THE INFLUENCING FACTORS OF GREEN DEVELOPMENT OF SMALL AND MEDIUM-SIZED MANUFACTURING ENTERPRISES IN WESTERN CHINA - A CASE STUDY OF GUILIN SHIDA TECHNOLOGY COMPANY

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This Independent Study Has Been Approved as a Partial Fulfillment of the Requirements for the Degree of Master of Business Administration

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Title:	The Influencing Factors of Green Development of Small and Medium-sized Manufacturing Enterprises in Western China - A Case Study of Guilin Shida Technology Company
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ABSTRACT

As the main body of a country's national economy, manufacturing is the key to achieving sustainable economic development. However, most small and medium-sized manufacturing enterprises in western China face more challenges in green development. Due to the low level of green manufacturing technology and the high proportion of traditional resource input, they lack the continuous motivation for green innovation. The purpose of this study is: 1) To explore the factors affecting the green development of small and medium-sized manufacturing enterprises; 2) To provide suggestions for the green development of small and medium-sized manufacturing enterprises.

This study adopted the qualitative research method, applied the green manufacturing theory, and analyzed the green development factors of Guilin Shida Company. Interviews were conducted with ten experts in the field of green innovation. This study found that the five major factors that affect the green development of small and medium-sized manufacturing enterprises are green policy, green finance, green supply chain, green innovation and green manufacturing. Small and medium-sized manufacturing enterprises need to make the following improvements: 1) To drive green development with green policies; 2) To improve the support system for green finance construction; 3) To build a green supply chain to achieve green transformation; 4) To develop green innovation to achieve sustainable development; 5) To promote green manufacturing transformation and reduce energy consumption. The above suggestions for the green development of small and medium-sized manufacturing enterprises can help them to orderly promote the green process under limited resource conditions and enhance their market competitiveness.

Keywords： small and medium-sized manufacturing enterprises, green manufacturing theory, green development

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LIN YULIAN

DECLARATION

I, LINYULIAN, hereby declare that this Independent Study entitled “The Influencing Factors of Green Development of Small and Medium-sized Manufacturing Enterprises in Western China - A Case Study of Guilin Shida Technology Company” is an original work and has never been submitted to any academic institution for a degree.

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Chapter 1 Introduction

1.1 Background of the Study

The fifth meeting of the Central Financial and Economic Commission emphasized that "my country's manufacturing industry ranks first in the world and is the only country in the world that has all industrial categories" and "we must give full play to the entrepreneurial spirit and craftsmanship and cultivate a group of 'specialized, refined and innovative' small and medium-sized enterprises". Under the guidance of the "Guidelines for the Construction of Green Manufacturing Standards System" and the "14th Five-Year Plan for Industrial Green Development", green manufacturing will become an important part of the future competitiveness of enterprises (Jie & Ning, 2021). At present, many countries have formulated a series of green manufacturing strategies to promote sustainable development and green economy, such as the United States' Advanced Manufacturing Partnership Program (AMP2.0), Europe's European Union Horizon 2020, Germany's "Industry 4.0", Japan's "Green Development Strategy Master Plan", the United Kingdom's "Future Manufacturing", and India's "National Climate Change Action Plan" (Ke & Lin, 2016).

Nonetheless, China's existing low-carbon and green policies and regulatory regimes focus primarily on large enterprises. The carbon emissions of small and medium-sized enterprises are relatively small, but due to their large number, their cumulative carbon emissions cannot be ignored (Mao, 2022). At the same time, small and medium-sized enterprises face many obstacles when implementing green manufacturing, such as low willingness, low technical level, weak management capabilities and insufficient funds (Xie & Sun, 2021; Mao, 2022). However, most small and medium-sized manufacturing enterprises in my country have low levels of green manufacturing technology and a high proportion of traditional resource input. Moreover, achieving green development requires enterprises to invest a lot of costs in the early stage. As a result, many small and medium-sized manufacturing enterprises lack the continuous motivation for green innovation.

In China, there has been a long-term imbalance in the development of small and medium-sized manufacturing enterprises in the east and west (Pu & Shen, 2009; Guo & Yu, 2011). In May 2019, when General Secretary Xi Jinping hosted a symposium on promoting the rise of the central region in Nanchang, Jiangxi, he emphasized that promoting high-quality development of the manufacturing industry is the key to accelerating the rise of the central region.

Small and medium-sized manufacturing enterprises in western China face more challenges

in green development: the manufacturing industries in the western region are mostly low-end manufacturing (Mao & Wu, 2019); the level of green manufacturing is related to the degree of regional economic development (Li, 2022), the level of green manufacturing in the west is significantly lower than that in the east (Deng & Huang, 2021), resulting in green manufacturing construction falling significantly behind (Wang & Ye, 2020). When promoting new industrialization, due to limited resources, small and medium-sized manufacturing enterprises in western China are unable to fully implement green transformation from raw materials, process equipment (including energy consumption), sewage discharge to packaging (including recycling) in green development like large manufacturing enterprises. Therefore, it is of great significance to study the priorities of small and medium-sized manufacturing enterprises in western China in terms of various indicators of green development.

1.2 Questions of the Study

For small and medium-sized manufacturing enterprises in western China, green development is an inevitable transformation process. However, due to limited resources, they cannot fully promote the green process like large manufacturing enterprises. Therefore, the main issues studied in this study are as follows:

1.What factors affect the green development of small and medium-sized manufacturing enterprises?

2.How can small and medium-sized manufacturing enterprises improve their green development?

1.3 Objectives of the Study

This study aims to explore the connotation of green development in depth, and from the perspective of small and medium-sized manufacturing enterprises in western China, systematically sort out relevant literature, summarize the factors affecting the green development of small and medium-sized manufacturing enterprises, and provide suggestions for their promotion of green development. The specific research objectives include:

1.To explore the factors that affect the green development of small and medium-sized manufacturing enterprises;

2.To provide suggestions for the green development of small and medium-sized manufacturing enterprises.

1.4 Scope of the Study

This study primarily adopted the qualitative research method. From February to March 2024, interviews were conducted with 10 middle and senior managers of Guilin Shida company.

In addition, 61 relevant academic papers were reviewed using the content analysis method for secondary data analysis.This study took Guilin Shida Technology Company as a case study, and analyzed the influencing factors of green development of small and medium-sized manufacturing enterprises to understand the influencing factors at each stage of green development. The main scope of the study covered green manufacturing, green finance, green innovation, green supply chain, and green policy. Through in-depth analysis of the above five factors, this study constructed a green development system suitable for small and medium-sized manufacturing enterprises in western China, and provided suggestions for the green development of small and medium-sized manufacturing enterprises.

1.5 Significance of the Study

1.5.1 Theoretical Significance

Under the dual background of the country's active advocacy of the macro-policy requirements of the sustainable development strategy and the economic downturn in the industry, the development of new industrialization and green manufacturing is urgent. Small and medium-sized manufacturing enterprises actively explore green transformation and have become an inevitable choice for achieving sustainable development. This not only reflects the urgent need of enterprises for their own development, but also a positive response to the national sustainable development strategy. Therefore, the study of green transformation, especially the green transformation of small and medium-sized manufacturing enterprises, has far-reaching significance. At present, there have been a lot of relevant studies on the driving factors and effects of green transformation of enterprises at home and abroad. However, in the relevant research on green transformation, most scholars have relatively few studies on the driving factors and effects of green transformation of enterprises at the micro level. They basically focus on the discussion of the correlation between green transformation and enterprise effects at the macro level. The methods used are mostly empirical research, but there are relatively few studies on single cases, especially green transformation cases of small and medium-sized manufacturing enterprises. Therefore, through the case analysis of Guilin Shida Company, it can enrich the research in the field of green transformation of small and medium-sized manufacturing enterprises to a certain extent, provide more references for the green transformation of small and medium-sized manufacturing enterprises, and have certain theoretical significance.

1.5.2 Practical Significance

Governments around the world have made a series of major decisions and strategic

deployments aimed at accelerating the green transformation of development models, with the goal of promoting sustainable practices. These initiatives call for the encouragement of research and application of green and low-carbon technologies, the acceleration of technological innovation and its commercialization, and the provision of policy support and incentives to drive the green transformation of enterprises. Small and medium-sized manufacturing enterprises (SMEs), due to their high energy consumption, pollution, and emissions, face significant challenges. Therefore, these enterprises must actively embrace change, adapt to new development requirements and market demands, and turn the pressures they face into momentum for transformation. Implementing a green strategic transformation is an effective approach for SMEs to address issues related to high energy consumption, emissions, and pollution. Based on this, this study conducts a case study of Guilin Shida company to explore the process and outcomes of its green strategic transformation. The study aims to provide insights for other SMEs undergoing green transformations, while also offering feedback to policymakers on the effectiveness of green transformation initiatives, thus contributing to the adjustment of relevant policies. This research has practical significance.

1.6 Definition of Key Terms

1.6.1 Small and medium-sized manufacturing enterprises

"Small and medium-sized manufacturing enterprises" refer to relatively small manufacturing enterprises in a specific economic environment based on indicators such as enterprise scale, number of employees, operating income and total assets. Such enterprises usually have flexible production capabilities and strong market adaptability, but due to their relatively limited resources, capital and market share, they often face higher operating risks and financing difficulties.

1.6.2 Green Development

The concept of "green development" is derived from the green economy proposed by British environmental economist Pearce and others (Liu & He, 2020). Green development usually refers to a model that combines the ecological environment capacity and the carrying capacity of existing resources to promote sustainable development on the basis of maintaining ecological stability and protecting the natural environment. For example, in the process of high-quality development of the manufacturing industry, more advanced and more economical economic production methods can be adopted to achieve the reduction of pollution emissions in the manufacturing industry and the transformation and upgrading of the manufacturing industry structure.

1.6.3 Green Manufacturing Theory

"Green manufacturing theory" refers to the principle of systematically considering environmental protection and sustainable development in the manufacturing process and product life cycle. Green manufacturing is a manufacturing model with environmental protection and sustainable development as the core concept. Through innovative technology, management methods and production processes, it minimizes resource consumption and environmental impact while improving economic benefits and social value. Its core concept is to achieve the unity of economic benefits, social benefits and environmental benefits by optimizing the production process and product design.

Chapter 2 Literature Review

This chapter focuses on the theoretical basis of green manufacturing and recent research on the green development of small and medium-sized manufacturing enterprises. This study sorts out and analyzes relevant theories, explores the limitations of existing research, and provides a basis for determining the research area and formulating research objectives.

2.1 Research on Green Development at Home and Abroad

The proposal of the concept of green development has generally gone through three stages.

The first stage was from the middle of the last century to the 1990s. This stage was the budding stage of green development awareness, and people realized the importance of green development. On the one hand, the industrial revolution promoted the development of the world economy, but on the other hand, it also caused ecological problems such as environmental pollution to emerge in an endless stream. Countries around the world realized the limited self-purification capacity of the environment and reflected on the harm caused to the environment by rapid economic expansion. Green awareness was thus generated. Brown (1987) proposed that the world economy should develop in a sustainable direction, which can be achieved by protecting the environment, controlling the population and developing renewable resources. Holdgate (1995) found that in 1987, the World Commission would formulate a strategy to achieve sustainable development before the year 2000 (and continue after 2000), and proposed ways to improve international cooperation and national actions to deal with environmental problems and establish common environmental goals and aspirations in the international community. This stage mainly emphasizes the end-of-pipe treatment of environmental pollution.

The second stage was from the 1990s to 2008, during which people began to pay attention to the role of green development. During this stage, countries around the world faced a series of crises such as global warming, shortage of strategic resources, and the outbreak of the global financial crisis. The global spread of the concept of sustainable development and low-carbon technology set off a climax in the construction of green development systems in various countries from the two dimensions of values and technical routes. At the beginning of the second stage, a consensus on sustainable development was reached at the United Nations Conference on Environment and Development in 1992. The sustainable development model emphasizes the dominance of people to a certain extent and attempts to correct the way people control nature. With the changes in the global economic development model, the green economy, green governance and sustainable development of the green development model have become the global consensus at this stage. Porter & Linde (1995) studied the impact of corporate

environmental protection and found that corporate investment in the environment would increase corporate pressure in the short term and limit the speed of corporate development; but in the long run, companies can effectively respond to the pressure of national environmental policies, effectively control pollution through technological innovation and the use of advanced technical means, and enhance their competitiveness. Buysse & Verbeke (2003) from the perspective of stakeholders, through empirical analysis, believe that enterprises should adopt more proactive environmental strategies, take environmental issues into account in corporate business strategies, and promote green and sustainable development of enterprises. Stiglitz (2000) compiled that Western developed countries have successively promulgated the Energy Policy Act, the National Energy Comprehensive Strategy, the Organic Agricultural Products Production Act and other bills in this stage to promote the process of environmental governance. This stage emphasizes the source governance of the environment.

The third stage has been widely applied since 2008. Environmental pollution has become a global problem. It is a global consensus for enterprises to take the path of green development. It is an inevitable requirement to promote the steady progress of the global economy through green transformation of development mode. Foreign scholars have continuously emerged in the study of green development of enterprises, mostly focusing on the two aspects of green economy and sustainable development. Gong (2010) believed that "the era of pressure and rationing is inevitable" and needs to move towards green economy and seek sustainable energy policies in the future. Kirchoff et al. (2016) believed that the successful implementation of sustainable practices in corporate management needs to be viewed from the background level. They point out that by practicing green development methods, enterprises can help society and the environment, which helps to obtain sustainable investment and promote sustainable practices. Vargas-Hernández & Warner (2020) proposed that in view of the increasingly urgent need to permanently prevent global climate disasters, there is an urgent need to fully and successfully transition to a truly green economy at one time. Murali et al. (2019) used a mixed research method to study the level of implementation of green human resource management practices in the healthcare sector and found that the strategy has a positive impact on corporate sustainable performance. Kong et al. (2021) studied the relationship between corporate business strategy and green sustainable development in a top BSE journal and proposed improving environmental performance and promoting business practices. Abdullah et al. (2016) found that clean energy production, green innovation and green trade have positive contributions to green economic growth. This stage reflects the control of green development in the entire production

process.

2.2 Current Status of Green Development of Small and Medium-sized Manufacturing Enterprises

Foreign literature on the green development of SMEs mainly includes the characteristics and specific measures of policy promotion (Del et al., 2010). Enterprises may face various internal and external obstacles in the process of greening (Marin et al., 2015), including the constraints of legal norms and the requirements of pollution reduction (Henseler et al., 2016). In addition, research shows that the green development of SMEs is not only driven by laws and regulations (Murali et al., 2019), but also encounters problems such as willingness, capital, technology, management, manpower, policy support, stakeholders, market, and cooperative relationships in the process, which will also lead to problems such as supply chain management, brand reputation, competitiveness, and pollution prevention.

There are relatively few studies on the green development of small and medium-sized manufacturing enterprises in China. The main research is on the transformation and upgrading countermeasures of Chinese small and medium-sized enterprises under the conditions of a low-carbon economy. It points out that most of the products produced by small and medium-sized manufacturing enterprises are high-consumption and low-value-added products, which are at the low end of the technology chain and value chain and are difficult to meet the requirements of a low-carbon economy. Therefore, it is necessary to develop low-consumption green manufacturing technologies based on policy support and the premise of saving resources and protecting the environment (Zhang & Zhang, 2011). The second is to explore the obstacles to green innovation in small and medium-sized manufacturing enterprises through empirical research. The research shows that internal obstacles include technical, financial, management and human obstacles, while external obstacles include the market, lack of government support and poor external cooperation relations (Xie & Sun, 2021). Third, a logical deduction method is used to explore the multidimensional model of green international competitiveness of small and medium-sized manufacturing enterprises. The model includes three main construction dimensions: external competitiveness in the international market, endogenous competitiveness of enterprises, and supporting environmental protection competitiveness. At the same time, the study also pointed out that my country's small and medium-sized manufacturing enterprises have not gotten rid of the extensive growth mode, the product structure is mostly at the middle and low end of the value chain, the product quality standards are not in line with the international advanced level, the production process consumes a lot of resources, and lacks

strategic thinking for green development (Jie & Ning, 2021). Fourth, a game model is used to explore the evolution of pollution control strategies of small and medium-sized manufacturing enterprises from the perspective of "government market regulation and core enterprise green procurement". The study points out that local governments act on core enterprises through market regulation, and core enterprises use the dominant advantages of the supply chain to force small and medium-sized manufacturing enterprises to control pollution (He et al., 2022).

2.3 Green Manufacturing Theory

2.3.1 Connotation

Green manufacturing is a production method that focuses on reducing resource consumption, energy consumption and environmental pollution. Its core concept is to achieve the unity of economic benefits, social benefits and environmental benefits by optimizing the production process and product design (Wang et al., 2022). As global environmental problems become increasingly serious, people are calling for sustainable development. The traditional industrial production model has brought about problems such as resource waste and environmental pollution, forcing people to find more environmentally friendly and efficient production methods, and green manufacturing has emerged.

There are three main aspects of green manufacturing theory. First, in terms of process, the goal is to reduce environmental impact and resource consumption throughout the entire cycle from product design, manufacturing, packaging, use to scrapping (Liu et al., 2020). The green manufacturing theory system includes the "production degree" of "small manufacturing" and "large manufacturing", the "green degree" that describes the quality of the two target dimensions of resources and environment throughout the product life cycle, and the "coordination degree" that emphasizes economic benefits, social benefits and ecological benefits (Liu et al., 2021).

Faced with the general trend of high-end and green development of traditional industries, it is imperative for enterprises to implement green transformation. What factors drive enterprises to carry out green transformation during the transformation process have become a hot topic for discussion among scholars at home and abroad. In domestic and foreign literature, there has been a lot of research on the driving factors of corporate green transformation, mainly focusing on government regulation, corporate management decision-making, industrial structure changes, and industry competition. Faced with the complex changes in the internal and external environment and the multiple pressures of the urgency of transformation, enterprises will actively adopt green transformation strategies to enhance their core

competitiveness (Yang et al., 2022). With the gradual deepening of research, scholars have mostly conducted detailed explorations on the driving factors of corporate green transformation from the perspective of internal and external environment.

2.3.2 External Driving Factors

(1) Green Policy

Government promotion and environmental regulation are the main external driving factors for enterprises to carry out green transformation. The driving factors for enterprises to carry out green transformation are mainly government influence, supply and demand (Del et al., 2010). Some studies have also pointed out that the government is the guide of the green transformation of enterprises. By issuing environmental regulatory policies, it calls on enterprises to actively participate in environmental governance, thereby promoting the willingness of the manufacturing industry to transform green (Xiang et al., 2019). Government regulation is the main external factor driving the green transformation of enterprises. The formulation of green and low-carbon transformation policies by the state can bring certain positive declaration effects to green and low-carbon transformation enterprises. Enterprises can make full use of the effects brought by the policies and expand their market competitive advantages (Liu et al., 2021). Studies have shown that environmental regulation has a great effect on improving the green competitiveness of enterprises and can effectively drive the green transformation of enterprises (Lü et al., 2022). Through practice, an ideal green transformation model is constructed, and it is pointed out that the decline in environmental carrying capacity is the direct cause of the transformation of resource-based enterprises, and the government needs to formulate and implement relevant policies to strengthen its guiding and intervention role. Provide enterprises with more policy support and resource guarantees to promote the smooth progress of the green transformation of resource-based enterprises (Wang & Wang, 2021).

(2) Green Finance

Research shows that insufficient capital supply is usually the key reason why enterprises lack the motivation for green innovation (Chen & Ding, 2020). In response to the problem of "difficult and expensive financing" for enterprises, regulators have proposed that supply chain finance should be developed in a standardized manner, and banking financial institutions should be encouraged to provide credit support to small and medium-sized enterprises in the industrial chain through accounts receivable, bills, etc. In recent years, with the development of digital technology, supply chain finance has transformed from the initial offline "1+N" model to the online "N+1+N" model (Chen & Li, 2022). Based on the new generation of information technology, financial institutions can provide enterprises with online factoring, reverse factoring and other services through the supply chain financial platform, activate the dormant

and solidified accounts payable and credit idleness of high-quality enterprises, and maximize the satisfaction of the underlying supply chain financing needs.

(3) Green Supply Chain

As an innovative environmental management method, green supply chain management plays an important role in improving the greening level of corporate supply chains (Mao, 2022). From the perspective of low-carbon economy, it is believed that low-carbon economy and green supply chain management involve the coordination and cooperation of suppliers, manufacturers, logistics service providers, consumers and other parties (Guo & Yu, 2011). Starting from the connotation of supply chain management, the strategy for China's manufacturing enterprises to implement green supply chain management, the technical barriers caused by the traditional supply chain model (Lee & Raschke, 2023), the direct and indirect peer effects of green supply chain management in manufacturing enterprises, and the construction of a more targeted green supply chain management evaluation system based on the actual situation of the industry are proposed in three aspects to propose suggestions for green supply chain management in manufacturing enterprises (Ma & Zhu, 2022).

2.3.3 Internal Driving Factors

(1) Green Innovation

In terms of the choice of transformation path, technological innovation and development play an important role in promoting green transformation. In the transformation and upgrading of enterprises, technological innovation plays a key role (Marin et al., 2015). Studies have shown that enterprises need to continuously strengthen technological innovation and establish internal development mechanisms to cope with increasingly severe environmental challenges and enhance their competitiveness in the market (Moldavska & Welo, 2017). From the perspective of high-quality development, the path for state-owned enterprises to achieve green transformation is explored, including technological innovation, organizational innovation and industrial chain innovation (Qiu et al., 2020). Through case analysis, the key role of technological innovation and corporate culture in green transformation is explained, and the importance of both in promoting enterprises to move towards green development is emphasized (Wang & Wang, 2021). Green technological innovation is a development model of green transformation. Green innovation cannot achieve the optimal effect without external environmental regulation, while environmental tax incentives can greatly motivate enterprises to implement green technological innovation (Chen & Li, 2022) and achieve green transformation of enterprises. The transformation and upgrading of enterprises needs to rely on green technology and product innovation (Lin, 2021), and strategically integrate innovation into corporate development to highlight their social responsibility and national mission and achieve

the goal of sustainable development.

(2) Green Manufacturing

Internal factors such as resources, organization and technology of resource-based enterprises are key factors that determine their green transformation. Based on the research perspective of the resource-based view (Xie et al., 2019), research has found that an enterprise's own resources and capabilities have a significant impact on promoting its adoption of green strategies and successful green transformation (Gong, 2010). After clarifying the basic role of small and medium-sized enterprises in the development of circular economy, it was further identified that key resources such as corporate environmental strategy, capital, technology, and competency in the green transformation process of small and medium-sized enterprises are important driving forces for corporate transformation (Jiang & Feng, 2022). Resources are an indispensable cornerstone of corporate green development (Lin, 2021), and improving resource utilization efficiency is a key link in achieving green transformation, further highlighting the strategic position of resources and their effective utilization in green transformation. At the micro-enterprise level, resource elements are not only the basis for corporate strategic changes and green innovation, but also an important guarantee for promoting the smooth progress of corporate green transformation (Xie & Han, 2022). By integrating and optimizing the internal and external resources of the enterprise, it can provide continuous power and support for its green transformation, thereby achieving sustainable development goals.

2.4 Company Introduction

2.4.1 Introduction to Guilin Shida Company

This case study is about an electron beam irradiation equipment manufacturing company located in Guilin, Guangxi. It is a small and medium-sized high-tech enterprise and a high-energy-consuming enterprise. It is currently in the green development planning stage. The company was established on September 10, 2001 and is a private high-tech enterprise specializing in the production of vacuum electron beam welding machines and vacuum electron beam melting furnaces. Shida Company has more than 20 years of rich experience in the production of electron beam equipment. The various types of electron beam welding equipment it produces are widely used in China's aerospace, aviation, nuclear industry, automobile industry, instrumentation industry, electrical industry and other fields, and its products are exported to Southeast Asia. Guilin Shida company has widely absorbed foreign advanced technology and developed key technologies such as high-performance flip-top electron guns and accelerating voltage high-frequency inverter switching power supplies, making the THDW series electron

beam welding machine stand at the forefront of catching up with the international advanced level. There are currently 151 employees, including 26 managers, 90 production personnel, 30 technicians, and 5 financial personnel.

2.4.2 Driving factors of green development of Guilin Shida Company

(1) Increasing R&D Investment is the First Step towards Green Development

Electron beam irradiation is a cutting-edge technology in China and is mostly used for the manufacture of regulatory equipment or components. The key core technology is the manufacture of high-precision electron guns, so Guilin Shida company has become one of the few chain leaders in the supply chain. In the entire process of electron beam irradiation equipment, except for the electron guns and control equipment manufactured by the company itself, the remaining components are outsourced to cooperative suppliers according to order specifications, radiation protection and quality requirements. Therefore, the company can dominate the capabilities of other cooperative suppliers in the region. Although non-core components are completed by cooperative suppliers, because the electron beam irradiation equipment will generate at least 10MeV high-energy rays during operation, the outer shell metal (mainly zinc) must prevent the radiation from leaking, so the outer shell quality and protection parameters will be higher than the general requirements, and the remaining components such as automatic control shells, high-voltage cables, generators, etc. can be used at the same level as general equipment.

After actively understanding the dual carbon goals, Guilin Shida Company actively carried out green technology innovation. According to the data in its annual report, it increased its investment in research and development in 2024 and achieved a reduction in material costs through technological innovation (Table 2.1). Because the electron beam irradiation equipment is operated and debugged according to the application scenario or purpose after manufacturing, the core components of the electron beam irradiation (electron gun) consume a high amount of electricity during operation and debugging. Therefore, engineers will develop new technologies to reduce the energy consumption of the equipment, make improvements in the energy efficiency management of irradiation equipment, and introduce the latest high-efficiency accelerator equipment. These devices have a higher energy efficiency ratio and can reduce electricity consumption while maintaining the irradiation effect. In addition, the cooling system of the irradiation device has been upgraded, using more energy-saving cooling technology to reduce energy loss during equipment operation.

Table 2.1 Guilin Shida Company's R&D Expenses in 2024

Project	Amount of this period/yuan	Previous period amount/yuan
Employee Compensation	1,120,710.08	802,197.38
Material cost	819,719.48	1,142,213.18
Utilities	96,016.09	176,187.89
Depreciation	453,632.62	292,288.74
Other expenses	305,551.43	534,428.36
Total	2,795,629.70	2,947,315.55

Data Source: Company Annual Report

(2) The Lack of Green Finance has Led to Higher Corporate Costs

When promoting green manufacturing and environmental protection projects, the company needs a lot of financial support. Because there is no effective construction of green finance, Guilin Shida Company can only rely on traditional financing channels, such as contract liabilities and short-term loans, which become the main components of the company's current liabilities (Table 2.2), and the interest rates of these channels are usually high, which increases financial costs. Relying on short-term bank loans or high-interest credit loans has led to increased financial pressure in environmental protection technology upgrades, equipment introduction, etc. The interest rate of cash flows such as borrowing funds from other financial institutions is usually high. Especially for small and medium-sized manufacturing enterprises, the cost of short-term borrowing funds may be much higher than long-term green credit. Instead of bearing higher borrowing costs, green financial products with lower interest rates and more appropriate terms can help companies effectively control financial costs, but this is also the plan that Guilin Shida Company currently hopes to implement.

Table 2.2 Current Liabilities of Guilin Shida Company in 2024

Project	Notes	January-June 2024	January-June 2023
Current Liabilities:			
Short-term Loans		30,600,000.00	40,250,000.00
Borrowing from the Central Bank			

Borrowing Funds			
Trading Financial Liabilities			
Derivative Financial Liabilities			
Notes Payable			
Accounts payable			
Derivative Financial Liabilities			
Advance Payment			
Contract Liabilities		42,654,122.75	45,964,323.62
Selling and Repurchasing Financial Assets			
Deposits and Interbank Deposits			
Securities Trading Agency			
Securities Underwriting Agency			
Employee Wages Payable		1,265,197.45	3,208,010.70

Data Source: Company Annual Report

(3) Independent Research and Development to Achieve Green Transformation of Production

Guilin Shida Company not only considers reducing the use of toxic and hazardous materials in the design, development, production, sales, and recycling of electron beam irradiation equipment, but also requires cooperative suppliers to carry out eco-friendly design, reduce packaging materials, and use environmentally friendly materials instead, and provide green certification for related products. Traditional chemical modification processes usually produce a large amount of wastewater and waste gas, but through electron beam irradiation technology, materials can be modified efficiently without producing any harmful by-products. The successful case of green innovation is the green application in polymer material modification, which has helped its customers reduce production costs while also improving environmental protection.

Guilin Shida company focuses on the process of green innovation. According to the

“Notice of the General Office of the Ministry of Industry and Information Technology on the Cultivation of Specialized, Refined and New”Little Giant “Enterprises”, the company was listed in the fourth batch of specialized, refined and new “little giant” enterprises in Guangxi Zhuang Autonomous Region in 2022; according to Gui Gongxin Zhengfa No.427 “Regional Department of Industry and Information Technology on Issuing the First Batch of Guangxi Manufacturing Single Champion Enterprises” issued by the Department of Industry and Information Technology of Guangxi Zhuang Autonomous Region on December 6, 2021, it was listed in the first batch of Guangxi manufacturing single champion demonstration enterprises in 2021; according to the “Announcement on the Filing of the Second Batch of High-tech Enterprises Certified by the Guangxi Zhuang Autonomous Region Certification Agency in 2022” issued by the Office of the Leading Group for the Certification and Management of National High-tech Enterprises on January 9, 2023, it was included in the second batch of high-tech enterprises in the autonomous region in 2022. The filing list is valid for three years.

Guilin Shida Company's R&D model is mainly based on independent R&D, supplemented by cooperative R&D. The company conducts R&D activities based on its own technical reserves and industry development trends, mainly adopting an independent R&D model. The company has built a multi-departmental R&D system that adapts to its own business development, formulated systematic internal rules and regulations, clarified the division of labor, responsibilities and authority of personnel at each stage of the R&D process, and strictly controlled the key technology transformation process such as design plan, review, improvement and re-review. The company adopts a talent strategy that combines introduction and training, continuously improves the innovative talent guarantee system, and fully mobilizes the innovation enthusiasm of R&D personnel through innovative incentive mechanisms.

(4) Building a Green Supply Chain to Promote Green Development

In the process of promoting green supply chain, the biggest difficulties faced by Guilin Shida Company are mainly in two aspects: the uneven environmental awareness and capabilities of suppliers, and the cost pressure of green supply chain. These two challenges constitute a great obstacle to the establishment and maintenance of the entire green supply chain. It can also be found from the analysis of the company's annual report that its packaging costs still account for the main part of its supply chain costs (Table 2.3).

Guilin Shida Company has established a traceability mechanism for the production process to improve product production efficiency and quality. Based on the business characteristics of metal processing machinery and equipment such as electron beam welding machines, combined

with its own grasp of the terminal production process and quality control process of equipment such as electron beam welding machines, the company adopts the ETO production and manufacturing model. The ETO production and manufacturing model can be roughly divided into the following four stages: the initial stage of the project, the planning stage of the project, the execution stage of the project, and the end stage of the project. Each stage contains several tasks. The complexity of the product structure and process and the coarseness and fineness of production control can determine the number of tasks in the project. The company's ETO production and manufacturing model includes basic links such as project establishment, quotation, discussion, contract signing, design, planning, production, procurement, assembly, commissioning, delivery, accounting, and collection. All links are carried out around the "project contract" and belong to the project-based manufacturing model. The company sets quality control points throughout the production process and implements full-process quality control.

Table 2.3 Guilin Shida Company's Supply Chain Costs in 2024

Project	Amount of this Period	Previous Period Amount
Packaging Fee	186,599.03	265,757.55
Other	26,481.32	25,507.19
Total	213,080.35	291,264.74

Data Source: Company Annual Report

(5) External Policies can Drive Enterprises to Develop Green

Guilin Shida Company attaches great importance to national and local green policies and actively responds to these policy requirements. In particular, in recent years, the country has vigorously promoted green development and carbon neutrality strategies. The company has actively participated in the local government's green development plans and received a large amount of government subsidies (Table 2.4).

Therefore, the company has made corresponding strategic adjustments based on the characteristics of the industry and its own development needs to ensure that the company's sustainable development meets policy requirements. According to Guilin Shida Company's 2024 annual report, the company actively cooperated with the tax preferential policies and obtained the high-tech enterprise certificate with certificate number GR202245000505 on December 19, 2022, which is valid for three years. According to the second paragraph of Article 28 of the Enterprise Income Tax Law, the enterprise income tax shall be paid at a reduced rate of 15%. The subsidiary Guilin Sanyi Shida Machinery Processing Co., Ltd. has enjoyed the

small and micro enterprise income tax preferential policies since 2019 in accordance with the provisions of the “Announcement of the Ministry of Finance and the State Administration of Taxation on the Income Tax Preferential Policies for Small and Micro Enterprises and Individual Industrial and Commercial Households”.

Table 2.4 Details of Government Subsidies for Guilin Shida Company in 2024

Project	Amount of This Period/yuan	Previous period Amount/yuan	Asset-related/income-related
Technical transformation of vacuum electron beam welding machine manufacturing base	9,350.64	9,350.64	Asset related
Shida Electron Beam Manufacturing Base Expansion Project	25,000.02	25,000.02	Asset related
Shida Electron Beam Manufacturing Base Expansion Project	11,250.00	11,250.00	Asset related
Technical transformation of electron beam welding workshop	25,641.00	25,641.00	Asset related
Implementation of high-power and high-precision digital multi-mode scanning electron gun in metal powder bed additive manufacturing	389,610.36		Asset related
Electron beam 3D processing smart factory	55,144.74	55,144.74	Asset related
Advanced Manufacturing and Automation Gazelle Enterprise Cultivation Fund	28,242.12		Asset related
2022 Incentive Funds for Industrial Enterprises to Become Bigger and Stronger	270,000.00		Revenue related
Personal tax refund	2,701.30	14,788.04	Revenue related
Subsidy for recruiting college graduates	18,000.00		Revenue related
Guilin Market Supervision and Administration Bureau Intellectual Property Award	131,725.00		Revenue related

Job Stability Subsidy	3,000.00		Revenue related
Subsidies for “specialized, specialized and innovative” small and medium-sized enterprises	30,000.00		Revenue related
Tax relief	349,509.34		Revenue related
Employment Subsidy	2,000.00		Revenue related
Other	100,000.00	107,692.10	Revenue related
Total	1,046,449.52	653,591.54	

Data Source: Company Annual Report

2.5 Conceptual Framework

Based on the green manufacturing theory, this study analyzes the factors affecting the green development of China's small and medium-sized manufacturing enterprises from five aspects: green policy, green finance, green supply chain, green innovation and green manufacturing.

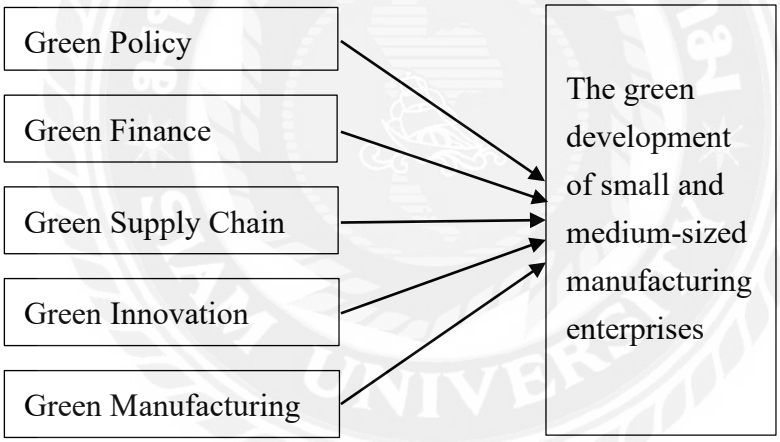

Figure 2.1 Theoretical Framework

Chapter 3 Research Methodology

3.1 Research Design

This study mainly adopted the qualitative research method, analyzed the factors affecting the green development of small and medium-sized manufacturing enterprises based on the green manufacturing theory, and selected Guilin Shida company for a case study.

This study obtained secondary data by reviewing a large amount of literature, sorted out literature on green manufacturing, green finance, green innovation, green supply chain, green

policy and explored the factors affecting the green development of small and medium-sized manufacturing enterprises.

3.2 Population and Sample

This study interviewed 10 experts, including the founder and other middle and senior managers of Guilin Shida company, and conducted face-to-face communication. Each interview lasted no less than 1 hour.

The inclusion criteria for semi-structured interview experts are as follows: 1) long-term research in the manufacturing industry, familiar with the manufacturing industry and green development process; 2) middle and senior management positions or with associate senior or senior professional titles; 3) more than 2 years of experience in research in the field of green manufacturing; 4) interested in the subject and actively cooperate in completing each round of expert questionnaire survey. This study included a total of 10 experts in green innovation.

3.3 Research Instrument

This study is based on the theory of green manufacturing, and the research tools mainly include semi-structured interviews.

Semi-structured interviews: In order to gain a deeper understanding of the key influencing factors of green development of small and medium-sized manufacturing enterprises in western China, this study used semi-structured interviews as the main data collection tool. Semi-structured interviews are flexible and allow researchers to adjust questions according to the actual situation of the interviewees while ensuring the focus of the interview topic.

The Delphi method was used to consult the middle and senior managers of Guilin Shida company. The Delphi method, also known as the expert survey method, is an important qualitative research method with advantages such as anonymity, iteration and controllable feedback (Chen & Li, 2022). First, 10 middle and senior management experts of the case companies were invited anonymously to conduct semi-structured interviews to obtain their opinions and suggestions on the green development factors of small and medium-sized manufacturing, and the opinions and suggestions were statistically summarized and integrated.

The interview questions were designed based on the five factors of the green manufacturing theory: green finance, green manufacturing, green innovation, green supply chain and green policy.

Table 3.1 Interview Outline

Serial Number	Influencing Factors	Question
1	Green Policy	Q1 How does the company respond to national and local green policies? Has the company adjusted its strategic planning to comply with relevant policy requirements?
		Q2 Does the company participate in or cooperate with the local government's green development projects or plans? What specific cooperation is there?
2	Green Finance	Q3 What are the specific practices of the company in green finance? Does it use green financial instruments for financing?
		Q4 Has green finance had an impact on the company's business strategy? If so, in what specific aspects?
3	Green Supply Chain	Q5 How does the company implement the concept of green development in supply chain management? Has it established a green cooperation mechanism with suppliers?
		Q6 What are the biggest difficulties that companies face in promoting green supply chains? How to overcome these difficulties?
4	Green Innovation	Q7 How does the company promote green development through technological innovation? Are there any successful cases in green innovation?
		Q8 What impact does green innovation have on the company's technology R&D direction and strategic planning?
5	Green Manufacturing	Q9 What practices does the company have in green manufacturing? Has it introduced any new energy-saving or environmentally friendly technologies or processes?
		Q10 Which major challenges did the company encounter in the process of promoting green manufacturing? How did you deal with them?

3.4 Data Collection

This study mainly used Internet channels and internal corporate data to obtain secondary data, and semi-structured interviews to obtain primary data.

Internet channel: Literature was collected using CNKI and websites, and secondary data were collected and sorted using a series of words such as “manufacturing enterprise”, “green development” and “factors” as keywords.

Internal corporate information: mainly includes company website information, archival information (the company's promotional videos, PPTs and internal publications), annual reports, social responsibility reports, internal publications and information obtained from on-site observations.

Semi-structured interview: The research focuses on the green development factors of Guilin Shida Company. The formal interview adopted a semi-structured method, and conducted face-to-face exchanges with the founders of the company and other middle and senior managers. Each interview lasted no less than 1 hour. A total of 10 experts in green innovation were included in this study. The interviews were recorded throughout, and transcribed and sorted in time after the interviews to ensure the authenticity and reliability of the data.

3.5 Data Analysis

Based on the green manufacturing theory, this study summarized the collected literature, extracted the core factors affecting the green development of small and medium-sized manufacturing enterprises, and summarized the theoretical framework. Then, the data of semi-structured interviews were analyzed to further explore the logical relationship between the five factors to ensure the accuracy and consistency of the research results.

Chapter 4 Findings and Discussion

4.1 Findings

Through in-depth interviews and analysis, this study reached the following four main findings.

4.1.1 Green Policies Affect the Green Development of Small and Medium-sized Manufacturing Enterprises

Green policies introduced by the government, such as pollutant emission standards and environmental tax incentives, have prompted Guilin Shida Company to gradually carry out green transformation.

Guilin Shida Company has been active in responding to national and local green policies, especially in the context of the carbon neutrality strategy. The company has adjusted its strategic planning through policy guidance and has enjoyed relevant tax incentives and government subsidies. According to the company's annual report, the company received a large number of government subsidies related to green development in 2024, such as the technological transformation of the vacuum electron beam welding machine manufacturing base and the electron beam 3D processing smart factory construction project. The company stated that these policies have a significant role in promoting the green development of enterprises and effectively reduce the financial pressure on enterprises in environmental protection investment.

Generally speaking, external policies have played a significant driving role in the green development of Guilin Shida Company, especially in terms of financial and policy support, which have provided a solid guarantee for the company's green transformation. This allows the company to be more flexible in adjusting its strategic direction when facing future green development challenges. However, the continuity and consistency of policies still need to be strengthened, and the company has certain uncertainties about future policy changes.

4.1.2 Green Finance Affects the Green Development of Small and Medium-sized Manufacturing Enterprises

Guilin Shida Company has limited practice in green finance and mainly relies on traditional financing channels, such as short-term bank loans and high-interest credit loans, which puts the company under great financial pressure in upgrading green technology and introducing equipment. Although the government and financial institutions provide certain green financial products, the green loan approval process for SMEs is cumbersome and the threshold is high, which makes it impossible for the company to fully utilize green financial

tools for transformation and upgrading. This shows that there is still room for improvement in green financial support for SMEs.

Guilin Shida Company's short-term loans have decreased, it still faces high capital costs, which hinders its further investment in green manufacturing.

If green financial support is obtained, the company's financial costs will be greatly reduced, especially in equipment transformation and environmental protection technology investment. Although the company currently plans to use green financial instruments for financing, the construction of green finance is not yet sound, resulting in relatively high capital costs in its green transformation.

4.1.3 Green Supply Chain Affects the Green Development of Small and Medium-sized Manufacturing Enterprises

Guilin Shida started late in building a green supply chain. Currently, it has only introduced some green procurement standards in the raw material procurement link, but still lacks systematic green management measures in the production and transportation links. Guilin Shida is still actively promoting the development of the green supply chain, especially in the production process of electron beam welding equipment. By setting up quality control points and introducing green procurement mechanisms, it has established a close green cooperation relationship with upstream and downstream companies. The ETO (engineering order production) model adopted by the company ensures that every link in the green production process meets environmental protection standards through refined management of each production link. Through this model, Guilin Shida not only improves production efficiency, but also ensures high-quality output of products.

However, the company still faces two major challenges in promoting green supply chain: first, the environmental awareness of suppliers varies, and second, the cost of green supply chain is high. These problems have hindered the comprehensive greening of the company's supply chain to a certain extent. The company needs to strengthen the implementation of green concepts in all links of the supply chain, especially to establish a closer green cooperation relationship with suppliers and partners to improve the environmental benefits of the overall supply chain.

4.1.4 Green Innovation Affects the Green Development of Small and Medium-sized Manufacturing Enterprises

Guilin Shida Company has taken an important step towards green development by increasing R&D investment and realizing independent R&D in the field of electron beam

irradiation technology. Due to the high -energy radiation requirements of electron beam irradiation equipment, the company has performed well in the manufacture of metal protection for the outer shell and high-precision electron guns, and has led the development of the capabilities of suppliers in the region.

In addition, Guilin Shida Company has implemented a number of energy-saving measures in green manufacturing. In particular, in the energy efficiency management of electron beam irradiation equipment, the power consumption has been reduced by introducing the latest high-efficiency accelerator equipment. The upgrade of the cooling system is also an important part of its technological innovation. These measures have greatly reduced the energy loss during the operation of the equipment. However, the company still faces challenges in technology research and development and application, such as the high cost of research and development of high-efficiency and energy-saving equipment, the lack of popularization of technological innovation, and the high demand for technical talents. Its R&D investment structure has undergone certain changes, and employee salaries and depreciation expenses have increased significantly, reflecting the company's efforts to attract high-tech talents and update equipment. Although the overall R&D expenses have decreased slightly, the investment in key technology research and development has remained stable, reflecting the company's emphasis on green technology innovation.

4.1.5 Green manufacturing Affects the Green Development of Small and Medium-sized Manufacturing Enterprises

In terms of green manufacturing, Guilin Shida Company has realized the importance of green manufacturing to the long-term development of the company and has made significant progress. The company has performed well in the green modification of polymer materials through electron beam irradiation technology, achieving green processing without harmful by-products. This not only improves customers' environmental protection level, but also reduces production costs. Introduce some environmentally friendly equipment and technologies into the production process, such as water recycling systems and energy-saving equipment.

The company's technology research and development model is mainly based on independent research and development, supplemented by cooperative research and development. It has built a multi-department collaborative research and development system and formulated a systematic research and development process. However, the company's technology application in green manufacturing is still in its early stages, and the existing equipment and technology are updated slowly, resulting in production efficiency and

environmental benefits failing to meet expectations.

4.2 Discussion

4.2.1 Green Policies Increase Corporate Revenue

Green policies have a positive impact on the revenue growth of the electron beam irradiation industry. Green policies issued by the national and local governments, such as environmental protection subsidies, tax exemptions and green financial support, encourage enterprises to adopt environmental protection technologies and promote the green transformation of Guilin Shida. As a green process with low pollution and low energy consumption, electron beam irradiation technology not only meets these policy requirements, but also reduces operating costs through policy dividends and obtains additional financial support. At the same time, green certification and policy support have also enhanced the market competitiveness and brand value of Guilin Shida, expanded its market share, and thus increased corporate revenue.

4.2.2 Green Finance Optimizes Capital Allocation

Green finance plays a key role in the green transformation of the electron beam irradiation industry. As an environmentally friendly and efficient processing method, electron beam irradiation technology meets the requirements of green manufacturing, but its equipment upgrades and technological innovations require a lot of financial support. Through green financial instruments, such as green credit and green bonds, Guilin Shida Company hopes to obtain funds at a lower financing cost and focus on the research and development and application of energy-saving and consumption-reducing technologies. The introduction of green finance has indeed optimized capital allocation, helping companies invest more resources in clean technology and environmental protection projects, and promoting the sustainable development and green transformation of the industry.

4.2.3 Green Supply Chain Promotes Sustainable Development of Enterprises

Guilin Shida Company's sales products are mainly concentrated in electron beam welding machines, and the proportion of electron beam welding machine revenue in the current operating income is 91.24%. Electron beam welding machines have high application costs and are mainly used in aerospace industry, nuclear energy industry, new materials, semiconductor industry, steel industry, automobile industry, shipbuilding industry and other manufacturing fields with high-quality welding requirements, as well as research and development fields of colleges and universities and research institutes. The company's subsequent business development will be affected by the development of these application fields. The company will

consolidate its traditional market advantages, dig deep into the application fields and customer resources of electron beam welding machines, and actively promote the application of other electron beam technologies, expand the product categories of electron beam technology applications and the upstream and downstream industrial chains.

4.2.4 Green Innovation is the Primary Productive Force

Guilin Shida Company is in a relatively niche field of electron beam technology-related welding and processing equipment. The company is a key enterprise in the industry and has a relatively stable market share. If the company cannot make full use of its own accumulated advantages, seize favorable opportunities, expand its talent team, improve product technology, optimize product structure, and expand its business scale, it may face increasing market competition risks. The company will face the risk of declining market competitiveness and market share in the field of electron beam-related welding and processing equipment. Therefore, the company will continue to focus on electron beam technology products, continue to serve leading companies in niche industries, and rely on technological innovation to lead the rapid development of enterprises. At the same time, the company will further strengthen technological research and development, independently develop more core technologies, and lay a technical foundation for the company to increase its market scale and industry status. In addition, the company continues to improve production technology, improve product quality and services, and accumulate more rich customer resources.

4.2.5 Green Manufacturing Promotes the Green Transformation of Enterprises

The core of green manufacturing is to improve resource utilization efficiency and reduce energy consumption. Guilin Shida Company's electron beam irradiation technology replaces traditional high-pollution, high-energy-consuming processes such as chemical disinfection and sterilization by using electron beam energy for processing. This not only reduces the use of harmful chemicals but also reduces waste emissions. For example, in the sterilization of medical devices, food packaging and plastic materials, electron beam irradiation can achieve fast, efficient and environmentally friendly processing, significantly reducing the company's carbon footprint.

By promoting electron beam irradiation technology, Guilin Shida company can reduce waste of raw materials, optimize energy use, achieve efficient allocation of resources, and reduce environmental impact. This green production method not only improves energy efficiency, but also reduces long-term production costs for enterprises.

Chapter 5 Conclusion and Recommendation

5.1 Conclusion

This study summarized the theoretical research on green manufacturing and clarified the connotation of green development, that is, a sustainable development model that integrates environmental protection, resource utilization, and economic development based on the carrying capacity of resources and the environment. Based on this, this study analyzed the how five factors, namely green finance, green manufacturing, green innovation, green supply chain, and green policy, affect the green development of small and medium-sized manufacturing enterprises. Semi-structured interview were conducted on the case of Guilin Shida company, and the following conclusions were drawn.

5.1.1 Green Policies have Emerged as a Significant Mechanism for Facilitating the Green Development of Enterprises

The green policies of the national and local governments have played an important role in guiding and promoting the green development of enterprises. The policies have reduced the cost pressure of enterprises in promoting green development and promoted green production and technological innovation of enterprises by providing incentives such as financial subsidies, tax exemptions and green industrial policies. However, some small and medium-sized enterprises have limited understanding and adaptability to the policies, resulting in poor policy implementation. Guilin Shida Company can better grasp green market opportunities and obtain more policy dividends by actively responding to and implementing green policies.

5.1.2 Green Finance is a Key Resource Allocation for the Green Development of Enterprises

Green finance plays a key role in resource allocation in the greening process of small and medium-sized manufacturing enterprises. By obtaining financial support such as green credit and green bonds, enterprises have reduced the financing costs of green technology innovation and green production projects, and improved the feasibility and effectiveness of green investment. However, as the green financial system is not yet fully mature, some enterprises find it difficult to obtain sufficient green financial support, which limits the depth and breadth of their green transformation.

5.1.3 Green Supply Chain plays an Important Role in the Green Development of Enterprises

Green supply chain management plays an important role in the green transformation of enterprises. By implementing green procurement, optimizing logistics and transportation, and

reducing waste emissions, small and medium-sized manufacturing enterprises can effectively improve resource utilization efficiency and reduce the overall environmental impact of the supply chain. At the same time, the construction of a green supply chain can promote collaborative innovation among upstream and downstream enterprises and promote the green transformation of the entire industrial chain. However, since the construction of a green supply chain involves multi-party coordination and inconsistent technical standards, small and medium-sized manufacturing enterprises face great challenges in integrating green supply chain resources.

5.1.4 Green Innovation is the Driving Force for Promoting Green Development of Enterprises

Green innovation is the driving force for the green development of enterprises. By developing and introducing new environmental protection technologies, small and medium-sized manufacturing enterprises can not only improve production efficiency, but also reduce the generation and emission of pollutants, achieving a win-win situation of economic and environmental benefits. Case studies show that enterprises with strong innovation capabilities often perform well in green transformation and can improve their market competitiveness through technological advantages. However, the lack of innovation resources and the limited incentives of innovation policies are still the main obstacles to green innovation of small and medium-sized enterprises.

5.1.5 Green Manufacturing is the Core Path for Enterprises to Achieve Green Development

Green manufacturing is the core path for enterprises to achieve environmentally friendly production methods. Small and medium-sized manufacturing enterprises reduce energy consumption and pollutant emissions in the production process by adopting clean production technologies and energy-saving and consumption-reducing measures, and promote the greening of production processes. However, in the process of promoting green manufacturing, enterprises face challenges such as high technology costs and great pressure on equipment renewal, especially for small and medium-sized enterprises that lack technological innovation capabilities and efficient resource integration mechanisms. The promotion of green manufacturing is relatively slow.

5.2 Recommendation

5.2.1 Drive Green Development with Green Policies

Small and medium-sized manufacturing enterprises should actively use green policies to

achieve green development. First, they should deeply understand and utilize various green incentives provided by national and local governments, such as financial subsidies and tax incentives, to reduce the economic burden of introducing green technologies and transforming. At the same time, enterprises should strive to obtain relevant green certifications to enhance brand value and market competitiveness through certification. In addition, it is recommended that enterprises strengthen the research and development of environmental protection technologies, use government special funds to support technological innovation, and improve resource utilization efficiency and environmental friendliness of the production process. At the same time, enterprises should cooperate with upstream and downstream supply chains to promote overall greening and ensure the effective implementation of policies in practice. Through these measures, small and medium-sized manufacturing enterprises can better adapt to the green policy environment and achieve sustainable development goals.

5.2.2 Improve the Support System for Green Finance Construction

A reasonable green financial system can provide financial support and policy benefits for the green transformation of enterprises. Through the investment and allocation of special funds, it can help small and medium-sized manufacturing enterprises reduce the cost of green technology application and innovation and improve green production capacity. The government's strict management of green projects and the evaluation of implementation effects enable small and medium-sized manufacturing enterprises to obtain more efficient resource allocation and improve the benefits of green development projects. At the same time, it is necessary to strengthen supervision and management during the budget execution process to ensure that the use of funds is transparent and effective. In order to maximize the benefits of the use of funds, the government should strictly manage and evaluate the implementation effects of green development projects. In addition, the PPP model (government and social capital cooperation) can be promoted to attract social capital to participate in the construction and operation of public utilities.

5.2.3 Build a Green Supply Chain to Achieve Green Transformation

Small and medium-sized manufacturing enterprises should achieve green development by building and optimizing green supply chains. First, they should actively establish close ties with upstream and downstream partners in the supply chain, jointly implement green procurement and environmental protection standards, and ensure that all links from raw material procurement to product delivery meet environmental protection requirements. At the same time, enterprises should encourage suppliers to adopt clean production technologies to reduce

resource consumption and environmental impact in their production processes, thereby improving the sustainability of the entire supply chain. In addition, it is recommended that small and medium-sized manufacturing enterprises establish a green performance evaluation mechanism and regularly monitor the environmental performance of the supply chain to identify improvement opportunities and strengthen green practices. Through these measures, small and medium-sized manufacturing enterprises can effectively integrate resources, achieve a win-win situation of economic and environmental benefits, and promote overall green transformation.

5.2.4 Develop Green Innovation to Achieve Sustainable Development

Green innovation is the core driving force for small and medium-sized manufacturing enterprises to achieve sustainable development. At the same time, as a key driving force for enterprise technology upgrading and product research and development, green innovation can prompt small and medium-sized manufacturing enterprises to continuously innovate in process flow, product design and management mode, and form differentiated competitive advantages. Green innovation not only promotes the improvement of enterprise technology level, but also promotes the accumulation of knowledge and capacity building of enterprises in the field of green development, thereby enhancing the long-term competitiveness of enterprises. The process of improving green innovation capabilities is the process of transitioning the green innovation practice of enterprises from “light green” to “dark green”. Therefore, enterprises can optimize the strategic combination, resource combination and capability combination of green innovation, integrate the use of clean production technology innovation and end-of-pipe treatment technology innovation, adopt circular production and remanufacturing technology, and increase the proportion of green product innovation.

5.2.5 Promote Green Manufacturing Transformation and Reduce Energy Consumption

Small and medium-sized manufacturing enterprises should implement green manufacturing strategies to achieve green development. First, they should actively introduce clean production technologies and environmentally friendly processes to reduce energy consumption and pollutant emissions and ensure the sustainability of the production process. At the same time, enterprises should strengthen employees' environmental awareness and training, and promote all employees to participate in green manufacturing practices to form a good corporate culture. In addition, it is recommended that enterprises establish a green management system to improve resource utilization efficiency and reduce operating costs by implementing resource recycling and waste reduction measures. Through these comprehensive

measures, small and medium-sized manufacturing enterprises can not only enhance their market competitiveness, but also establish a good corporate image in the field of environmental protection, thereby achieving the dual goals of economic and environmental benefits.

5.3 Further Study

The advancement of pertinent research on small and medium-sized manufacturing enterprises may be initiated from the following perspectives. First, select specific enterprise supply chains, analyze the spatial layout of small and medium-sized manufacturing enterprises in different links, and formulate cross-regional supply chain collaborative development plans and policy measures. Second, deeply analyze the key points and difficulties of ecological construction of small and medium-sized manufacturing enterprises in the process of green development, clarify the direction of innovation, and promote the integration of enterprise development and ecological construction. Third, design a cross-regional coordination and cooperation mechanism, and put forward specific suggestions on the division of functions, division of responsibilities, distribution of benefits and coordination of relationships, so as to promote the collaborative cooperation and green transformation and upgrading of small and medium-sized manufacturing enterprises.

References

Abdullah, M., Zailani, S., Iranmanesh, M., & Jayaraman, K. (2016). Barriers to green innovation initiatives among manufacturers: The Malaysian case. *Review of Managerial Science*, *10*(4), 683-709.

Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. (1987). Global sustainability: Toward definition. *Environmental Management*, 11, 713-719.

Buysse, K., & Verbeke, A. (2003). Proactive environmental strategies: A stakeholder management perspective. *Strategic Management Journal*, *24*(5), 453-470.

Cao, H., Li, H., Zeng, D., & Ge, W. (2020). Research status and future strategies of green manufacturing. *China Mechanical Engineering*, *31*(02), 135-144.

Chen, H., & Ding, X. (2020). Political economy analysis of the mechanism of green manufacturing. *Contemporary Economic Research*, (07), 15-26.

Chen, K. S., & Yang, C. M. (2019). Quality capability assessment for thin-film chip resistor. *IEEE Access*, *7*(1), 92511–92516.

Chen, S., & Li, X. (2022). Mechanism of digital economy driving the green development of manufacturing. *Enterprise Economy*, 12, 140-150.

Del Río, P., Carrillo-Hermosilla, J., & Könnöl, T. (2010). Policy strategies to promote eco-innovation: An integrated framework. *Journal of Industrial Ecology*, *14*(4), 541-557.

Deng, Z., & Huang, Q. (2021). Research on pollution issues caused by manufacturing agglomeration in western China from the perspective of high-quality development. *Inquiry into Economic Issues*, (05), 74-83.

Driessen, P. H., Hillebrand, B., Kok, R., & Verhallen, T. (2013). Green new product development: The pivotal role of product greenness. *IEEE*, *60*(2), 315-326.

Duffle, N. (1998). Trends in green manufacturing. CASA/SME Technology Trends [EB/OL]. [2019-12-11].

Gong, Z. (2010). Research on economic evaluation methods of quality improvement for small and medium-sized manufacturing enterprises. *Industrial Engineering*, *13*(06), 6-9+17.

Guo, R., & Yu, Y. (2011). Regional differences in technological systems of innovation investment in small and medium-sized enterprises: A case study of China's manufacturing SMEs. *Science of Science and Management of Science and Technology*, *32*(06), 65-71.

Holdgate, M. W. (1995). Pathways to sustaina: The Evolving Role of Transnational Institutions. *Environment: Science and Policy for Sustainable Development*, *37*(9), 16-42.

He, Q., Tang, J., & Luo, X. (2022). Evolution of pollution control strategies for small and medium-sized manufacturing enterprises from the perspective of "government regulation + green procurement by core enterprises." *Operations Research and Management*, 1-8. [Published online].

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: Updated guidelines. *Industrial Management & Data Systems*, *116*(1), 2-20.

Jiang, Y., & Feng, T. (2022). Green supply chain integration: A literature review and future prospects. *Foreign Economics & Management*, *44*(06), 135-152.

Jie, X., & Ning, S. (2021). Multidimensional model of green international competitiveness of China's small and medium-sized manufacturing enterprises under the "dual circulation" background. *Enterprise Economy*, *40*(10), 14-23.

Ke, L., & Lin, B. (2016). Impact of energy conservation policies on the green productivity in China's manufacturing sector: Evidence from a three-stage DEA model. *Applied Energy*, 168, 351–363.

Keynes, J. M. (1936). *The General Theory of Employment, Interest, and Money*. Macmillan.

Kirchoff, J. F., Tate, W. L., & Mollenkopf, D. A. (2016). The impact of strategic organizational orientations on green supply chain management and firm performance. *International Journal of Physical Distribution & Logistics Management*, *46*(3), 269-292.

Kong, T., Feng, T. W., & Huo, B. F. (2021). Green supply chain integration and financial performance: A social contagion and information sharing perspective. *Business Strategy and the Environment*, *30*(5), 2255-2270.

Lee, M. T., & Raschke, R. L. (2023). Stakeholder legitimacy in firm greening and financial performance: What about greenwashing temptations? *Journal of Business Research*, 155, 113393.

Li, J. (2022). Development status and future paths of green and intelligent manufacturing in China. *Research on Economics and Management*, *43*(06), 3-12.

Lin, Z. (2021). Research on green manufacturing strategy of the supply chain considering output uncertainty. *Soft Science*, *35*(03), 123-128+144.

Liu, F., Cao, H., & He, N. (2020). Research status and development trend of green manufacturing. *China Mechanical Engineering*, (Z1), 114-119+5.

Liu, J., Wang, Y., & Chen, K. (2021). Green manufacturing partner selection based on the CRITIC algorithm. *Tool Engineering*, *55*(02), 43-47.

Liu, P., Liu, F., Wang, X., Yin, Z., Cao, H., & Li, C. (2021). Theoretical and technical system and new framework of green manufacturing. *Journal of Mechanical Engineering*, *57*(19), 165-179.

Lü, Y., Tian, J., & Chen, L. (2020). Promoting green development of industrial parks in China to realize industrial ecology: Practices and insights. *China Environmental Management*, *12*(03), 85-89.

Lü, Z., Sun, H., Lü, Z., Chen, C., & Jiang, B. (2022). Exploring the green manufacturing path of the synthetic leather industry. *Leather Science and Engineering*, *32*(05), 35-39.

Ma, D., & Zhu, Q. (2022). Innovation in emerging economies: Research on the digital economy driving high-quality green development. *Journal of Business Research*, 145, 801-813.

Maiti, M., & Phillips, F. (2022). Does development in venture capital investments influence green growth? *Technological Forecasting and Social Change*, 182, 121878.

Mao, T. (2022). Pilot of green supply chain management and its improvement in China—An analysis from the perspective of carbon peaking and carbon neutrality. *Environmental Protection*, *50*(Z1), 31-34.

Mao, Y., & Wang, J. (2019). Integration of corporate social responsibility, stakeholder management, and green product innovation: A case study of Robam Appliances. *Management Review*, *31*(07), 149-161.

Mao, Z., & Wu, Y. (2019). Distribution pattern, formation factors, and development paths of manufacturing in western China. *Quantitative & Technical Economics*, *36*(03), 3-19.

Marin, G., Marzucchi, A., & Zoboli, R. (2015). SMEs and barriers to eco-innovation in the EU: Exploring different firm profiles. *Journal of Evolutionary Economics*, *25*(3), 671-705.

Melngk, S. A., & Smith, R. T. (1996). *Green manufacturing*. Society of Manufacturing Engineers.

Moldavska, A., & Welo, T. (2017). The concept of sustainable manufacturing and its definitions: A content-analysis-based literature review. *Journal of Cleaner Production*, 166, 744-755.

Murali, K., Lim, M. K., & Petruzzi, N. C. (2019). The effects of ecolabels and environmental regulation on green product development. *Manufacturing & Service Operations Management*, *21*(3), 519-535.

Porter, M. E., & Linde, C. V. D. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, *9*(4), 97-118.

Pu, L., & Shen, X. (2009). Analysis of the cost dilemma of small and medium-sized enterprises in western China. *Science and Technology Management Research*, *29*(07), 92-94.

Qiu, L., Hu, D., & Wang, Y. (2020). How do firms achieve sustainability through green innovation under external pressures of environmental regulation and market turbulence? *Business Strategy and the Environment*, *29*(6), 2695-2714.

Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. W. Strahan and T. Cadell.

Stiglitz, J. E. (2000). *Economics of the Public Sector*. W.W. Norton & Company.

Tiwari, S., Ahmed, W., & Sarkar, B. (2018). Multi-item sustainable green production system under trade-credit and partial backordering. *Journal of Cleaner Production*, 204, 82–95.

Vargas-Hernández, J. G., & Warner, I. (2020). Necessary prerequisites for successful green economic transition and subsequent green development: An exploratory analysis and appraisal. *International Journal of Public and Private Perspectives on Healthcare, Culture, and the Environment (IJPPPHCE)*, *4*(2), 25-49.

Wang, M., & Ye, C. (2020). Research on the evaluation of regional industrial green manufacturing level based on entropy-weighted TOPSIS. *Science and Technology Management Research*, *40*(17), 53-60.

Wang, X., & Wang, M. (2021). Problems and development paths of green manufacturing in China. *Low Carbon World*, *11*(08), 21-22.

Wang, X., Zhang, C., Sun, Y., & Tian, J. (2022). Application practice of green manufacturing technology in Hebei Iron and Steel Tangshan New Area. *Environmental Engineering*, *40*(07), 179-185.

Wei, S., Cheng, D., Sundin, E., & Tang, O. (2015). Motives and barriers of the remanufacturing industry in China. *Journal of Cleaner Production*, 94, 340–351.

Xiang, F., Huang, Y., Zhang, Z., Jiang, G., Zuo, Y., & Tao, F. (2019). New product lifecycle green manufacturing model based on digital twins. *Computer Integrated Manufacturing Systems*, *25*(06), 1505-1514.

Xie, X., & Han, Y. (2022). How local manufacturing enterprises achieve a “gorgeous transformation” in green innovation: A multi-case study based on the attention-based view. *Management World*, *38*(03), 76 -106.

Xie, X., & Sun, J. (2021). An empirical study on the obstacles to green innovation in small and medium-sized manufacturing enterprises. *Science and Technology Management Research*, *41*(18), 214-219.

Xie, X., Luo, D., & Gao, Y. (2019). An empirical study on the collaborative mechanism of supply chain enterprises based on green innovation. *Journal of Industrial Engineering and Engineering Management*, *33*(03), 116-124.

Yan, S., Almandoz, J. J., & Ferraro, F. (2021). The impact of logic (in)compatibility: Green investing, state policy, and corporate environmental performance. *Administrative Science Quarterly*, *66*(4), 903–944.

Yang, C. M., Chen, K. S., & Hsu, C. H. (2019). Developing a multi-quality characteristic analysis model to measure the quality of quick-release bicycle hubs. *Journal of the Chinese Institute of Engineers*, *42*(4), 309–318.

Yang, H., Li, L., & Liu, Y. (2022). The effect of manufacturing intelligence on green innovation performance in China. *Technological Forecasting and Social Change*, 178, 121569.

Zhou, M., Pan, Y., Chen, Z., & Yang, W. (2013). Optimizing green production strategies: An integrated approach. *Computers & Industrial Engineering*, *65*(3), 517-528.

Zhang, C., Zhou, B., & Tian, X. (2022). Political connections and green innovation: The role of a corporate entrepreneurship strategy in state-owned enterprises. *Journal of Business Research*, 146, 375-384.

Zhang, M., & Zhang, Q. (2011). Transformation and upgrading of China's small and medium-sized enterprises under the low-carbon economy. *Ecological Economy*, (04), 92-94+101.

Zhang, Q. S., Pan, J. Y., Xu, D. H., & Feng, T. W. (2020). Balancing coercive and non-coercive powers to enhance green supplier integration: Do relationship commitment and closeness matter? *Supply Chain Management: An International Journal*, *25*(6), 637-653.

Zhang, X., Ming, X., Liu, Z., Qu, Y., & Yin, D. (2019). General reference model and overall frameworks for green manufacturing. *Journal of Cleaner Production*, 227, 117757.

Appendix

Interview outline on factors affecting the green development of Guilin Shida company.

Serial Number	Influencing Factors	Question
1	Green Policy	Q1 How does the company respond to national and local green policies? Has the company adjusted its strategic planning to comply with relevant policy requirements?
		Q2 Does the company participate in or cooperate with the local government's green development projects or plans? What specific cooperation is there?
2	Green Finance	Q3 What are the specific practices of the company in green finance? Does it use green financial instruments for financing?
		Q4 Has green finance had an impact on the company's business strategy? If so, in what specific aspects?
3	Green Supply Chain	Q5 How does the company implement the concept of green development in supply chain management? Has it established a green cooperation mechanism with suppliers?
		Q6 What are the biggest difficulties that companies face in promoting green supply chains? How to overcome these difficulties?
4	Green Innovation	Q7 How does the company promote green development through technological innovation? Are there any successful cases in green innovation?
		Q8 What impact does green innovation have on the company's technology R&D direction and strategic planning?
5	Green Manufacturing	Q9 What practices does the company have in green manufacturing? Has it introduced any new energy-saving or environmentally friendly technologies or processes?
		Q10 Which major challenges did the company encounter in the process of promoting green manufacturing? How did you deal with them?