

Challenges of Environmental Business Practices: A Proposed Sustainable Green Industrial Development Model for Manufacturing Enterprises in Guangdong Province, China

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Abstract: Grounded in Institutional Theory, Resource-Based View (RBV), and Diffusion of Innovation Theory, the study examines how SMEs navigate resource constraints, supply chain management, regulatory frameworks, and awareness gaps in pursuing sustainable green development. The research utilizes a quantitative-descriptive approach with a causal-comparative research design and employs purposive sampling to select 303 SME owners from Guangdong Province, China. Data were collected through a structured survey focusing on business practices like energy-efficient technologies, waste minimization, partnering with environmentally responsible suppliers, water-saving technologies, integrating environmental considerations into product designs, and renewable energy investment and implementing an Environmental Management System (EMS). Findings reveal that SMEs recognize the importance of environmental practices, and they face less challenges in resource allocation, awareness, supply chain management and regulatory landscape.

Keywords: Sustainable development, Environmental business practices, Small and medium enterprises (SMEs), Guangdong Province.

1. Introduction

1.1. Background of the Study

The urgency of addressing environmental issues and fostering sustainable business practices has become a global necessity. With the adverse effects of climate change becoming increasingly evident, there is a growing consensus that businesses must play a pivotal role in mitigating environmental impact. Governments, international organizations, and consumers are demanding more responsible and sustainable approaches from businesses across all sectors.

In 2020, with the impact of the global epidemic and the turmoil of the situation, the world is undergoing a prolonged Paradigm Shift, shifting from the old paradigm to the new paradigm. No one knows what the new paradigm will be like, but China's proposed 2035 long-term plan has a clearer understanding of the importance of green development in the future development process. China has become one of the countries with the fastest reduction in global energy consumption intensity.

China's economy is undergoing an important period of transformation from rapid growth to high-quality development. Although environmental development has achieved certain results, the efficiency of the green economy is lower than that of the traditional economy. Further, according to Zhou et al. (2020), significant obstacles are contributing to environmental carrying capacity and the traditional manufacturing sector contributes to a growing amount of major industrial pollution.

In today's world, sustainable development is no longer just a lofty goal on the shelf but a mandatory thing that businesses do as good practices. This technology-based turnaround works best for SMEs, which drive their economies and have

the greatest environmental effect. While the rest of the world is being bombarded by erratic weather and the unfeasible waste accumulation, sustainability is becoming top of the list for companies.

Regardless of size, SMEs are vital to economic development, innovation, and job creation. In view of the fact that they have a critical role to play, it is not only crucial but also captivating to study how these enterprises are incorporating sustainable practices in their activities. SMEs have some peculiar traits that can be harnessed for sustainable development, e.g., flexibility, adaptability, and innovation potential.

Guangdong Province, referred to as the "Factory of the World", is an embodiment of fast industrialization and economic development. Apart from other qualities, the Guangdong Province located in southern China is noted for having a diverse and distinctly dynamic manufacturing sector and for having strong trade ties with various countries. With economic success comes environmental issues, including air and water pollution, deforestation, and resource depletion.

Implementing sustainable practices that are environmentally friendly is not free of difficulties, especially for SMEs. The major challenges are financial constraints, lack of awareness, and preconceived ideas that sustainability initiatives are too expensive. Grasping the meaning of these obstacles is key to creating tailor-made strategies that help SMEs in successfully maneuvering their barriers to sustainability.

Thorough examination of the existing literature disentangles the absence of sufficient deep study of the main difficulties that may arise in the process of forming green industrial development models, which specifically relate to SMEs in this region. This research focused principally on macro-level studies; thus, the details and particularities of SMEs' sustainability issues were hardly considered in the

sector of innovation and enlargement. Barriers determined by financial drawbacks and technological restraints to the absence of rigorous frameworks of rules, therefore, remain unexplored to a great extent as to how these factors might hinder the integration of green practices by small size enterprises in the Guangdong province.

This study explored the SMEs in Guangdong that employ eco-friendly methods in business operations, examining the obstacles of green industrial transformation. It intended to offer a green growth model to the small and medium companies, enabling them to thrive and be sustainable. Additionally, the proposed framework is anticipated to serve as a blueprint for SMEs globally, fostering a shift towards sustainability and demonstrating the feasibility of integrating environmental consciousness into business strategies. The researcher expects that this extensive assessment would enrich the global conversation on sustainable development and promote grassroots change.

1.2. Statement of the Problem

(1) How effective are the environmental business practices of manufacturing enterprises in terms of:

- 1.1 Energy efficient technologies and practices;
- 1.2 Waste minimization strategies and recycling;
- 1.3 Partnering with environmentally responsible suppliers;
- 1.4 Water-saving technologies and practices;
- 1.5 Integrating environmental considerations into product design;
- 1.6 Investment in renewable energy sources; and
- 1.7 Implementing Environmental Management System (EMS)?

(2) What are the challenges of the environmental business practices in terms of:

- 2.1 Resource allocation;
- 2.2 Awareness and education;
- 2.3 Supply chain management; and
- 2.4 Regulatory landscape?

(3) How will the challenges impact the environmental business practices in terms of:

- 3.1 Resource allocation;
- 3.2 Awareness and education;
- 3.3 Supply chain management; and
- 3.4 Regulatory landscape?

(4) Based on the study's results, what sustainable green development model can be proposed?

1.3. Hypotheses

H₀₁ There is no significant impact of the challenges to environmental business practices in terms of resource allocation, awareness and education, supply chain management, and regulatory landscape.

1.4. Scope and Limitations

This study explored the challenges for sustainable industrial green development by examining the environmentally conscious business practices of SMEs in Guangdong Province. This study designed an industrial green development model to assist SMEs expand sustainably.

The scope of this study is manifested in the following aspects:

The Guangdong Province in China, which is well-known for its thriving industrial sector and substantial economic output, is the subject of the study. The research can offer focused insights and recommendations suited to the

circumstances of SMEs operating in Guangdong Province by focusing its coverage on this area.

The research focused on SMEs' businesses in the manufacturing industry. Due to the fact that Guangdong Province has a plethora of manufacturing industries, particularly in electronics, textiles, and machineries, a detailed study on the pros and cons for the SMEs in this sector is likely to supply some valuable knowledge for ecological change initiatives.

The study's shortcomings were visible in multiple ways including:

The first is that Guangdong Province is one of the provinces in China that controls the Pearl River Delta, the eastern, western, and northern regions of Guangdong. The economic level, ecological environment, and policy environment of different regions vary. Therefore, the degree of green industrial development in these regions may vary, thereby affecting the universality of research results. The study's conclusions might not immediately be applied to SMEs in other areas or sectors of the economy outside the Guangdong Province. The suggested model's generalizability may be limited by variables like the regulatory environment, market dynamics, and resource availability that change depending on the situation.

Secondly, in terms of selecting variables for green industrial development, there is currently no unified standard recommended internationally or domestically. Different scholars choose different variables, and their criteria for judging green development are different. This study selected inter-provincial statistical data from the Guangdong Provincial Bureau of Statistics. Therefore, the deviation from the judgment criteria may have an impact on the research results.

Thirdly, considering the availability of data related to green industrial development in Guangdong Province, this study selected enterprises that have developed green industries in Guangdong Province from 2015 to 2022, particularly small and medium businesses from the manufacturing sector as the initial research sample. The selection of samples only included data from eight (8) consecutive years, and the research time range was too short to fully confirm the long-term impact of challenges and opportunities in the adopted environmentally conscious business practices to sustainable green industrial development using factors such as resource efficiency, pollution control, and safe chemical management of small and medium businesses in the manufacturing industry in Guangdong Province, China.

The study's availability of data, especially from SMEs, may also be a constraint. It may be difficult for SMEs, particularly the smaller ones, to provide detailed information on their organizational performance, environmental policies, and other pertinent factors. This restriction could have an impact on the analysis's precision and depth. Furthermore, a significant amount of time, money, and experience were needed to do a thorough study on sustainable development and environmentally friendly company practices. Due to the study's scope, access to funds, time, and data collection instruments may be limited, which could influence the study's thoroughness. Likewise, the fields of environmental management and sustainability are always changing, with new laws, innovations, and best practices appearing throughout time. Because of this, the study's conclusions and suggestions could be out of date rather rapidly, requiring constant observation and modification to stay up to date with

the most recent advancements.

1.5. Definition of Terms

Awareness and education. This is the knowledge and understanding of sustainable business practices.

Energy-efficient technologies and practices. These refer to the various methods, tools, and practices that are developed to reduce energy consumption while at the same time allowing for continuous improvement in performance and productivity to be achieved.

Green industrial development. It envisions a future in which industrial sectors use renewable energy sources and reduce waste in all its forms. resources as fuels and inputs, and take all reasonable precautions to prevent damage to the environment, communities, workers, or the climate.

Implementing an Environmental Management System (EMS). This involves establishing a structured framework for managing and improving an organization's environmental performance.

Integrating environmental considerations into product design. This means incorporating sustainability principles to minimize environmental impact throughout the product's life cycle.

Investment in renewable energy sources. This is the process of investing funds in the creation and use of sustainable energy sources including hydro, wind, and solar electricity.

Partnering with environmentally responsible suppliers. This means collaborating with vendors who prioritize sustainable practices and minimize their ecological footprint.

Regulatory landscape. These are policies of the government that play a major role in pressuring SMEs to implement eco-friendly activities to abide by rules, stay out of trouble, and improve their reputation.

Resource allocation. It is the process of distributing and overseeing resources in order to fulfill the goals of strategic planning for an organization.

Resource efficiency. In order to attain resource productivity, the supply cycle will be optimized by examining the extraction of raw materials, the production of components, the design of goods, and the organization of return markets.

Sustainable development. This kind of growth meets present needs without endangering the ability of future generations to meet their own.

Waste minimization strategies and recycling. These involve reducing the amount of waste produced and reusing materials to conserve resources and reduce environmental impact.

Water-saving technologies and practices. These involve using methods and tools to reduce water consumption and promote efficient water use.

1.6. Related Literature

1.6.1. Environmental Business Practices in Guangdong Province, China

China is said to be the top carbon emitter in the world and a major factor contributing to rising carbon emissions is the country's explosive export growth. The net export accounts for 1.177 billion tons of CO₂ emissions annually, or 22% of China's total CO₂ emissions, seriously degrades the environment (Ge et al., 2020).

When the Chinese government announced its voluntary carbon emissions abatement plan to the UN in June 2015 at the Climate Change Summit in Paris, it pledged to reduce its CO₂ emissions by 60–65% per unit of GDP from 2005 levels. China announced a significant commitment to global society

and humanity, which comes with a great deal of responsibility (Li et al., 2020).

Manufacturing businesses in Guangdong Province are increasingly adopting various initiatives and activities aimed at reducing their environmental footprint and promoting sustainable development. In order to reduce greenhouse gas emissions and energy consumption, these companies are investing in energy-saving technologies and procedures. This includes, first and foremost, the energy management system, the best possible use of manufacturing technology, and the upgrading of machinery and equipment (Li et al., 2020). Advanced pollution control techniques are becoming more and more commercially feasible thanks to the progress in technology (Oloruntobi, 2023).

Between 1998 and 2018, the daughter's generation of waste from China grew a huge 9.74 Mt (1 Mt = 109 kg) to 75 Mt. In that sequence, the totals of the three activities, the used, the disposed, and the stored, between 2001 and 2017 were 5-20 Mt, 2-15 Mt, and 3-10 Mt, respectively. The way waste is generated and handled is certainly becoming for change, thus, indicating to the environment the effect of such change and, on the other hand, the danger of human health. China has taken the position of the world in resource saving and recycling programs for hazardous refuse and returning it in product form. One of the methods of reducing pollution from waste production is the manufacturing companies in Guangdong coming up with waste reduction and recycling programs. This is done by separating the waste at the source, recycling existing materials like paper, plastics, and metals, and investigating new methods of reuse and repurpose waste (Kanwal et al., 2022).

Guangdong Province's grave air quality issues have led the manufacturing companies to take measures for the reduction of emission as well as the improvement of the atmospheric pollution. Therefore, this entails using cleaner industrial techniques, installing pollution control systems like scrubbers and filter devices, and the abidance to the strict emissions regulations that have been sanctioned by the regulatory bodies (Wang et al., 2023).

Acknowledging the significance of conserving water and preventing pollution, Guangdong's manufacturing businesses are adopting technology that saves water and are practically instituting wastewater treatment plans. These initiatives aim to aid the water pollution reduction, decreases water use, and ensure the water quality standards compliance (Zhang et al., 2021).

Guangdong manufacturers are focusing on green product innovation, which refers to the investments of the companies in new technologies and production processes that are friendly to environment since consumers' eco-friendly items demand is increasing. To do so, they need to produce low-carbon products, develop a green supply chain, and integrate the potential of technology in the life cycle management of materials over conventional parts (Zhang et al., 2019).

1.6.2. Challenges in Adopting Environmental Business Practices for Manufacturing SMEs in Guangdong Province, China

he phenomenal economic growth of China has no doubt, been a prime move; however, at the same time, it has generated several serious obstacles in its way, such as air and water pollution, energy consumption, and environmental pollution. In the context of sustainable development, these hindrances hinder China's economy and society. According to Ge et al. (2020), the environmental damages in China cause

an average of 10% loss of its GDP.

The implementation of sustainable development among manufacturing SMEs in Guangdong, China through green business practices is a primary method to protect the environment. China has a low-carbon goal in the 13th Five-Year Plan to reduce carbon dioxide emissions per GDP unit by 40% to 45% by 2020 compared to 2005 levels. China also said that it intended to accomplish the goals of the Sino-US Joint Statement on Climate Change, which was due in 2030. According to its authors, China's SMEs confront significant challenges in the context of the low-carbon economy (Tong et al., 2019).

Guiding resource allocation is one of the most significant challenges for Guangdong Province's manufacturing SMEs that are willing to go green. Limited financial resources and contradicting priorities are some of the most common problems that SMEs experience in their green technology and activities. SMEs, on the other hand, encounter difficulties in completing their environment-friendly initiatives due to insufficient finances and support (Zhang & Huang, 2021). It is considered that one of the biggest barriers to SMEs' environmentalism is the lack of funding for implementing sustainable practices. (Chowdhury & Shumon, 2020).

One of the easy-to-cross barriers that manufacturing SMEs in the Guangdong Province of China face is the lack of education and knowledge of the environment-sensitive procedures. Many SMEs do not have the right skills and resources needed to go green, or they, in fact, do not have any idea about what sustainability means and its realities. To encourage the use of sustainable practices in SMEs demands overcoming the information gap and increasing environmental awareness (Pang & Shang, 2019; Zheng et al., 2023).

It has been anticipated that SMEs will adopt greener business practices with a view to reducing their environmental implications. One of the strategies of this type is through introducing a green approach to the teams that deal with supply chain management and afflict the environment and the society along the supply chain in a less grave way (Tseng et al., 2019). The problem of supply chains in terms of their complexity, however, is the major snag in the effort of the Guangdong Province manufacturing SMEs to green their operations. The elements required to conduct business with suppliers that are necessary for sustainability throughout a supply chain are coordination, cooperation, and logistics. Small and medium-sized businesses face challenges as the number of green supply chain management techniques increases.

The adoption of environmentally sensitive corporate practices is not supported by the other stakeholders, which further widens the divide. Most often, small and medium-sized enterprises (SMEs) are seen as the less significant business categories - Those may be smaller in size are the ones that their business partners, such as suppliers and purchasers, are less helpful in the implementation of these practices. Moreover, the SMEs do not have enough bargaining power which is needed when it is time to ask for help from other supply chain members to comply with the environmentally conscious business practices policy.

SMEs are unable to enforce sustainability along the entire supply chain by imposition of conditions on their partners due to the weakness of their bargaining power (Chowdhury & Shumon, 2020).

Guangdong Province's manufacturing SMEs face obstacles

due to lack of government support and incentives for eco-friendly practices. Although the Chinese government has implemented policies aimed at fostering sustainability, bureaucratic processes, qualifying requirements, and insufficient financing frequently pose obstacles to SMEs seeking assistance. For SMEs to migrate to sustainable practices, increased government support and policy frameworks are crucial (Zhang & Huang, 2021).

Even though China has been giving the industry financial and political support for circular production patterns and green supply chains, large companies are more likely to get this support because they already have a greater number of resources to implement environmentally conscious business practices, whereas SMEs typically receive less support from the authorities despite having fewer resources and less relevant information, experience, and expertise. They possess fewer resources, such as funds, expertise, time, opportunities, and relationship capital (Gao et al., 2022). In Guangdong Province, a lot of manufacturing companies are focusing on supply chains in addition to their operations when it comes to sustainability. This entails collaborating closely with suppliers to advance responsible environmental sourcing, moral labor standards, and sustainable sourcing methods along the entire supply chain.

The Chinese government has launched several programs and laws to encourage environmentally friendly business practices and sustainable growth. Guangdong Province's manufacturing SMEs can make use of grants, tax breaks, and subsidies from the government to fund green projects and technology (Wang et al., 2022). A key tool for promoting China's high-quality economic growth and green transformation is the country's green credit strategy. With credit leverage, it seeks to motivate businesses to take on environmental responsibility. The China Banking Regulatory Commission's Green Credit Guidelines (2012) serve as one specific illustration (henceforth referred to as the Guidelines). The Guidelines, which establish a connection between corporate environmental performance and green finance policy, seek to restrict lending to highly polluting businesses, so compelling them to undertake green transformation and upgrade. The introduction of green credit and other policies may decrease the amount of debt financed, raise the cost of debt, and have an impact on the operations and production of businesses (Ge et al., 2020).

1.6.3. Sustainable Green Development of Small and Medium Businesses in the Manufacturing Industry

The topic of sustainable development is still important and well-thought-out, affecting every aspect of the world economy. Globally, sustainability is reshaping a lot of industries. The global supply chain now prioritizes sustainable development because of laws and plans aimed at minimizing environmental harm. Reducing emissions throughout the economy has become a worldwide initiative due to climate change. Many countries continued to support additional UN Sustainable Development Goals (SDG) 2050 accords and joined the Paris Agreement Protocol in December 2015 due to the necessity to drastically reduce emissions (Ulucak, 2019). Numerous nations have taken individual steps to reduce their carbon footprint at the national level.

These days, the lack of energy and resources is placing a heavy load on industry and government, while environmental disruption, climate change, air pollution, and water contamination are all having an increasing negative impact on people's lives and health. Because traditional manufacturing

damages the environment and uses resources that will be used by future generations, it cannot comply with present environmental regulations. As a result, sustainable manufacturing has emerged as a response to the growing recognition of the significance of sustainability. A large and growing number of industrial firms are benefiting financially and environmentally from sustainable business practices.

When it comes to manufacturing, sustainability involves producing goods in a financially viable way. It aims to minimize adverse environmental impacts. Additionally, it focuses on conserving energy and natural resources. In addition to improving the lives of future generations, sustainable manufacturing also improves worker, community, and product safety (United Nations, 2023) The following succinctly describe the requirements for sustainable manufacturing:

1. No or little damage to society and the environment
2. No depletion of natural resources
3. Sufficient to meet current and future energy requirements
4. High efficiency
5. No harmful emissions to the land, air, or water
6. Little or no emissions of greenhouse gases, and
7. No strain on future generations

Manufacturing is under a lot of pressure to maintain environmental balance and preserve resources for future generations. The idea of sustainable manufacturing was put forth to address environmental issues and conserve energy and natural resources. Governments, businesses, and academia have all given this subject a lot of attention. The goal of sustainable manufacturing is to replace the conventional production mode with one that emits fewer harmful emissions, is more environmentally friendly, uses fewer natural resources, and emphasizes long-term thinking. Many countries enacted the legislation to enforce sustainability in industry. This includes regulating factory emissions as well as incentivizing the use of renewable energy sources.

The manufacturing industry in Guangdong Province, where this research was done, is the significant factor of China's economy contributing to both employment and GDP growth. The impact of green industrial factors in the growth of small and medium-sized businesses (SMEs) in the manufacturing sector is a very important element in the province of Guangdong plans for sustainable development; thus, it should be examined.

Resource efficiency implies the effective and efficient use of resources, covering items such as energy, water, and raw materials, and waste minimization within the supply chain. Moreover, multiple research studies have underscored the pivotal role of resource management in the improvement of the sustainability performance of SMEs. The strategic implementation of resources and waste reduction by SMEs results in financial savings, increased productivity, and reduced emissions inputs to the environment (Pang & Shang, 2019).

The efficient use of resources, such as energy, water, raw materials, and waste reduction, in industrial processes is called resource efficacy. Resource efficacy has been demonstrated to be a significant factor in the improvement of the sustainability performance of SMEs in a number of studies. SMEs can decrease their environmental footprint, raise their productivity, and cut operating costs by the efficient use of resources and waste management (Pang &

Shang, 2019). Zheng et al. (2023) revealed that resource optimization led to dollar savings and increased market share. The research spotlighted techniques of resource efficiency for small and medium-sized enterprises in Guangdong Province. Lean manufacturing methods, implementing energy-saving technologies, and executing waste reduction projects were identified as successful strategies for improving resource efficacy.

The minimization of the environmental impacts related to production activities requires the implementation of pollution control measures. SMEs can achieve emission reductions and inclusion in regulations by means of pollution control technologies/systems, example of which includes air and water pollution abatement systems. According to scholars, the effective policy for pollution control that seems to yield the best results in the reduction of environmental pollution and the efficiency of the SMEs operations, thereby ensuring the long-term sustainability of the small and medium-sized enterprises (Geng et al., 2021), was introduced. The pollution control measures that small and medium manufacturing enterprises cover in their environmental performance in Guangdong province in China were reported by Ali et al. (2021). The study showed that pollutant emissions decreased and environmental compliance improved due to the implementation of comprehensive management systems and the use of pollution control technology. Small and medium-sized enterprises can emit less pollution and meet regulations by investing in technologies that are related to pollution control methods. The methods to be followed by SMEs to move towards the pollution-free progress and green growth included installing pollution of control equipment, conducting regular monitoring and audits over the environment, and impementing cleaner production practices (Ren et al., 2020).

1.7. Synthesis

China, being the country's most populous and the top carbon emitter in the world, is confronting problems caused by its enormous export growth that mainly leads to a significant rise in carbon emissions (Tang et al., 2017; Zhang et al., 2024). Net export is responsible for 22% of the total CO₂ emissions of China in a year, Earth's ecosystem being heavily damaged as a result of this (Ge et al., 2020). The Chinese government has committed to cutting CO₂ emissions by 60%–65% per unit of GDP from 2005 levels, which is an exemplary move on the part of the nation in global environmental mitigation (Li et al., 2020).

Manufacturing companies in the Guangdong province have been more and more involved in projects to minimize their own effects on the environment and to promote the sustainability of the world by taking up energy-efficient technologies and processes (Li et al., 2020; Olorunubi, 2023). China has taken a decisive step to the rising hazardous waste production by introducing the world-renowned standards for resource-related and recycling techniques. As a result, many manufacturing companies in Guangdong are now running waste reduction and recycling programs (Kanwal et al., 2022).

Guangdong Province's severe air pollution problems have induced manufacturing companies to take measures to limit the problem. Zhang and Huang (2021) state that waste management, water conservation, and the introduction of energy-efficient technologies are parts of the management frameworks of the companies that show highly effective at reducing operational costs by up to 25% and increasing

profitability for businesses. Energy-efficient techniques, such as LED lighting systems and energy-efficient equipment, provide substantial long-term cost savings for the businesses (Prashar, 2019; Shurrab et al., 2019).

Recycling initiatives not only cut down costs related to disposal but also may quite likely bring in profit from the sale of recycled materials. Bringing environmental motivation to their operations, businesses can follow regulatory policies and reduce potential exposure to the ever-increasing environmental regulations (Li et al., 2020; Khan et al., 2020; Amankwah-Amoah, 2023).

Government policies and green credit strategies encourage organizations to transition to green and upgrade; thus, further facilitating environmentally sustainable tendencies (Ge et al., 2020; Wang et al., 2022). Actions for sustainable development promote the market-specific and the innovation of the enterprises, making them the leaders in the sector that they are in by providing green solutions that are different from the others (Zhang et al., 2019). SMEs in Guangdong Province, China, are the ones that can benefit most from government programs and policies that are targeted toward environmental practices. They can get financial support and incentives for sustainable growth (Ge et al., 2020; Wang et al., 2022).

Besides others, one of the most important types of brands which will be divested as a result of this restructuring process is the fast-moving consumer goods (FMCG) brands. The reshuffling of the company's ownership structure will hereinafter act in accordance with the operational mode of the company and its commercial strategy. Also, the endeavor, considered from the perspective of an assignor for the absolute fulfillment of the assigned obligations, will then be used to further reinforce the apex leadership's mission to be the leader over their competitors. In the due course of the assignment, the priority of the organizational leaders will be to promote brands that have high potential for further development by increasing the potential of both internal and external stipends.

Moreover, Guangdong's manufacturing businesses are accommodating the use of water-efficient technology and wastewater treatment systems to reduce water pollution and support water quality standards. Also, Guangdong's manufacturing companies through the growing need for eco-friendly products are switching to green production techniques by not only designing sustainable products that are favorable to the environment but also through renewable resources that are less harmful to the environment.

Resource allocation is actually a big problem for SMEs in Guangdong Province, which is a huge region that covers one-third of China's population (Zhang & Huang, 2021; Chowdhury & Shumon, 2020). It indeed prohibits their investment in green technologies, but eventually, the deficiency in financial resources (Zhang & Huang, 2021; Chowdhury & Shumon, 2020) is the main cause of this problem. Another challenge is the lack of knowledge and related skills regarding environment-sensitive procedure which is why efforts to raise awareness and provision of the necessary skills as well as resources should be made.

In Guangdong Province, suppliers are now the key focus to the manufacturing firms' effort to produce in a more environmentally friendly way, which enables the suppliers to come closer to sourcing from the environment in a responsible manner. The implementation of green practices in the supply chain is expected to decrease the adverse environmental effects. However, the sheer scale of the supply

chains becomes the main hurdle of SMEs (Tsen et al., 2019). The weak support from the stakeholders, for example, the suppliers and the purchasers, makes it difficult for SMEs to initiate environment-responsible activities, as the SMEs have no bargain power and resources (Chowdhury & Shumon, 2020).

The government provides insufficient support and incentives, which in turn has some negative consequences for the SME community's adoption of environmentally friendly practices, even though sustainable development is one of the policies that have already been established (Zhang & Huang, 2021). Henceforth, the big enterprise will have a better chance to benefit from the green initiatives that financial and political entities are likely to support. SMEs, on the other hand, will have fewer resources and less support available to them (Govindan et al., 2024; Gao et al., 2022).

Addressing these challenges requires governments, businesses, and other parties to work together to provide support, incentives, and education for the SMEs to switch over to the use of environmentally-friendly practices for the region.

Sustainable development is still one of the most urgent universal issues, which has affected numerous sectors around the world, thus placing environmental protection as a top priority in the international supply chain by means of laws and measures as the Paris Agreement (Ulucak, 2019). Traditional manufacturing practices have a negative effect on the exhaustion of resources and the environment. Consequently, sustainable manufacturing has appeared as a solution to environmental degradation (Menget al., 2018). The United Nations reported that sustainable manufacturing was meant to cut down on the negative impact of production, to preserve the environment and future generations, and to boost health and security in the workplace. Governments, businesses, and academia are actually practicing green manufacturing by many means, such as enactment, research, and the policy framework. Guangdong Province in China is the manufacturing sector of the economy where this sector has a great impact in the economy, considering the economic effect on how green industrial factors can help SMEs to grow for sustainable development.

1.8. Conceptual Framework

Based on the framework comprising the development of green industrial industry, the challenge of small and medium enterprises while implementing eco-friendly business strategies has been clarified. The problems that small and medium manufacturers face to exceed in environmentally friendly business practices are represented in this idea. This study examined how resource allocation (Zhang & Huang, 2021), awareness and education (Kanwal et al., 2022), supply chain management (Tseng et al., 2019; Jiang et al., 2018), and regulation landscape (Ge et al., 2020; Li et al., 2021; Wang et al., 2022; Ulibarri et al., 2022; Fang, 2024) form the core of challenges to be addressed.

The researcher investigated how these challenges may affect various environmental business practices. These practices are about energy-efficiency technologies and practices, waste management and recycling strategies, cooperations with environmentally favorable suppliers, saving water technologies and practices, covering environmental issues in product design, investment in renewable energy outputs, and the enactment of Environmental Management System or EMS (Zhang et al.,

2019; Zhang et al., 2021; Kanwal et al., 2022; Wang et al., 2023). The researcher suggested a model of green industries that focuses on the manufacturing SMEs of this province, sustainability-wise.

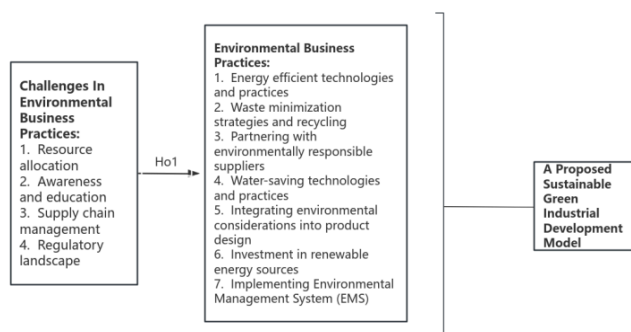


Figure 1. Author's Conceptual Framework

2. Methods

2.1. Research Design

To address the study questions and provide concrete evidence in support of the hypotheses, this study made use of a quantitative-descriptive approach with causal-comparative research design with a focus on business owners of small and medium enterprises as its respondents. A research method called quantitative-descriptive is one that uses the real-world data related to provide a precise description and a hypothesis. Empirical data are facts that can be physically measured through the use of tools employed in the collection of participants' data. The objective of the causal-comparative research design in this study is to look for links between independent and dependent variables after an action or event has already taken place. By comparing two or more groups of people, the researcher's objective was to ascertain if the independent variable had an impact on the result of the dependent variable. Here, the researcher gathered precise evaluations from the owners of small and medium enterprises who took part in this study regarding the challenges they had encountered as they adopted environmental business practices in their respective establishments.

2.2. Data Management

The researcher established robust data management procedures, including secure storage, backup systems, and access controls to protect the confidentiality and integrity of the data collected. The researcher also maintained clear documentation of data sources, collection methods, and any data transformations or manipulations performed during analysis. Secondary data were collected from a variety of sources, such as websites, e-journals, Google Scholar, and libraries.

A quantitative research design was utilized as part of the methodology. Structured surveys gathered quantitative data, encompassing company profiles, forms of environmentally conscious business practices, and challenges encountered by business

owners as they adopt environmentally conscious business practices and green industrial factors to the sustainable development of small and medium businesses in the manufacturing industry.

To ensure anonymity, all gathered data were safely kept in electronic databases using access controls and encryption. Throughout the study process, a backup system was put in

place to ensure ongoing availability and prevent data loss. To make organizing and categorizing easier, a common coding scheme for the quantitative data was used. To guarantee consistency and clarity, variables were specified precisely, and a data dictionary was kept up to date.

Only authorized personnel were able to access sensitive data. The identity of responding companies and individuals was protected by adhering to relevant data protection regulations and guidelines, particularly when dealing with sensitive or personally identifiable information. To protect confidentiality, only the study researcher had access to raw data unless she specifically consents to data sharing.

2.3. Sampling Design

This study made use of a purposive sampling technique. Purposive sampling is a non-probability sampling technique. Which is also known as discriminative or selective sampling. Researchers intentionally select participants using this method. They make their selections based on specific criteria related to the research objectives. In the context of this study on environmental business practices among small and medium enterprises (SMEs) in Guangdong Province, China, purposive sampling was employed to ensure that the selected business owners possess relevant knowledge and experience in the subject matter.

In this case, the researcher focused on small and medium business owners operating in Guangdong Province who have experience or interest in environmentally conscious business practices within the manufacturing sector. Hence, only owners of SMEs were the ones who answered the survey instrument as they were the ones involved in decision-making processes related to environmental practices and sustainability initiatives.

2.3.1. Sample Population

There are 1,420 small and medium manufacturing enterprises in Guangdong Province, China. This research study made use of 303 owners whose manufacturing businesses are in the area. The Raosoft calculator was used to determine the sample size. The owners should be operating for at least five (5) years which the researcher believed was enough to measure the challenges in the adoption of environmentally conscious business practices to sustainable green industrial development of the manufacturing industry in Guangdong province.

2.3.2. Research Instrument

The researcher employed a customized survey questionnaire to gather data from the participants. The most common and extensively utilized approach to gathering data for a descriptive study design that answers the questions "what," "who," "where," "how much," and "how many" is the survey technique. Survey instruments are widely used because they are simple and efficient to administer, particularly to large number of people.

Further, alterations and content validation were performed on this instrument. The survey items were taken from the literature and study analysis. Research experts were also consulted for advice. There were two (2) versions of the questionnaire, the original questionnaire (English version) and the translated one (Chinese version). This was to allow the respondents more understanding of the instrument. Then before the statistical treatment, the researcher translated back into English version the used questionnaires.

Except for the organizational part, respondents' understanding of the challenges as well as the effectiveness of

environmental business practices was rated on a four-point Likert scale. In this study, the pilot test was considered to determine what aspects of the survey instruments were needed to be modified before being made available to a wider audience. The test enabled the researcher to test theories and obtain initial data before devoting additional resources to a comprehensive research investigation.

The first part of the survey instrument is the organizational profile which includes the number of employees, and the number of years in business.

The second part of the questionnaire is about the forms of environmental business practices that small and medium enterprises adopt in the manufacturing industry to measure their effectiveness. Seven (7) practices were asked here.

Table 1. Four-Point Likert Scale for Effectiveness of Environmental Business Practices

Likert Scale	Interpretation
3.26-4.00	Highly Effective
2.51-3.25	Moderately Effective
1.76-2.50	Lowly Effective
1.00-1.75	Not Effective At All

The second part of the survey involves how difficult it is for small and medium enterprises to mitigate challenges such as resource allocation, awareness and education, supply chain management, and regulatory landscape in engaging in environmentally conscious business practices. There were 12 items for this portion. The verbal interpretation of the Likert scale that was applied to this subject is given below:

Table 2. Four-Point Likert Scale for Challenges in Environmental Business Practices

Likert Scale	Interpretation
3.26-4.00	Highly Challenging
2.51-3.25	Moderately Challenging
1.76-2.50	Lowly Challenging
1.00-1.75	Not Challenging At All

Table 3. Four-Point Cronbach's Alpha Value for Reliability Test

Cronbach's Alpha Value	Reliability Interpretation
0.9 and above	Excellent
0.8 – 0.9	Good
0.7 – 0.8	Acceptable
Below 0.7	Considerable Refinement

Cronbach's Alpha was used to assess the reliability of the survey instrument. The reliability analysis shall examine the features of measurement scales and the parts that comprise them to determine their reliability. Data on the correlations between the scale's constituent items and several frequently used scale reliability indicators were produced by this procedure. Through reliability analysis, the degree of link between the items in a questionnaire was determined. A broad measure of the scale's internal consistency or repeatability was obtained from the test, which also highlighted problematic items that should be eliminated from the scale. Every item in this study must have internal consistency. Here, below is the Cronbach's Alpha table:

Table 4. Cronbach's Alpha Value of Forms of Environmental Business Practices and SMEs Challenges

Study Variables	Cronbach's Alpha Value	Reliability Interpretation
Forms of Environmental Business Practices	0.9001	Excellent
Challenges In Environmental Business Practices	0.8760	Good

For this study, the Cronbach's Alpha results of the survey are presented. The Cronbach's Alpha Value of the various forms of environmental business practices is 0.9001, that means the reliability of this part's data is excellent. The Cronbach's Alpha Value of the challenges in environmental business practices is 0.8760, that means the reliability of this part's data is good.

2.4. Statistical Treatment

To evaluate and interpret the data gathered, statistical techniques were used for each research sub-problem in this study.

For subproblem 1 which is about the effectiveness of the various forms of environmental business practices that small and medium enterprises in the manufacturing industry (SMEs) utilize, the researcher made use of ranking in addition to means. A four-point Likert scale was administered here.

For subproblem 2, the challenges of the environmental business practices that include resource allocation, awareness and education, supply chain management, and regulatory landscape were treated statistically with rank and means. A four-point Likert scale was administered here.

Subproblem 3 used multiple regression to address the research question about the impact of the challenges to the environmental business practices.

For the hypothesis testing, the researcher drew on multiple regression analysis with the environmental business practices as the dependent variable and challenges confronting SMEs as independent variables. She examined the coefficient estimates and their associated p-values to determine whether the challenges have a statistically significant impact on environmental business practices. If the p-values associated with the coefficients are greater than the chosen significance level (e.g., 0.05), the null hypothesis is accepted, indicating no significant impact.

3. Results

3.1. Effectiveness of Environmental Business Practices

The survey results show that manufacturing SMEs in Guangdong Province, China, have a lower perception of environmental business practices than their counterpart companies. The second point comes out in the case of investments in renewable energy sources, which make up the highest percentage (25.61%), meaning that they are seen as the most effective practices. The second measurement, waste reduction techniques and recycling, which has a mean of 2.0429. It indicates more desire to lower the waste. Meanwhile, the company has scored equally low in supplier engagement and environmental product design among other practices. Although different nature-friendly procedures have been developed, still, the collective low means in all the specified areas point to an urgent movement strengthening the effectiveness of these practices within SMEs.

Table 5. Effectiveness of Environmental Business Practices of Manufacturing Enterprises (SMEs)

The Various Forms of Environmental Business Practices	Mean	Verbal Interpretation
Energy-efficient technologies and practices	1.9967	Less Effective
Waste minimization strategies and recycling	2.0429	Less Effective
Partnering with environmentally responsible suppliers	2.0231	Less Effective
Water-saving technologies and practices	1.9901	Less Effective
Integrating environmental considerations into product design	2.0330	Less Effective
Investment in renewable energy sources	2.0561	Less Effective
Implementing an Environmental Management System	1.9835	Less Effective

The effect of the impact on energy-efficient technologies and Environmental Management Systems (EMS) in SMEs is consistent with studies that have shown the adoption and implementation issues among these companies. For example, Zheng et al. (2023) state that the SMEs, although the use of the technology that leads to energy saving, which is a key to sustainability, is more possible during the operation of the SMEs, the small companies are quite often limited by their finances and operations that make the technology widely accepted. This is the reason why measures like the energy-efficient technologies and water saving developments are put in the second tier in the Guangdong SMEs in spite of their known importance in the literature in the case of environmental performance improvement.

The company will probably use less energy from non-renewable sources and cut waste incentives for more quality employees. Such study results are aligned with the previous research studies' outcomes, stated by Pang and Shang (2019). They claim that resource efficiency, including waste reduction, is the most important part of the sustainable performance of SMEs. Aside from the fact that the evidence for these methods is barely above the noise threshold, SMEs might be more inclined to adopt practices that can be measured on important indicators like cost savings from waste reduction and renewable energy.

Although pollution control measures were rated lower in terms of effectiveness, the body of research, however, emphatically confirms their role in environmental enhancement. Ali et al. (2021) refers to the ways in which the adoption of more stringent pollution control technologies and environmental management systems could substantially draw down pollutant emissions. Still, SMEs in Guangdong may have a lower evaluation of the effectiveness of pollution control measures due to the high expenses and the complex situations of implementation, especially for small firms that have limited resources.

China's commitment to reducing CO2 emissions from 60% to 65% by 2030, as emphasized by Li et al. (2020), indicates strong governmental support for the use of environmentally friendly conservation technologies. Nonetheless, Ge et al.

(2021) also assert that the nation's shocking export growth, accounting for 22% of China's total CO2 emissions, indeed is a major issue that needs to be solved. The chasm between the declared governmental targets and the real effectiveness of the practices performed at the SME level indeed is the representative of widespread complications in the conversion of national targets into actions, mainly within the SME environment.

The literature agrees that recycling and resource efficiency are of great importance in reducing the environmental impact. Research examples such as Kanwal et al. (2022) highlighted that China is the country which 'shows the way to the world' when it comes to hazardous waste management, most of which is due to the fact that its recycling programs are the main driving forces behind the transformation. Nevertheless, the low perceived effectiveness of these initiatives among Guangdong SMEs denotes that although the recycling infrastructure is in place, the implementation of it at the SMEs level is only at the initial phase, as many companies might not have the right skills or incentives to fully embed these practices.

The inefficacy of unsustainable practices in relation to environmental measures signifies the deeper issues in the way of clean manufacturing. According to Ulucak (2019), the basic goal of manufacturing is to use methods that do not damage the environment, that conserve energy, and that do not release toxic chemicals. On the downside, however, they may encounter difficulties like the dearth of financial means, and the poor conveyance by technology that is why they are not taking up this new green lifestyle. It is still possible that new discoveries in technology that help to save energy and water, where they are needed, may just be seen as less successful.

Globally, the pressure to meet sustainability goals has reshaped industries, as evidenced by initiatives, such as the Paris Agreement. Nevertheless, China is one of those countries where small and medium-sized enterprises are grappling to comply with the given global standards due to the restrictions of cost, regulatory enforcement, and market competitiveness (Olorunjobi, 2023). The local-global disparity might be a partial cause of the low effectiveness ratings since the SMEs in Guangdong Province may prefer short-term survival to other long-term sustainability goals.

In short, the study implies that there is a huge difference between the ambitions of the states and the world towards the environment and what the manufacturers in the Guangdong actually do. Yes, they do a renewable energy project, they cut waste, and they recycle, but those are not perceived as successful practices by them. As a consequence, more solid systems of support that can be financial incentives, training, and technological upgrading are needed in order to foster the adoption and influence of the environmental practices. Pang and Shang (2019) said that a rise in the ability to utilize resources and a cut down in waste can give SMEs both economic and environmental advantages. However, partnership among government, industry, and academic establishments is needed.

3.2. The Challenges in the Environmental Business Practices

Table 6. The Challenges in Environmental Business Practices

Challenges		Mean	Verbal Interpretation
Resource Allocation	1. Allocate financial and human resources for environmentally friendly practices in manufacturing operations.	1.9505	Less Challenging
	2. Prioritize researching and adopting sustainable technologies and processes.	1.9637	Less Challenging
	3. Assess short-term costs versus long-term benefits to ensure sustainability in manufacturing operations.	1.9142	Less Challenging
Awareness and Education	1. Raise awareness and foster an environmentally conscious culture among employees and stakeholders.	1.9076	Less Challenging
	2. Provide comprehensive training programs to empower the workforce with the necessary skills for implementing eco-friendly practices.	1.8284	Less Challenging
	3. Disseminate information about sustainable practices to suppliers, partners, and industry stakeholders.	1.8680	Less Challenging
Supply Chain Management	1. Identify and evaluate the environmental impacts of my manufacturing business' supply chain activities and processes.	1.9208	Less Challenging
	2. Source environmentally sustainable materials and components for my manufacturing operations.	1.9241	Less Challenging
	3. Ensure that suppliers and partners adhere to environmental standards and regulations throughout the supply chain.	1.9043	Less Challenging
Regulatory Landscape	1. Navigate government regulations and access support for implementing eco-conscious practices.	1.9406	Less Challenging
	2. Secure funding and technical assistance from government programs for sustainable initiatives.	1.8977	Less Challenging
	3. Advocate for policy changes to enhance support for eco-friendly practices in manufacturing.	1.8812	Less Challenging
Challenges in Environmental Practices Mean		1.9084	Less Challenging

Resource allocation was evaluated as the highest obstacle out of four (4) categories. The respondents pointed out the need to focus highly on staff training and implementing green technologies which sounds like a herculean task to managers, with an average score of 1.9637 stressing the least challenging point of them all. Financial and human resources to be used for green practices were also mentioned, with a mean score of 1.9505. It means that in spite of the fact that resource allocation is regarded as one of the vital issues yet, SMEs in Guangdong consider it less of a problem which may be attributed to the awareness of the advantages in the long run and the relative availability of resources for such kinds of projects.

The third challenge in this area, "assessing short-term costs versus long-term benefits to ensure sustainability," received a mean score of 1.9142. Although this may indicate some hesitancy in making initial investments, the overall score reflects that SMEs understand the importance of long-term gains, even if short-term costs are incurred.

Interestingly, raising awareness and fostering an environmentally conscious culture among employees and stakeholders emerged as a top priority, but again, it was not viewed as highly challenging (mean of 1.9076). The relatively low challenge scores suggest that SMEs feel confident in their ability to engage employees and stakeholders in sustainability efforts, possibly due to existing corporate culture or educational initiatives already in place.

Providing training programs and disseminating information about sustainable practices to external partners, suppliers, and stakeholders were also ranked low in terms of challenge, with means of 1.8284 and 1.8680, respectively. This may indicate that these SMEs either have access to resources for education or that they believe training programs are not difficult to implement.

In the area of supply chain management, environmentally sustainability sourcing materials and components for

manufacturing operations came first within this category, with 1.9241 as the mean score, and the environmental impact of supply chain activities was the second-largest aspect with a mean of 1.9208. These scores indicate the significant SMEs' satisfaction with the implementation of sustainable supply chain management, even though the external factors such as green materials availability and supplier cooperation can give rise to the difficulties that may make these efforts incapturable.

Ensuring that suppliers and partners adhere to environmental standards came out to be the least supportive measure with a mean value of 1.9043. This challenge shows that the organization is now experiencing a deeper involvement of its supply chain in environmental practices. Nevertheless, the survey was meant for the respondents only and the implementation of these environmental issues in the entire supply chain was rated as less challenging.

The regulatory environment was seen as the easiest one compared to the others. The survey of SMEs in Guangdong regarding navigating government regulations and accessing support for green practices shows a mean score of 1.9406, being basically the main cause of the regulatory compliance but not the extent of it. This might be the result of China's growing sustainable line, where the authorities' policies and support procedures are easy to get through.

In relation to government fund awarding and technical assistance, convincing the partners and donor organizations was also seen as an easy task (mean of 1.8977), which implies that government initiatives are perceived as relatively effective. The least challenging was the persistent supporting policy changes toward sustainable practices (mean of 1.8812), as this might be due to the fact that SMEs concentrate more on compliance rather than initiating the systemic change approach.

The outcomes from the survey imply that SMEs in Guangdong Province are optimistic about their ability to implement and maintain sustainable operations. While

resource allocation and supply chain management are the major issues in this, however, these are not the most severe ones. Moreover, the fact that the correct of these programs is relatively little difficulties may also point out the increasing governmental support for the Chinese green agenda in regard to policies, funding, and technical assistance, which is in line with China's commitment to the Paris Agreement on climate change.

In conclusion, the challenges exist but they are not that seriously perceived. The small enterprises in Guangdong Province that are on the right track in adopting sustainable business practices, can still improve the efficiency of their environmental strategies to be in line with the global sustainability goals.

The literature also highlights the importance of resource efficiency which the SMEs in Guangdong Province. Pang and Shang (2019) pointed out that the key to sustainability is the optimal use of resources. The result of the study that even though SMEs consider resource allocation as an obstacle, they feel that they can overcome it. This might be due to their understanding of the resource-efficient technologies.

Moreover, Pang and Shang (2019) and Zheng et al. (2023) also said that sustainability can be achieved through education and awareness in SMEs as many have neither the expertise nor the resources to go green. On the other hand, SMEs in the study did not see awareness of creation or training their employees and partners as the major problems which may indicate a better level of internal capability or external support that would not be captured by the past studies.

This study has an overarching positive view of environmental practice implementation issues that may be reflected in worldwide sustainability trends. The Paris Agreement and the UN Sustainable Development Goals have produced a global push towards sustainability, which is drastically changing industries and supply chains all over the world (Ulucak, 2019). Meanwhile, the global push will allow China SMEs to operate along with the nations, China inclusive, which have put in place and/or provide facilities of stricter environmental regulations and give businesses more financial and technical help to reduce their environmental shows.

In the end, the study's findings, though pointing only to a low rate of the SMEs in Guangdong perceiving implementation of sustainable practices as a challenge, literature gives a more complex image. While small and medium-sized enterprises are confident because of the government support and overall long-term benefits of sustainable development. Besides, studies show that the financial constraints, the complexity of the supply chain, and the lack of knowledge have been a problem for many small and medium enterprises all over the world. Along with the existing efforts such as continued training for their employees, adequate resourcing, and a streamlined regulatory framework, religious adherence to the recommendations of these SMEs will be a key to attaining the global sustainability goals.

3.3. Impact of the Challenges on Environmental Business Practices

3.3.1. Impact of Resource Allocation Challenges on Environmental Business Practices

Allocating financial and human resources to environmental practices in the manufacturing industry can provide financial support and talent for SMEs to enhance innovation and

application of environmental protection technologies. The p-values of most environmental business practices, including energy-saving technologies ($p=0.789$), waste minimization strategies ($p=0.394$), water-saving technologies ($p=0.376$), incorporating environmental factors into product design ($p=0.961$), renewable energy investment ($p=0.300$), and implementing environmental management systems ($p=0.247$), indicated no significant impact. The p-values in these cases are above the typical significance threshold of 0.05, indicating that this challenge has no significant impact on the adoption of environmental practices by SMEs in these areas. Therefore, all these variables have accepted the null hypothesis.

However, partnering with environmentally responsible suppliers ($p = 0.016$) demonstrated a significant impact, suggesting that partnering with responsible suppliers is a critical factor in resolving financial and human resources issues related to sustainability. By collaborating with environmental suppliers, SMEs can obtain more efficient and environmentally friendly production methods and materials, further saving resources. SMEs can also leverage the technology and experience of environmental suppliers to provide training and development opportunities for employees, enhancing their skills and environmental awareness.

Researching and implementing sustainable technologies and processes are crucial for SME businesses that want to green their operations as well as increase efficiency. Caused by the fact that companies with CMS leading the industry in ecological supply management ($p = 0.001$), the acquisition of sustainable technologies is more prioritized. This underscores that the suppliers of the tools and resources should play a pivotal role in enabling SMEs to make more environmentally responsible choices. Suppliers, who look at sustainability first, may bring forth advanced and eco-friendly technology that could be used by the small and medium companies more easily, thus, a heightened commitment to sustainability will be the result.

Other practices, such as energy-efficient technologies ($p = 0.749$), waste minimization ($p = 0.663$), water-saving technologies ($p = 0.399$), product design considerations ($p = 0.368$), renewable energy investments ($p = 0.747$), and EMS implementation ($p = 0.751$), all indicated no significant impact. These findings suggest that, although these practices are valuable in general, they may not directly drive SMEs to prioritize sustainable research and adoption. The barriers may include the initial costs of these technologies or limited knowledge among SMEs about their benefits.

Assessing short-term costs versus long-term benefits to ensure sustainability challenges refers to how SMEs evaluate the financial impact of adopting sustainable practices, balancing immediate expenses with long-term gains. Significant results were found for partnering with environmentally responsible suppliers ($p = 0.045$) and integrating environmental considerations into product design ($p = 0.036$). These findings suggest that responsible suppliers and eco-friendly product design can help SMEs assess the long-term benefits of sustainability. Partnering with suppliers who share sustainability goals more likely helps SMEs reduce long-term costs through innovation, better materials, and more efficient processes. Similarly, integrating environmental considerations into product design may lead to more sustainable products that reduce future waste and resource usage, offering long-term savings.

Table 7. Impact of Resource Allocation Challenges on Environmental Business Practices

Resource Allocation	Environmental Business Practices	p-value	p-value interpretation	Accept/Reject Hypothesis
1. Allocate financial and human resources for environmentally friendly practices in manufacturing operations.	1. Energy-efficient technologies and practices	0.789	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.394	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.016	Significant	Reject
	4. Water-saving technologies and practices	0.376	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.961	Insignificant	Accept
	6. Investment in renewable energy sources	0.300	Insignificant	Accept
	7. Implementing an Environmental Management System	0.247	Insignificant	Accept
2. Prioritize researching and adopting sustainable technologies and processes.	1. Energy-efficient technologies and practices	0.749	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.663	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.001	Significant	Reject
	4. Water-saving technologies and practices	0.399	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.368	Insignificant	Accept
	6. Investment in renewable energy sources	0.747	Insignificant	Accept
	7. Implementing an Environmental Management System	0.751	Insignificant	Accept
3. Assess short-term costs versus long-term benefits to ensure sustainability in manufacturing operations.	1. Energy-efficient technologies and practices	0.371	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.915	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.045	Significant	Reject
	4. Water-saving technologies and practices	0.964	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.036	Significant	Reject
	6. Investment in renewable energy sources	0.437	Insignificant	Accept
	7. Implementing an Environmental Management System	0.392	Insignificant	Accept

Moreover, other practices like energy-efficient technologies ($p = 0.371$), waste minimization ($p = 0.915$), water-saving technologies ($p = 0.964$), investment in renewable energy ($p = 0.437$), and EMS implementation ($p = 0.392$) did not have a substantial impact either. Things bring out the fact that these practices can be preferably important but rely on quantitative evaluation, maybe because of big starting costs or being difficult to quantify their long-term financial benefits in the short term.

The findings indicate that collaboration with environmentally friendly suppliers is a constant factor in the successful management of different resource allocation challenges, including tackling financial and human resource problems, the adoption of sustainable technologies, and the evaluation of long-term sustainability benefits. This is a very strong argument for internal and external collaboration that is seen as the pulling tool for environmental improvement for SMEs.

In contrast, while other environmental drivers of sustainability such as energy-efficient technologies and investments into renewable energy are indeed vital for the long-term sustainability of the planet, at present their contribution is mostly limited to the direct environmental challenges of Guangdong's SMEs. These practices may even take more time, infrastructure, and investment before they become completely streamlined into SMEs' operations.

The insights that are gathered from integrating environmental ideas into product design suggest that inking up is one of the most important factors for small and medium enterprises for sustainability management in the long run. More specifically, the eco-friendliness of the products becomes the central focus of SMEs that get the dual environmental and financial benefits over the years from this approach.

Partnerships and innovation have been proven to be of inestimable value in overcoming the problem of resource allocation in the environmental sector. To fully enable Guangdong's SMEs fall into a sustainability integration,

projects should adopt an orientation towards supply chain relationships and product design in parallel with better energy efficiency and renewable energy applications in the areas of their operational and financial planning.

In summary, while the literature generally supports the importance of sustainable practices, the statistical results reveal that partnerships with responsible suppliers have the most immediate and significant impact on overcoming challenges in sustainable adoption, while other practices face barriers related to costs and technical capacity.

3.3.2. Impact of Awareness and Education Challenges on Environmental Business Practices

Raising awareness and fostering an environmentally conscious culture challenge centers on building a culture of environmental awareness within the workforce and among stakeholders, encouraging sustainable behavior across all levels of the organization.

Raising awareness and fostering an environmentally conscious culture challenge centers on building a culture of environmental awareness within the workforce and among stakeholders, encouraging sustainable behavior across all levels of the organization.

Energy-efficient technologies and practices ($p = 0.376$), waste minimization strategies ($p = 0.069$), partnering with environmentally responsible suppliers ($p = 0.051$), water-saving technologies ($p = 0.370$), integrating environmental considerations into product design ($p = 0.061$), renewable energy investments ($p = 0.772$), and implementing an Environmental Management System (EMS) ($p = 0.151$) all showed no significant impact. While the p-values for practices such as waste minimization (0.069), partnering with responsible suppliers (0.051), and environmental product design (0.061) are close to the threshold of significance ($p < 0.05$), they are still considered insignificant in this context. However, their proximity to significance suggests that these practices may contribute to fostering awareness in certain contexts or over time, even though they do not yet show statistically significant results in the current study. This

indicates that while these practices may play a role in building an environmentally conscious culture, they have not yet reached a point where their impact is quantifiable in SMEs of Guangdong. These enterprises might still be in the early stages of integrating such practices or need further development in awareness strategies. Training is crucial for equipping the workforce with the skills needed to implement sustainable initiatives effectively.

The p-values for energy-efficient technologies ($p = 0.579$), waste minimization ($p = 0.070$), partnering with responsible suppliers ($p = 0.763$), water-saving technologies ($p = 0.860$), environmental product design ($p = 0.133$), renewable energy ($p = 0.908$), and EMS implementation ($p = 0.400$) show that

none of these practices had a significant impact on the ability of SMEs to provide comprehensive training on eco-friendly practices. Despite waste minimization strategies showing a near-significant p-value of 0.070, the overall result suggests that environmental business practices have not yet translated into a robust impact on training efforts within these SMEs. This lack of significance may reflect the need for more formalized training programs or clearer links between environmental initiatives and workforce skill development. Training might still be an area where companies in Guangdong are underdeveloped, and greater investments may be required to create effective, structured training initiatives that are aligned with environmental goals.

Table 8. Impact of the Awareness and Education Challenges on Environmental Business Practices

Awareness and Education	Environmental Business Practices	p-value	p-value interpretation	Accept/Reject Hypothesis
1. Raise awareness and foster an environmentally conscious culture among employees and stakeholders.	1. Energy-efficient technologies and practices	0.376	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.069	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.051	Insignificant	Accept
	4. Water-saving technologies and practices	0.370	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.061	Insignificant	Accept
	6. Investment in renewable energy sources	0.772	Insignificant	Accept
	7. Implementing an Environmental Management System	0.151	Insignificant	Accept
2. Provide comprehensive training programs to empower the workforce with the necessary skills for implementing eco-friendly practices.	1. Energy-efficient technologies and practices	0.579	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.070	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.763	Insignificant	Accept
	4. Water-saving technologies and practices	0.860	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.133	Insignificant	Accept
	6. Investment in renewable energy sources	0.908	Insignificant	Accept
	7. Implementing an Environmental Management System	0.400	Insignificant	Accept
3. Disseminate information about sustainable practices to suppliers, partners, and industry stakeholders.	1. Energy-efficient technologies and practices	0.593	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.018	Significant	Reject
	3. Partnering with environmentally responsible suppliers	0.425	Insignificant	Accept
	4. Water-saving technologies and practices	0.387	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.088	Insignificant	Accept
	6. Investment in renewable energy sources	0.932	Insignificant	Accept
	7. Implementing an Environmental Management System	0.329	Insignificant	Accept

Disseminating information about sustainable practices to suppliers, partners, and stakeholders as a challenge focuses on how SMEs share their sustainability knowledge and practices beyond their internal operations, extending to their broader business ecosystem.

Energy-efficient technologies ($p = 0.593$), partnering with responsible suppliers ($p = 0.425$), water-saving technologies ($p = 0.387$), environmental product design ($p = 0.088$), renewable energy ($p = 0.932$), and EMS implementation ($p = 0.329$) mostly showed no significant impact on disseminating sustainable practices.

However, waste minimization strategies demonstrated a significant impact ($p = 0.018$) on disseminating information to external stakeholders. This suggests that SMEs are particularly focused on promoting waste reduction initiatives to their partners and suppliers. Waste minimization is likely an area where tangible results, such as reduced waste output and cost savings, make it easier for companies to communicate their sustainability successes to external parties. The near-significant result for environmental product design ($p = 0.088$) also implies that some SMEs are beginning to share knowledge about green product design with their suppliers and partners. This finding may point to growing interest in creating eco-friendly products that align with

broader market trends toward sustainability.

The results suggest that, while environmental business practices are in place within Guangdong SMEs, their impact on awareness, education, and training challenges remains limited. In particular, practices like the energy-efficient technologies, water-saving technologies, renewable energy investments, and EMS implementation have not exhibited any significant influence on awareness, training, or dissemination of sustainable practices.

The waste control area is one of the areas that have made a notable breakthrough; this is the result of the approach of passing on information between the suppliers and the partners. This study emphasized the point that SMEs in Guangdong are among the most active advocates of waste reduction which is, in the short term, extremely clear in the aspect of cost savings and environmental impact.

Furthermore, the outcomes of collaboration with environmentally conscious suppliers and designing eco-friendly products were nearly significant, hinting that those fields may become potential contributors to a more sustainable and eco-friendly society in the long run. Green environmental projects being directed at SMEs in Guangdong are one of those wonderful examples of how these practices will play a key part in making sustainability common

knowledge and its consequent adoption in the society.

Briefly, the SMEs in Guangdong might lead in ecologically sustainable practices thanks to some improvements they have made; however, there should be more work laid down to ensure these practices are not only bringing awareness but also prepare people through education and training against the issues faced. Particularly, the design of official education and the enhancement of the demonstrations of sustainability could facilitate the ecological factors entering into the routine activities of a business.

The fast economic growth in China, despite the increase in its global influence, has also caused a lot of environmental problems. Problems like air and water pollution, excessive energy consumption, and the environmental impacts of pollution have become major limitations to the country's green development. Ge et al. (2020) reported that about 10% of China's GDP is literally lost due to environmental pollution, which indicates the urgency of moving to sustainable practices. The manufacturing particularly of the SMEs in Guangdong Province is one of the critical areas in this sustainable development bid. The strategic 13th Five-Year Plan of China has outlined the abating of carbon dioxide emissions by 40%-45% per dollar amount of GDP by the 2020 deadline, compared with 2005 levels. Besides, China will as well contribute to the implementation of the Sino-US Joint Statement on Climate Change's 2030 carbon emission reduction goals (Tong et al., 2019).

However, the SMEs in Guangdong Province face notable challenges in the process of adjusting to environmental-friendly business practices. One of the major obstacles is the distribution of resources in the instances when these companies are operating with limited funds. According to the report by Zhang and Huang (2021), the lack of funding hampers the SMEs' potential to use eco-friendly technology and practices, which puts them in a tough spot when it comes to implementing sustainable practices. Besides the pandemic, also mentioned was a financial crunch by Chowdhury and Shumon (2020) in the report entitled "Towards Sector Specific Criteria for Deep Green SMEs" as another obstacle towards sustainable green methodologies.

Another challenge faced by SMEs in Guangdong is that they are not aware as well as educated about the environment-friendly practices. SME owners and managers also do not have the adequate skills and understanding to carry out sustainability programs successfully. Pang and Shang (2019), together with Zheng et al. (2023), expressed through the study the need for development of this informational gap, as awareness and environmental education are the basic requirements for promoting green practices in the business sector. Misguided SMEs, because of the lack of knowledge of the subject, often do not see the benefits that may appear to be environmentally irresponsible that operations may have.

Among small and medium-sized enterprises, carrying out sustainable production literally means the production of goods with reduced environmental impacts and rotating away from traditional energy forms. Sustainable practices not only help businesses meet environmental regulations but also improve their overall efficiency and competitiveness. Sustainable manufacturing very often includes such strategies as energy efficiency, resource conservation, waste reduction, and the use of renewable energy sources (United Nations, 2023).

The manufacturing sector in Guangdong Province, which is the main area of this study, is a key part of the Chinese

economy, providing employment and driving GDP growth. The province is at the helm of sustainable development, and it is essential that the green industrial practices that help the SMEs grow be scrutinized. Resource efficiency, or the best possible use of energy, water, raw materials, and waste minimization, has become the main focus for SMEs to enhance their sustainability. Several research works have shown that higher resource efficiency not only ensures cost savings but also ensures operational efficiency and environmental friendliness (Pang & Shang, 2019).

Though several business strategies and policies have been developed and implemented, research has proven that environmental business practices are not effective among Small and Medium-sized Enterprises (SMEs) in Guangdong Province. For example, some hypotheses were tested like the potential effects of raising awareness and creating an environmentally-conscious culture among employees on the adoption of energy-efficient technologies, waste minimization techniques, and water-saving practices. (Pang & Shang, 2019; Chowdhury & Shumon, 2020) Likewise, the provision of the employees with comprehensive training, on the other hand, did not bring about a substantial impact on energy-efficient technologies, waste minimization, and other green practices.

Although some green aspects have been incorporated into the product design, with the help of environmentally responsible suppliers, these practices have not reached most of the SMEs yet. According to research, it is concluded that although the issues of awareness and education are important ones, they are far from being key drivers of actual changes in SMEs' environmental business practices in Guangdong Province. The study, however, suggests that although progress is noticed, there is still a significant distance for SMEs to cover before they fully embrace sustainability in their businesses.

3.3.3. Impact of Supply Chain Management Challenges on Environmental Business Practices

Assessing the environmental impacts of supply chain activities that are of this type puts the emphasis on the importance of evaluating the environmental performance of the supply chain processes and practices. The p-values for the various environmental business practices in this category—energy-efficient technologies (0.463), waste minimization strategies (0.138), partnering with responsible suppliers (0.698), water-saving technologies (0.432), integrating environmental considerations into product design (0.854), renewable energy investments (0.153), and implementation of an Environmental Management System (EMS) (0.765)—all indicate no significant impact on evaluating the environmental impacts of supply chain activities. The acceptance of the null hypothesis across these practices suggests that SMEs in Guangdong currently lack effective strategies or tools to assess the environmental impacts of their supply chains. This could stem from a limited understanding of environmental metrics or inadequate resources allocated to perform such evaluations.

Sourcing sustainable materials is a critical aspect of minimizing the ecological footprint of manufacturing operations. In this context, the p-values for energy-efficient technologies (0.564), waste minimization strategies (0.774), partnering with responsible suppliers (0.547), water-saving technologies (0.139), integrating environmental considerations into product design (0.252), renewable energy investments (0.252), and implementing an EMS (0.273) all

indicate no significant impact. The results imply that SMEs are not prioritizing or successfully sourcing sustainable materials, potentially due to challenges in identifying environmentally friendly suppliers or the higher costs

associated with sustainable sourcing. This lack of impact raises concerns about the commitment of these SMEs to integrate sustainability into their supply chain management practices.

Table 9. Impact of Supply Chain Management Challenges on Environmental Business Practices

Supply Chain Management	Environmental Business Practices	p-value	p-value interpretation	Accept/Reject Hypothesis
1. Identify and evaluate the environmental impacts of my manufacturing business' supply chain activities and processes.	1. Energy-efficient technologies and practices	0.463	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.138	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.698	Insignificant	Accept
	4. Water-saving technologies and practices	0.432	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.854	Insignificant	Accept
	6. Investment in renewable energy sources	0.153	Insignificant	Accept
	7. Implementing an Environmental Management System	0.765	Insignificant	Accept
2. Source environmentally sustainable materials and components for my manufacturing operations.	1. Energy-efficient technologies and practices	0.564	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.774	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.547	Insignificant	Accept
	4. Water-saving technologies and practices	0.139	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.252	Insignificant	Accept
	6. Investment in renewable energy sources	0.252	Insignificant	Accept
	7. Implementing an Environmental Management System	0.273	Insignificant	Accept
3. Ensure that suppliers and partners adhere to environmental standards and regulations throughout the supply chain.	1. Energy-efficient technologies and practices	0.095	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.288	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.239	Insignificant	Accept
	4. Water-saving technologies and practices	0.334	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.279	Insignificant	Accept
	6. Investment in renewable energy sources	0.819	Insignificant	Accept
	7. Implementing an Environmental Management System	0.715	Insignificant	Accept

Ensuring adherence to environmental standards and regulations challenge involves monitoring and enforcing compliance with environmental regulations among suppliers and partners. The p-values for practices related to this challenge—energy-efficient technologies (0.095), waste minimization strategies (0.288), partnering with responsible suppliers (0.239), water-saving technologies (0.334), integrating environmental considerations into product design (0.279), renewable energy investments (0.819), and implementing an EMS (0.715)—also demonstrate no significant impact on ensuring compliance with environmental standards. Although the p-value for energy-efficient technologies (0.095) approaches significance, it ultimately suggests that there is no established relationship between these practices and adherence to environmental regulations. This may mean that despite SMEs being aware of the significance of compliance with green regulations, they do not have any solid mechanisms or policies in place to ensure that their suppliers comply.

The study's results indicate serious weaknesses in the SMEs in Guangdong concerning sustainable business practices in relation to supply chain management. The fact, that all practices evaluated were in compliance with the null hypothesis, shows that there is no substantial effect on the main difficulties that occur in supply chain management, such as the analysis of environmental impacts, the procurement of sustainable materials, and compliance with environmental standards in the main.

This circumstance indicates that although SMEs might be highly conscious of environmental problems, they face a significant difference between being aware of and doing things that are useful. The possible obstacles are their inadequate knowledge regarding sustainable sourcing, the

inability to analyze the supply chain effects, and the absence of structured policies that are important for suppliers' compliance.

To countermeasure the obstacles, Guangdong SMEs might be forced to augment capacity-building actions, among them being training programs regarding supply chain management, that are sustainability-oriented, and the creation of partnerships with organizations excelling at sustainable practices, in addition to the setting up of transparent guidelines and metrics to be used in the assessment of the environmental threats. Through amplifying sustainability in the value chains of their business, these firms not only can increase their performance in the area of the environment but also improve their higher- than-ever bargaining power, owing to the growing impact captured by products that are preferred for their environmental sustainability by consumers.

Nevertheless, the conclusions of the study reveal that the environmental actions implemented by SMEs in Guangdong have no major effect on their supply chains. For example, p-values of various practices relating to the environment such as energy-efficient technologies, waste minimization strategies, and the alliance with responsible suppliers imply that these practices do not significantly affect the environmental impacts of supply chain activities. This vacuum might be caused by the SMEs' deficiency in the knowledge of environmental metrics or their scant resources given to the sustainability assessment of their supply chains.

Similarly, in the case of using sustainable materials, the analysis reports no significant impact on the activities such as waste minimization or water-saving technologies. This suggests that the SMEs in Guangdong might have a hard time locating suppliers with green practices or that the additional expenditures for sustainable sourcing might be discouraging

them from fully engaging in such practices.

As far as compliance with environmental standards is concerned, the findings offer similar evidence for other practices such as renewable energy investments and EMS. Contrary to the significant p-value energy-efficient technology, SMEs in Guangdong still lack efficient measures to control their supply chain environmental compliance, the findings indicate. It is aligned with the literature which emphasizes the difficulties SMEs are going through when trying to get enough resources and know-how in order to monitor and enforce compliance with environmental regulations (Ren et al., 2020).

On the whole, although the surveys of academia show the unquestionable importance of SyMPs to SMEs in Guangdong, practical obstacles that small companies face in trying to be effective with ecology in reality have also been found by the research conducted. The results indicate there is a need for a venture capital investment along with tailored education and government help to enable the SMEs to deal with hurdles and for these businesses to make sure sustainability is the core part

of their operations.

3.3.4. Impact of Regulatory Landscape Challenges on Environmental Business Practices

The ability to efficiently handle government directives and approach the support program is the main criterion for the very environmental-friendly practices initiative. Energy-efficient technologies and practices (p-value = 0.565), waste minimization strategies and recycling (p-value = 0.741), partnering with environmentally responsible suppliers (p-value = 0.286), water-saving technologies and practices (p-value = 0.991), integrating environmental considerations into product design (p-value = 0.129), and implementing an Environmental Management System (EMS) (p-value = 0.554) all showed no significant impact. The p-values in these cases are well above the typical significance threshold of 0.05, indicating that regulatory measures in these areas have not significantly influenced the adoption of environmentally friendly practices by SMEs. As a result, the null hypothesis is accepted for all these variables.

Table 10. Impact of Regulatory Landscape Challenges on Environmental Business Practices

Regulatory Landscape	Environmental Business Practices	p-value	p-value interpretation	Accept/Reject Hypothesis
1. Navigate government regulations and access support for implementing eco-conscious practices.	1. Energy-efficient technologies and practices	0.565	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.741	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.286	Insignificant	Accept
	4. Water-saving technologies and practices	0.991	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.129	Insignificant	Accept
	6. Investment in renewable energy sources	0.005	Significant	Reject
	7. Implementing an Environmental Management System	0.554	Insignificant	Accept
2. Secure funding and technical assistance from government programs for sustainable initiatives.	1. Energy-efficient technologies and practices	0.844	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.954	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.004	Significant	Reject
	4. Water-saving technologies and practices	0.634	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.480	Insignificant	Accept
	6. Investment in renewable energy sources	0.001	Significant	Reject
	7. Implementing an Environmental Management System	0.752	Insignificant	Accept
3. Advocate for policy changes to enhance support for eco-friendly practices in manufacturing.	1. Energy-efficient technologies and practices	0.329	Insignificant	Accept
	2. Waste minimization strategies and recycling	0.413	Insignificant	Accept
	3. Partnering with environmentally responsible suppliers	0.138	Insignificant	Accept
	4. Water-saving technologies and practices	0.750	Insignificant	Accept
	5. Integrating environmental considerations into product design	0.051	Insignificant	Accept
	6. Investment in renewable energy sources	0.090	Insignificant	Accept
	7. Implementing an Environmental Management System	0.576	Insignificant	Accept

However, investment in renewable energy sources (p-value = 0.005) showed a significant impact, leading to a rejection of the null hypothesis. This suggests that regulatory support or incentives related to renewable energy investments are having a tangible effect on SMEs, encouraging them to adopt cleaner energy practices. This could be due to financial benefits, such as tax incentives or subsidies, making renewable energy an attractive investment for businesses.

In the second set of challenges, most environmental practices also showed no significant impact from government funding and support programs. These include energy-efficient technologies (p-value = 0.844), waste minimization (p-value = 0.954), water-saving technologies (p-value = 0.634), environmental product design (p-value = 0.480), and EMS implementation (p-value = 0.752). The high p-values here imply that SMEs have not benefited significantly from government funding or technical support in these areas, possibly due to limited access or awareness of available programs.

However, the results indicated significant impacts in two areas: Partnering with environmentally responsible suppliers (p-value = 0.004) and investment in renewable energy sources (p-value = 0.001) were both statistically significant. This means that government programs have effectively encouraged SMEs to partner with greener suppliers and invest in renewable energy. These findings suggest that the financial or technical support for these practices is more robust or better targeted, helping SMEs to incorporate sustainability more deeply into their supply chains.

In terms of advocating for policy changes to enhance eco-friendly manufacturing practices, none of the environmental practices analyzed showed a significant impact. Energy-efficient technologies (p-value = 0.329), waste minimization (p-value = 0.413), responsible supplier partnerships (p-value = 0.138), water-saving technologies (p-value = 0.750), environmental product design (p-value = 0.051), renewable energy investments (p-value = 0.090), and EMS implementation (p-value = 0.576) all failed to reach statistical

significance. The null hypothesis is accepted for all these variables, indicating that policy advocacy has not led to notable improvements in the adoption of eco-friendly practices within SMEs.

The results reveal that SMEs in Guangdong Province face challenges in leveraging government support and regulatory frameworks for most environmental business practices, as shown by the majority of non-significant p-values. However, investment in renewable energy and partnering with environmentally responsible suppliers stand out as areas where regulations and government initiatives have made a measurable impact. This suggests that more targeted or accessible support in other areas, such as waste reduction, water conservation, and environmental design, may be needed to encourage broader adoption of sustainable practices across SMEs. The findings imply that while certain aspects of the regulatory landscape are effective (particularly in renewable energy and supplier partnerships), there is a gap in the overall impact of environmental regulations and government programs on the broader scope of sustainable business practices within these SMEs. Further engagement with SMEs through tailored government policies, financial incentives, and awareness campaigns could help to bridge this gap.

The results of this study highlight the complexity of integrating environmentally conscious practices within manufacturing SMEs in Guangdong Province, China. The literature agrees with these findings, noting several systemic barriers that hinder the widespread adoption of sustainable practices.

To sum up, the study's results broadly align with the literature, underscoring the challenges Guangdong's

manufacturing SMEs face in adopting sustainable practices. Limited financial support, complex supply chains, and insufficient government incentives remain key obstacles. Nonetheless, specific areas such as renewable energy investments and greener supply chain partnerships show promise, as the statistical data and previous studies support. These findings suggest that targeted government interventions, especially in renewable energy and supply chain sustainability, may offer the most effective means of promoting eco-conscious business practices among SMEs.

3.3.5. Results of the Significant Impact of Each Challenge on Environmental Business Practices

The table outlines the impact of environmental challenges on various environmental business practices, using statistical testing to determine if each challenge significantly influences the associated business practice. These include resource allocation, awareness and education, and regulatory landscape. Each challenge represents actions or considerations companies must address to adopt sustainable practices, such as allocating resources for sustainability, raising awareness among stakeholders, and navigating environmental regulations. Each challenge is linked to specific sustainable business practices. For instance, under "Resource Allocation," companies aim to allocate resources to support eco-friendly manufacturing and partner with responsible suppliers. In "Awareness and Education," companies focus on waste minimization and recycling, while in "Regulatory Landscape," they consider investments in renewable energy and compliance with environmental policies.

Table 11. Summary of the Impact of Environmental Challenges to Environmental Business Practices

Challenges	Environmental Business Practices	p-value	p-value interpretation	Accept/Reject Hypothesis
Resource Allocation 1. Allocate financial and human resources for environmentally friendly practices in manufacturing operations. 2. Prioritize researching and adopting sustainable technologies and processes. 3. Assess short-term costs versus long-term benefits to ensure sustainability in manufacturing operations.	Partnering with environmentally responsible suppliers	0.016	Significant	Reject
	Partnering with environmentally responsible suppliers	0.001	Significant	Reject
	Partnering with environmentally responsible suppliers Integrating environmental considerations into product design	0.045 0.036	Significant Significant	Reject Reject
Awareness And Education 1. Disseminate information about sustainable practices to suppliers, partners, and industry stakeholders.	Waste minimization strategies and recycling	0.018	Significant	Reject
Regulatory Landscape 1. Navigate government regulations and access support for implementing eco-conscious practices. 2. Secure funding and technical assistance from government programs for sustainable initiatives.	Investment in renewable energy sources	0.005	Significant	Reject
	Investment in renewable energy sources	0.001	Significant	Reject
	Partnering with environmentally responsible suppliers	0.004	Significant	Reject

Allocating resources, such as funding and personnel, for environmentally friendly manufacturing is shown to have a significant impact on partnering with environmentally responsible suppliers, as indicated by p-values of 0.016, 0.001, and 0.045. Similarly, integrating environmental considerations into product design is significantly impacted by resource allocation ($p = 0.036$). Each p-value indicates that these resource allocations meaningfully contribute to

sustainable operations.

Educating suppliers, partners, and stakeholders on sustainability also demonstrates a significant effect ($p = 0.018$) on waste minimization and recycling practices. By increasing awareness, companies can drive more effective waste management strategies.

Navigating government regulations and accessing government support shows a significant impact on

investments in renewable energy sources ($p = 0.005$). Additionally, securing government funding for sustainable initiatives ($p = 0.001$) and partnering with responsible suppliers ($p = 0.004$) are influenced by regulatory incentives, highlighting how supportive policies encourage sustainable business practices.

For each row where the p-value is below 0.05, the table notes "REJECT Null Hypothesis," indicating that there is a statistically significant relationship between the environmental challenge and the business practice. This implies that implementing these environmental challenges can effectively drive sustainable practices.

In summary, the table illustrates that environmental challenges—when met with targeted business practices—have statistically significant impacts on achieving sustainability goals. These findings confirm the dominance of resource allocation, educational efforts, and regulatory compliance as the key elements of successful environmental business strategies.

3.4. The Sustainable Green Industrial Development Model

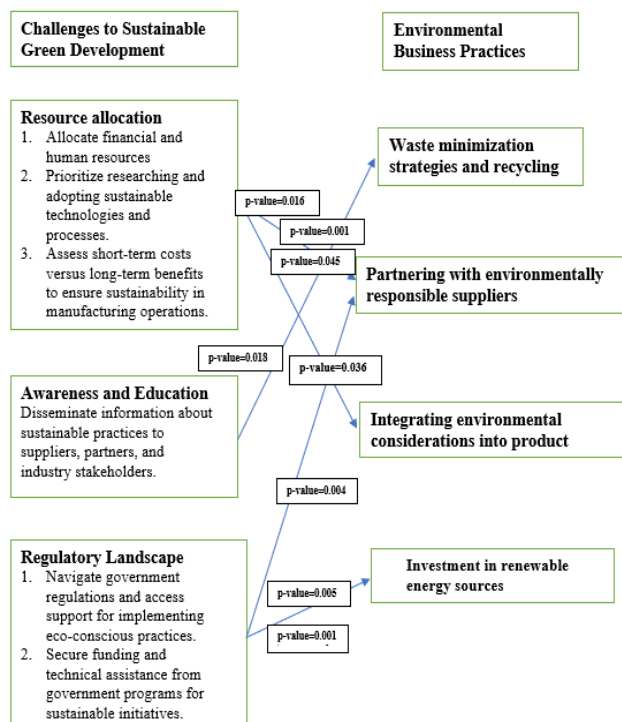


Figure 2. The Sustainable Green Industrial Development Model for SMEs

According to the analysis results of SOP 1-4, it can be found that the number of employees and number of years in business have no significant impact on the adoption of environmental business practices by SMEs. Only the analysis results of SOP5 show that resource allocation has a significant impact on the adoption of partnering with environmentally responsible suppliers and integrated environmental considerations into products by small and medium-sized enterprises. Awareness and education have a significant impact on waste minimization strategies and recycling. Regulatory Landscape has a significant impact on investment in renewable energy sources and partnering with environmentally responsible suppliers. The specific p-value is shown in Figure 2, which is the sustainable green industrial development model, and analysis are shown below.

Challenges to Sustainable Green Development

Resource Allocation: SMEs often struggle with limited financial and human resources, which hampers investment in green technologies. While the allocation of resources is definitely a crucial part of sustainable development, SMEs struggle between the short-run costs and long-term benefits of many investments in green projects with the returns just coming over a period of time (Zhang & Huang, 2021; Chowdhury & Shumon, 2020).

Awareness and Education: A barrier in suppliers, partners, and stakeholders who are not aware of sustainable practices has been stopping the adoption of these green methods. Awareness initiatives can help with this gap and make the small and medium enterprises comprehend and implement sustainability, according to the international standards (Tseng et al., 2019).

Regulatory Landscape: Navigating governmental procedures is a multifaceted issue; although there are sustainability policies that aim at promoting the path of green furniture and energy use, SMEs, at times, are struggling due to the lack of finance, incentives, and good governance. These regulatory hindrances hinder the options SMEs have to comply with the set standards and embrace such practices as green procurement (Govindan et al., 2024; Gao et al., 2022).

Pathways to Environmental Business Practices

(1) **Waste Minimization and Recycling-** In view and looking at China's toxic waste laws, the SMEs in Guangdong have started taking steps in waste reduction and recycling programs. Through minimizing, the SMEs may be able to trim waste costs as well as to find new waste streams to make money from recycled materials (Kanwal et al., 2022).

(2) **Partnering with Environmentally Responsible Suppliers-** Teaming up with suppliers who give priority to environmental responsibility is key. Such partnerships prove to be a suitable fit for small and medium-sized enterprises as they seek to align their supply chains with green initiatives, although the process of interconnecting various parts of a chain can often be burdensome (Tseng et al., 2019).

(3) **Integrating Environmental Considerations into Products-** Guangdong SMEs are reshaping technological processes by manufacturing the eco-friendly items that buyers are now looking for, thus this trend is becoming a drive among the consumers to buy the sustainable ones. Such strategy apart from being a market differentiator, builds customer loyalty, which in turn represents a competitive edge.

(4) **Investment in Renewable Energy-** Energy-saving technology such as LED systems is the focus of Guangdong, which is adopting them to lower electricity use. Since the upfront costs are mostly high, the economic value of these savings programs and the environmental contributions they offer to the future make them a possible growth strategy in sustainability (Prashar et al., 2019; Shurrab et al., 2019).

In summary, SMEs in Guangdong Province are confronted by substantial challenges, but, at the same time, also have ample chances to implement sustainable practices. Resources allocation, partnerships, and government support, as well, enable them to deal both with instantaneous operational needs and long-term environmental goals thus contributing to China's broader commitment to reducing carbon emissions (Li et al., 2020; Wang et al., 2023).

4. Conclusion

The following conclusions are drawn from the study's findings:

While the survey was titled as "Effectiveness of Green Operations," the researcher said that SMEs did not explain or demonstrate any actual usage of the green operational technique. Despite this, however, it was found that the investment in renewable energy is considered by no more than 5% of the survey respondents as a highly effective environmental protection practice. Congruently, these enterprises also prefer to improve waste management and recycling, although, in reality, the actual values of performance are yet insignificant. Possibilities such as funds from weather-positive suppliers as well as making environmental issues a priority in product design are affirmed and rated as fewer effective ones too. Overall, the findings indicate that there are great chances to enhance the efficiency of these eco-friendly projects with SMEs.

The study indicates that small and medium enterprises (SMEs) in Guangdong Province generally perceive low challenges in implementing environmental business practices, despite recognizing the importance of sustainability. Resource allocation emerged as the most significant challenge, though respondents did not view it as a major obstacle, likely due to awareness of long-term benefits. While raising awareness and fostering an environmentally conscious culture were prioritized, these tasks were also considered less challenging, reflecting confidence in engaging employees and stakeholders. In supply chain management, ensuring supplier adherence to environmental standards was seen as complex but manageable, indicating a level of confidence in sustainable practices. Overall, SMEs felt relatively supported by government initiatives and did not perceive regulatory compliance as particularly problematic, focusing more on existing regulations than on advocating for policy changes.

According to the survey results, manufacturing SMEs in Guangdong Province of China are commonly met with no trouble in delivering ecological principles in environmental business. Resource allocation is the main factor for them in being able to put this into effect; even then, this issue is not considered a serious problem. The companies have confidence that they will be able to place environmentally friendly technologies at the top of their priorities. As SMEs are still coming to grips with immediate costs versus long-term gains, they, however seem to have developed a greater understanding of the long-term potential of their environmental policies. Involving employees as well as stakeholders in sustainability efforts plus training is said to be not so serious according to them. Either the company's internal policies or the available resources made it this way. It is also connected to supply chain management and regulatory compliance, the SMEs perceived these areas to be quite uncomplicated, especially due to government interventions they could count on.

Moreover, the research emphasizes the issue of raising awareness and cultivating an environmentally friendly culture within SMEs and thus, the necessity for sustainable behavior among employees and stakeholders is being discussed. On the contrary, different ecological methods such as energy-saving and waste reduction turned out to be no more than just a further decrease in idleness while mindfulness was not significantly influenced though some measures were closer. Initiatives in the line of training are noted as the necessary ones for preparing the staff with the skills that are applicable in the execution of sustainability, yet the current practices do not have a mild influence on training. Spreading the word of sustainable practices to outer partners has almost brought no

results but waste minimization got the most positive one. This along with the indispensable knowledge acquired from credible sources allows SMEs to proclaim their waste reduction programs which can be quantified and shared with partners and suppliers.

Moreover, the study stresses the problem of evaluating supply chain activities' environmental impacts, which means that different environmental practices currently are not very powerful in this sector. SMEs in Guangdong seem to have a lack of knowledge in the field of green accounting as well as a lack of resources for their evaluations. Another issue related to using eco-friendly materials comes to light. The SMEs do not give enough weight or accomplish sustainable sourcing strategies, maybe because it is difficult to find eco-friendly suppliers and the prices are too high. On the other hand, adhering to environmental standards among suppliers and partners becomes another difficulty. The findings reveal that SMEs agree that compliance is a must, but they do not have adequate systems to ensure their adherence. In general, this evidence of a more successful supply chain management more sustainable solutions, along with top-down directives and policies, therefore, becomes the priority.

The study focuses on the critical role of idling through governmental rules and getting help for implementing green practices to clearly see that the majority of environmental projects do not greatly enforce the regulation. Mostly, green practices have no effect whereas only green energy saving is the clear example of those measures that are greatly supported by the government, so it seems that monetary incentives from the government are indeed quite likely to attract SMEs to the clean energy path. Furthermore, engaging the suppliers, who are involved in preserving the environment, is another field where the government programs have the positive impact. On the other hand, governmental support and finance, in general, have not been to the advantage of SMEs in implementing some sustainable technologies and practices. Also, the changes in the policy have been so minimal that they have not really affected the rate of eco-friendly actions in these companies.

The model for Sustainable Green Industrial Development in Guangdong, China, as presented in Figure 2 highlights key challenges and pathways for SMEs to adopt environmentally friendly practices. Figure 2 in Chapter 3 presents in detail the significant impact of different challenges, such as resource allocation, awareness and education, and regulatory patterns, on the adoption of different forms of environmental business practices by SMEs. Given China's significant contribution to global carbon emissions—largely due to rapid industrialization and export-driven growth—there is a pressing need for sustainable practices in its manufacturing sector (Zhang et al., 2024). Guangdong Province, a major industrial hub, faces environmental degradation from hazardous waste, air pollution, and water contamination, driving local manufacturing SMEs to adopt eco-conscious initiatives (Ge et al., 2020; Li et al., 2020).

5. Recommendations

Based on the results and conclusions of SOP1, two recommendations are proposed: Firstly, small and medium-sized manufacturing enterprises in Guangdong Province should increase their investment in environmental protection technologies and practices, especially in renewable energy and waste minimization strategies. Although these areas are considered relatively effective in current environmental

business practices, their overall efficiency still needs to be improved. Enterprises should actively explore and apply more advanced renewable energy technologies, such as solar and wind energy, to reduce energy consumption and carbon emissions. Meanwhile, strengthening waste management and recycling, reducing resource waste and environmental pollution, are also key to enhancing the effectiveness of environmental protection practices. Secondly, the Guangdong Provincial Government and relevant departments should introduce more policies and measures to support the environmental protection practices of SMEs. The government can formulate preferential policies such as tax reductions and funding subsidies to encourage enterprises to increase their investment in environmental protection and improve their environmental technology level. At the same time, strengthen the supervision and enforcement of environmental regulations, ensure that enterprises comply with environmental regulations, and reduce environmental pollution. In addition, the government can also establish platforms to promote cooperation between small and medium-sized enterprises, environmental technology suppliers, research institutions, etc., to jointly promote environmental technology innovation and application, and enhance the environmental practice ability and level of enterprises.

Based on the results and conclusions of SOP2, four recommendations are proposed:

(1) Strengthen resource allocation for sustainable development initiatives. Small and medium-sized enterprises in Guangdong should prioritize resource allocation, support the adoption of green technologies, and balance short-term costs with long-term environmental and economic benefits. Small and medium-sized enterprises can optimize resource allocation and gradually implement environmental protection practices while maintaining financial stability.

(2) Invest in awareness raising and educational programs. In order to bridge the knowledge gap between suppliers, partners, and stakeholders, small and medium-sized enterprises should implement awareness and education initiatives focused on sustainable practices that meet global standards, such as developing training programs, organizing seminars, or collaborating with industry organizations to share best practices for sustainable development. Educating stakeholders will help better align with sustainable development goals and cultivate a more ecologically conscious corporate culture.

(3) Strengthen green supply chain management. Small and medium-sized enterprises can integrate internal and external resources to promote the joint implementation of green procurement, clean production, and environmentally friendly logistics strategies by upstream and downstream enterprises in the supply chain. At the same time, they can strengthen cooperation with government, industry associations, and other institutions, obtain policy support and market information, ensure that all links in the supply chain comply with environmental standards, and comprehensively improve the environmental performance and sustainable development capabilities of the supply chain.

(4) Simplify regulatory compliance and leverage government support. Small and medium-sized enterprises should utilize existing government plans and incentives aimed at promoting sustainable development, and work closely with regulatory agencies to help these enterprises cope with complex compliance environments and ensure

compliance with environmental standards. In addition, advocating for strengthening financial incentives or simplifying regulatory procedures can further help SMEs achieve sustainable development.

Based on the results and conclusions of SOP3, four recommendations are proposed:

(1) Increasing efforts to minimize and recycle waste. Implementing waste reduction and recycling plans can help small and medium-sized enterprises reduce disposal costs and may generate additional sources of income from recycled materials. According to China's hazardous waste regulations, small and medium-sized enterprises should assess their waste production and identify opportunities to minimize it. Encouraging internal recycling and exploring partnerships with waste management companies can further support these goals.

(2) Strengthen partnerships with environmentally responsible suppliers. Collaborating with suppliers who prioritize environmental responsibility is crucial for achieving a sustainable supply chain. Small and medium-sized enterprises should establish environmental supplier standards and conduct regular evaluations to ensure compliance with these standards. This strategy not only reduces the impact on the environment, but also enhances the company's reputation by aligning with sustainable development partners.

(3) Develop and sell environmentally friendly products. Small and medium-sized enterprises in Guangdong can stand out in the market by designing products with minimal environmental impact. Environmental product innovation caters to consumers' growing demand for sustainable choices, establishes brand loyalty, and provides competitive advantages. By incorporating environmental factors into product design, small and medium-sized enterprises can strengthen their market positioning while promoting sustainable development.

(4) Expand investment in renewable energy. Small and medium-sized enterprises should consider adopting energy-saving technologies such as LED lighting systems and renewable energy to reduce energy consumption and lower long-term operating costs. Government incentive measures, such as green loans, can help small and medium-sized enterprises provide funding for these projects, enabling them to reduce their carbon footprint and contribute to China's broader sustainable development goals.

Based on the results and conclusions of SOP4, two recommendations are proposed: Firstly, it is recommended that small and medium-sized enterprises in Guangdong Province pay special attention to the rationality of resource allocation when promoting sustainable development. Resource allocation is a key factor affecting the cooperation between small and medium-sized enterprises and environmentally responsible suppliers, as well as incorporating environmental factors into product design. Therefore, enterprises should optimize resource allocation and ensure sufficient funds, technology, and human resources are invested in green supply chain management, such as supporting green procurement, promoting clean production, and environmentally friendly logistics, to achieve the green transformation of the supply chain. Secondly, given the significant impact of awareness and education on waste minimization strategies and recycling, small and medium-sized enterprises in Guangdong Province should increase environmental training and publicity efforts for their

employees. By enhancing employees' environmental awareness, they can better understand and participate in the company's green supply chain management practices, such as actively participating in waste classification, recycling, and other activities. At the same time, enterprises can also cooperate with educational institutions, industry associations, and other organizations to jointly carry out environmental education and training projects, cultivate more professional talents with environmental literacy, and provide strong support for the sustainable development of enterprises.

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