industry to comprehend and adhere to international and national sustainability and environmental protection standards. This approach not only fosters new employment and income opportunities but also mitigates environmental degradation (Ni et al., 2023; Xu et al., 2023; Mehmood et al., 2024).

By pursuing sustainable development goals, companies with a sustainability mindset can achieve a brighter future as it enhances their relationships with stakeholders (Baah, 2021). Consequently, it leads to reduced conflict costs, improved overall efficiency, increased employee productivity, and ultimately, performance enhancement (Zheng, 2018; Bello - Pintado, 2023). Geng et al. (2017) propose in their research that green practices demonstrate better performance across social, operational, environmental, and economic aspects. GSCM practices helps restore a sustainable environment (Dzikriansyah, 2023), and well-managed social, environmental, and economic systems are essential for long-term sustainability, and therefore, managers should consider green practices as a competitive advantage for future returns in their organizations (Ait Sidhoum and Serra, 2018; Jum'a, 2023).

GSCM practices need to be taken seriously by businesses as they possess the capability to address environmental issues. It can fulfill all the requirements of the entire supply chain and enhance the market competitiveness of the companies, even during the Covid-19 pandemic (Zhang, 2022). Successful implementation of GSCM practices will reduce waste and costs and enhance the awareness of employees and the organization regarding green marketing (Nazir, 2024; Freihat, 2024), all of which contribute to improved performance of the company, including its environmental, economic, and manufacturing operations (Chen et al., 2020). Furthermore, the effective implementation of GSCM practices will impact the innovation capabilities of businesses in their production processes (Khan, 2022), which is crucial for enhancing performance and competitiveness. Therefore, further strengthening research related to GSCM practices becomes particularly important.

1.2.3 The important of green innovation

As mentioned in the aforementioned China Green Development White Paper, China must further stimulate the intrinsic motivation and innovation vitality of various market entities to provide strong support for promoting green, low-carbon development and building a modern society characterized by harmonious coexistence between humans and nature (National Energy Administration, 2023). Therefore, in order to meet these demands, green innovation has become a core concern in enterprise management and activity coordination (Fujii et al., 2013). Chen (2008) defines green core competence as "collective knowledge and professional know-how about green innovation and the environment" and "management science." The Organisation for Economic Co-operation and Development (OECD) defines green or ecological innovation as "the development of new or improved products (goods and services), processes, marketing methods, organizational structures, or institutional arrangements intentionally or unintentionally aimed at reducing environmental impacts and replacing existing practices" (OECD, 2009).

Green innovation (GI) is becoming increasingly important in both practice and academia (Dong, 2024). It is regarded as an effective means for enterprises to gain competitive advantage. Understanding market demands helps companies formulate green innovation strategies and better respond to market needs (Shao et al., 2010; Borah, 2023). Customer demand for green products and services has been shown to be crucial in driving green innovation (Halila and Lundquist, 2011; Sahoo et al., 2023). Although Berthon et al. (1999) expressed skepticism about this claim, a review of relevant empirical studies confirms a positive relationship between GI and firm performance (Shao et al., 2010). Tseng et al. (2013) point out that with the continuous

transformation of green technologies and the shortening of product lifecycles, companies have strengthened green innovation, enhancing their competitiveness. Chiou et al. (2011) further demonstrate that green product and process innovation will impact an organization's competitive advantage and reputation. It also affects a company's environmental performance.

For enterprise, green innovation is considered a vital driver for achieving sustainable development (Yuan, 2022). The Chinese government actively encourages enterprises to implement GI, integrating green principles and sustainable practices into their operations, and assuming social responsibility for environmental sustainability (Zhang, 2020; Xiong, 2023; Sarfraz et al., 2023). Green innovation is poised to emerge as a pivotal catalyst for China's economic advancement, promoting sustainable growth (Pan et al., 2021; Ren et al., 2022).

Nevertheless, the fact is that the technical assistance for green development in China remains constrained, as indicated by data from the China National Intellectual Property Administration (CNIPA), as of the end of 2022, China had 218,000 effective green and low-carbon patents, accounting for only 5.2% of the total number of invention patents in China. Among the top 50 patent holders worldwide, only eight are large Chinese enterprises, while the rest are research institutions (CNIPA, 2024). This indicates that small and medium-sized enterprises do not show a development trend in this area, enhancing green innovation within enterprises is an urgent issue that needs to be addressed. This thesis aims to find the impact of green innovation, enhance research and understanding of green innovation from various perspectives.

1.2.4 The importance of institutional pressure

It is well known that rapid economic development and long-term growth in a country are inevitably accompanied by exacerbated environmental issues (Qin et al., 2019; Wang et al., 2023). For instance, industrial water pollution in China has become a widespread health hazard (Wang and Yang, 2016; Song et al. 2023). The early stages of China's rapid development and economic pursuit led to negligence towards the environment. These economic expansions were largely attributed to Chinese manufacturers, who faced corresponding increases in environmental pressures (Song, 2023). International clients, particularly image-conscious multinational corporations, also exert pressure on numerous Chinese manufacturers to enhance their environmental reputation and performance (Zhu and Sarkis, 2007).

At the same time, the comprehensive environmental regulations formulated by China have forced companies to make choices between paying pollution fines and managing environmental investments recent years (Fu et al., 2021). The pressures from government regulations and institutional oversight drive the whole manufacturing industry to engage in environmental protection and innovation (Xie, 2022; Siyal et al., 2023). As a manufacturing company, not transforming may mean being eliminated in the industry.

The reasons for the impact of pressures on corporate behavior can be explained using institutional theory. The report indicates that businesses face institutional pressures from various aspects in their development and operational processes. These pressures can be categorized into different isomorphic pressures, namely regulatory (coercive), market (normative), and competitive (mimetic) pressures (Majid et al., 2020; Beta and Ogunmokun, 2023; Kadir et al., 2024). Zhu et al. (2005) suggest that

the existence and responses to these institutional pressures will lead to changes in the relationship between adoption practices and performance. Comprehending these environmental pressures and dynamics is crucial for companies to strategically oversee their performance. GSCM practices and green innovation are important methods and technologies to help Chinese manufacturing company to face these pressures.

Institutional pressures promote market orientation within organizations, thereby facilitating the implementation of green behavior. This also reflects the impact of institutional pressures on businesses, which compel them to take measures to cope with and control shared external influences, precisely identify relevant institutional precedents, and strategically respond to them (Gonzalez et al., 2022), to help Chinese manufacturers enhance their economic and environmental performance. Nonetheless, as previously noted, the environmental uncertainties in recent years have made companies indecisive about whether to adopt new measures (Ren et al., 2023). This study will also consider environmental uncertainty while investigating the influence of institutional pressures on corporate behavior, aiming for a more accurate and comprehensive investigation.

1.2.5 The importance of environmental uncertainty

Environmental uncertainty refers to the unpredictable changes in regulations, market demands, and technological advancements. With increasingly stringent environmental policies and ambitious goals like “peak carbon” and “carbon neutrality,” firms face significant challenges in navigating uncertain environments (Asif, 2024). Regulatory changes can impose unexpected compliance costs, while shifts in consumer preferences and advancements in green technologies create additional

uncertainty. Such unpredictability often forces firms to reconsider their strategic choices, particularly concerning green supply chain management (GSCM) practices and green innovation.

Institutional theory suggests that firms experience coercive, normative, and mimetic pressures to adopt environmentally friendly practices (DiMaggio & Powell, 1983). However, the degree of environmental uncertainty can alter how firms respond to these pressures. Under high uncertainty, firms may become more hesitant in their decision-making processes, fearing the risks associated with new technologies and compliance measures (Ren et al., 2023). Conversely, firms may also see uncertainty as an opportunity to proactively adopt green innovations and GSCM practices to gain a competitive edge (Chen, 2022).

Therefore, this study includes environmental uncertainty as a moderating variable to examine how it influences the relationship between institutional pressures and the adoption of GSCM practices and green innovation. Understanding this relationship will provide valuable insights into how firms can effectively respond to external pressures in uncertain environments to achieve sustainable performance.

1.2.5 The importance of supply chain traceability

Supply chain traceability refers to a firm's ability to track and monitor products, components, and materials throughout the supply chain. Effective traceability systems enable firms to collect real-time data on product origins, production processes, and environmental impacts (Tachizawa & Ward, 2014). This transparency facilitates better decision-making and enhances accountability across the supply chain, which is particularly critical for implementing GSCM practices.

GSCM practices, such as green procurement, eco-design, and waste reduction, often require extensive coordination with suppliers and other stakeholders. Without adequate traceability, firms may struggle to verify supplier compliance with environmental standards or detect inefficiencies within their supply chains (Biswas, 2023). As a result, poor traceability can undermine the effectiveness of GSCM initiatives and hinder firms from achieving their sustainable performance goals.

By incorporating supply chain traceability as a moderating variable, this study investigates how traceability capabilities influence the effectiveness of GSCM practices in enhancing sustainable performance. Firms with robust traceability systems are expected to achieve greater environmental, economic, and social performance outcomes compared to those with limited traceability. This analysis will provide practical insights for companies aiming to strengthen their supply chain management strategies and improve overall sustainability performance.

1.3 Problem Statement

As the global population is projected to reach 9 billion by 2050, the difficulty and cost of obtaining non-renewable resources continue to rise, making the urgency of sustainable development increasingly evident (Henao, 2019). This challenge has prompted governments, organizations, and businesses to prioritize sustainability. However, for enterprises, achieving this goal is not easy. Historically, many businesses prioritized economic performance over environmental protection and social responsibility until the late 20th century (Pagell & Shevchenko, 2014). Today, China is actively implementing environmental policies to achieve its “peak carbon” and “carbon neutrality” goals, which require businesses to confront sustainability challenges (Asif, 2024).

In this context, this study proposes a sustainability strategy that aims to balance economic, environmental, and social performance by integrating institutional pressures, GSCM practices, and green innovation based on institutional theory and Practice-Based View (PBV) theory. These variables were chosen based on existing literature and theoretical frameworks, as they directly impact firms' sustainable performance (Vachon & Klassen, 2006). Additionally, environmental uncertainty and supply chain traceability are selected as moderating variables because they affect the impact of GSCM practices and green innovation on sustainable performance (Zhu et al., 2005; Tachizawa & Ward, 2014).

This study integrates institutional theory and the PBV theory. Institutional theory suggests that external pressures (such as regulatory, normative, and mimetic forces) compel firms to adopt GSCM practices and green innovation (DiMaggio & Powell, 1983). Meanwhile, PBV highlights the dynamic interplay between corporate practices and the external environment, demonstrating how the adoption of green practices can enhance corporate performance (Khan et al., 2023). By combining these perspectives, this study seeks to explain how the interaction between external and internal factors drives firms to achieve sustainability goals.

This study specifically focuses on China's manufacturing sector with production capabilities, as it is one of the major contributors to carbon emissions and environmental degradation. While the service sector also plays a role in sustainability, the challenges and opportunities for green innovation and green supply chain management practices are more prominent in manufacturing. Therefore, in order to provide a deeper analysis, this study limits its scope to manufacturing enterprises.

To remain competitive in the increasingly fierce market and ever-changing environmental policies, enterprises must focus on and balance the relationship between economic, environmental, and social performance. While it is possible to prioritize one aspect in the short term, it is essential not to neglect the other two. This balance helps ensure that enterprises not only achieve short-term profit goals but also maintain good social responsibility and environmental impact in the long term.

If enterprises fail to effectively balance these three dimensions of performance, they may face a range of long-term negative consequences. For instance, excessive focus on short-term economic benefits may lead to neglecting environmental and social responsibilities, resulting in regulatory penalties, customer dissatisfaction, and damage to brand reputation (Wang, 2023). On the other hand, an overemphasis on environmental performance at the cost of economic benefits could lead to financial pressures, hindering investment in green technologies and innovations. Ultimately, such imbalances may affect the enterprise's long-term sustainable development.

However, even if enterprises have not yet realized the importance of balancing economic, environmental, and social performance, external institutional pressures—such as regulatory pressures, customer demands, and market competition—can still drive firms to focus on environmental issues and integrate these concerns into daily operations and decision-making. Specifically, external pressures can encourage enterprises to adopt GSCM practices and green innovation through incentives, laws, regulations, and consumer demands, improving their environmental and social performance and ultimately driving better achievement and balance of sustainable performance (Zou, 2021).

Therefore, even when enterprises are unable to fully balance economic, environmental, and social performance, green supply chain management practices and green innovation, driven by external pressures, can still help them achieve better sustainable performance and gradually compensate for the imbalance between internal and external factors.

When environmental uncertainty increases, firms may face more market fluctuations and pressures for technological change, which leads them to adopt new technologies and innovative practices to enhance productivity and competitiveness. For example, when facing environmental policy changes and resource shortages, firms may rapidly shift to green technologies and low-carbon practices rather than maintaining existing production models (Chen, 2022). On the other hand, the state of supply chain traceability also affects the implementation of green supply chain management practices (Tachizawa et al., 2015; Biswas, 2023). When there are deficiencies or significant changes in supply chain management, firms will find it more challenging to focus on sustainable performance (Zhou, 2023; Oubrahim, 2023).

In summary, this study proposes an innovative research model to explore how institutional pressures, GSCM practices, and green innovation collectively influence firms' sustainable performance. Through this model, the study not only provides a new theoretical framework for academia but also offers practical guidelines for Chinese manufacturing industries to address sustainability challenges.

1.4 Research Objectives

The green supply chain management of production enterprises is the most used research case for analysis because the production enterprises will produce various environmental pollution behaviors in the whole production and transportation process.

To thoroughly explore the impact of green supply chain management practices and green innovation on corporate sustainable performance, and to further examine the moderating roles of environmental uncertainty and supply chain traceability, this study proposes clear research objectives to ensure a systematic and in-depth examination of the hypothesized relationships.

This study will investigate based on the manufacturing company.

The primary aims of this study are as follows:

1. To examine the relationship between regulatory pressure and GSCM practices
2. To study the relationship between regulatory pressure and green innovation
3. To investigate the relationship between customer pressure and GSCM practices
4. To examine the relationship between customer pressure and green innovation
5. To study the relationship between competitive pressure and GSCM practices
6. To analyze the relationship between competitive pressure and green innovation
7. To investigate the moderating role of environmental uncertainty on the relationship between regulatory pressure and GSCM practices
8. To investigate the moderating role of environmental uncertainty on the relationship between customer pressure and GSCM practices
9. To investigate the moderating role of environmental uncertainty on the relationship between competitive pressure and GSCM practices
10. To investigate the moderating role of environmental uncertainty on the relationship between regulatory pressure and green innovation
11. To investigate the moderating role of environmental uncertainty on the relationship between customer pressure and green innovation

12. To investigate the moderating role of environmental uncertainty on the relationship between competitive pressure and green innovation
13. To examine the relationship between GSCM practices and green innovation
14. To study the relationship between GSCM practices and economic performance
15. To investigate the relationship between GSCM practices and environmental performance
16. To study the relationship between GSCM practices and social performance
17. To analyze the relationship between green innovation and economic performance
18. To study the relationship between green innovation and environmental performance
19. To investigate the relationship between green innovation and social performance
20. To investigate the moderating role of supply chain traceability on the relationship between GSCM practices and economic performance.
21. To investigate the moderating role of supply chain traceability on the relationship between GSCM practices and environmental performance.
22. To investigate the moderating role of supply chain traceability on the relationship between GSCM practices and social performance.

1.5 Research Questions

This study aims to explore the drivers and outcomes of green transformation in China's manufacturing sector, with a focus on the roles of institutional pressures, GSCM practices, green innovation, and sustainability performance. The term "impact"

is used throughout the research questions to denote the measurable effects or influence of one variable on another, as quantified through statistical analysis. Specifically, it refers to the extent to which changes in an independent variable lead to changes in a dependent variable. Additionally, the study examines how contextual factors, such as environmental uncertainty and supply chain traceability, moderate these relationships. Research questions are designed based on the requirements of the theoretical framework and hypotheses, covering both the main effects and moderating effects. To ensure the achievement of research objectives, this study proposes a series of specific research questions:

RQ1: What is the relationship between regulatory pressure and GSCM practices ?

RQ2: What is the relationship between regulatory pressure and green innovation ?

RQ3: What is the relationship between customer pressure and GSCM practices ?

RQ4: What is the relationship between customer pressure and green innovation ?

RQ5: What is the relationship between competitive pressure and GSCM practices ?

RQ6: What is the relationship between competitive pressure and green innovation ?

RQ7: What is the impact of environmental uncertainty on the relationship between regulatory pressure and GSCM practices?

RQ8: : What is the impact of environmental uncertainty on the relationship between customer pressure and GSCM practices

Q9: What is the impact of environmental uncertainty on the relationship between competitive pressure and GSCM practices

Q10: What is the impact of environmental uncertainty on the relationship between regulatory pressure and green innovation

Q11: What is the impact of environmental uncertainty on the relationship between customer pressure and green innovation

Q12: What is the impact of environmental uncertainty on the relationship between competitive pressure and green innovation

RQ13: What is the relationship between GSCM practices and green innovation?

RQ14: What is the relationship between GSCM practices and economic performance?

RQ15: What is the relationship between GSCM practices and environmental performance?

RQ16: What is the relationship between GSCM practices and social performance?

RQ17: What is the impact of green innovation on economic performance?

RQ18: What is the impact of green innovation on environmental performance?

RQ19: What is the impact of green innovation on social performance?

RQ20: What is the impact of supply chain traceability on the relationship between GSCM practices and economic performance?

RQ21: What is the impact of supply chain traceability on the relationship between GSCM practices and environmental performance?

RQ22: What is the impact of supply chain traceability on the relationship between GSCM practices and social performance?

1.6 Significance of Study

The major significance of this study lies in its introduction of environmental uncertainty and supply chain traceability as critical variables influencing the relationship between GSCM practices, green innovation, and sustainable performance. While existing literature has often overlooked or insufficiently explored these factors

(Thoo et al., 2014; Zaid et al., 2018; Zhang et al., 2020; El Ayoubi and Radmehr, 2023; Naseer et al., 2023; Rahman et al., 2023; Shahzad, 2023; Rashid, 2024), this study provides empirical evidence on how environmental uncertainty shapes firms' strategic responses to external pressures and how supply chain traceability enhances the effectiveness of GSCM practices in driving sustainable outcomes.

From a policy and intervention perspective, the findings suggest that governments can design tailored regulatory frameworks and incentive mechanisms to support firms in overcoming environmental uncertainties, such as subsidies for green technology adoption or tax incentives for companies investing in supply chain transparency. Additionally, industry associations and non-governmental organizations can use these insights to develop best practice guidelines that encourage firms to strengthen supply chain traceability, thereby improving overall sustainability governance.

On the theoretical significance, this study deepens the understanding of the role of environmental uncertainty as a contingent factor that moderates how institutional pressures translate into GSCM and green innovation adoption. Specifically, firms operating under high environmental uncertainty may exhibit stronger adaptive behaviors, leveraging GSCM and green innovation to enhance resilience. Meanwhile, supply chain traceability serves as a key mechanism that strengthens the link between GSCM practices and sustainable performance, facilitating better resource utilization, reducing risks, and improving compliance with environmental regulations. By specifying these roles, this study refines the application of institutional theory and practice-based views in the context of sustainable supply chain management.

Moreover, considering China's unique environmental challenges and the pivotal role of its manufacturing sector, these findings provide actionable insights for