

Article

How Green Technology and Company Green Commitment Affect SME Internationalization Performance Through Eco-Innovation: The Moderator of Government Support Programs

Jinghui Wang ¹, Noor Afzainiza binti Afendi ^{2,*} and Muhamad Ali Imran Bin Kamarudin ^{3,*}

¹ School of International Studies, Universiti Utara Malaysia, Sintok 06010, Kedah Darul Aman, Malaysia; wang_jinghui@gsgg.uum.edu.my

² International Business Program, Universiti Utara Malaysia, Sintok 06010, Kedah Darul Aman, Malaysia

³ Entrepreneurship Program, Universiti Utara Malaysia, Sintok 06010, Kedah Darul Aman, Malaysia

* Correspondence: afzainiza@uum.edu.my (N.A.b.A.); aliimran@uum.edu.my (M.A.I.B.K.)

Abstract

This study investigates the relationship between green technology, company green commitment, and the internationalization performance of small and medium-sized enterprises (SMEs), with a particular focus on the mediating role of eco-innovation and the moderating effect of government support programs. Based on a resource-based view, we develop and test a comprehensive model using the partial least squares structural equation modeling (PLS-SEM) method to determine the variables that significantly affected the mechanisms (i.e., green technology, company green commitment) and internationalization performance. The results revealed that both green technology and company green commitment positively affect the internationalization performance of SME with eco-innovation mediating the relationships. Furthermore, the government support programs moderate the relationship between SMEs' green technology/company green commitments and internationalization performance by strengthening this relationship under higher levels of institutional support. This suggests that policymakers need to focus on the intensity and effectiveness of government support programs, and enterprises should actively integrate high-quality policy resources to maximize international competitiveness. The findings contribute to sustainable international business by elucidating the mechanisms through which sustainable development translates into competitive advantages. Practical implications suggest that SME managers should strategically align technological and commitment-based green elements while actively leveraging governmental support mechanisms to optimize international expansion.

Keywords: green technology; company green commitment; internationalization performance; SMEs; eco innovation; government support programs

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1. Introduction

In the context of escalating environmental pressures and intensifying global competition, small-medium enterprises (SMEs) are increasingly required to integrate sustainability-oriented practices into their internationalization strategies [1,2]. For Chinese SMEs in particular, participation in international markets is no longer driven solely by cost advantages but increasingly by their ability to meet stringent environmental standards and

sustainability expectations imposed by global value chains and foreign regulators [2]. The global shift toward a green economy represents not only an environmental imperative but also a substantial economic opportunity [3]. For SMEs, which constitute approximately 90% of businesses worldwide and account for significant employment and value creation, navigating the intersection of environmental responsibility and global market expansion presents both challenges and competitive advantages [4].

As a major manufacturing and exporting nation, Chinese SMEs face pressure from international green trade barriers and the environmental standards of global supply chains, which compel a shift toward sustainable business models. This transition positions eco-innovation, the development of new products, processes, and services that reduce environmental impact, as a critical strategic lever [1,5]. While the adoption of green technology and a strong company green commitment are intuitively linked to improved internationalization outcomes, the specific pathways and contingent conditions of this relationship within the unique institutional context of China remain inadequately explored. The existing literature often examines these factors in isolation or within developed economy contexts [6–9], leaving a significant gap in understanding how they interact dynamically to shape the export and international performance of SMEs in the world's second-largest economy, particularly under the influence of government support programs.

Prior research has shown that environmentally oriented strategies enhance firm competitiveness and performance; however, the empirical evidence on how green-oriented firm capabilities translate into internationalization performance remains fragmented [10,11]. More importantly, the current literature tends to conceptualize firms' green orientation in an aggregated or undifferentiated manner without sufficiently distinguishing between green technology implementation and company green commitment as distinct organizational capabilities [12,13]. Green technology reflects a firm's operational and technological capability to adopt and deploy environmentally friendly technologies [8], whereas company green commitment captures a strategic and value-based orientation toward environmental responsibility embedded in managerial intentions and organizational culture [14]. Although both have been linked to innovation and performance outcomes, prior studies rarely examine their differentiated roles within a single analytical framework nor do they clarify the mechanisms through which these green-oriented capabilities affect SME internationalization performance [12]. As a result, the process by which green-oriented resources are transformed into international performance advantages remains theoretically underdeveloped and empirically underexplored [15,16].

Also, the role of government support programs as a potential moderator, amplifying or enabling the effects of green drivers on innovation and performance, is frequently mentioned but lacks systematic empirical validation within China's policy ecosystem. Previous research has established that institutional support significantly influences green export strategies and outcomes, and that green innovation strategies enhance firms' probability of both entering and persisting in international markets [17,18]. Furthermore, studies have demonstrated that the depth of internationalization among innovation enterprises correlates positively with innovation performance and sustainability, while international expansion generally promotes eco-innovation [19]. Despite these valuable contributions, critical gaps remain in understanding how green technology and company green commitment affect the internationalization of Chinese SMEs [20,21].

To address these gaps, this study advances the literature by proposing and empirically testing a mechanism-based model in which eco-innovation serves as the mediating pathway linking green technology and company green commitment to SME internationalization performance. Based on the resource-based view (RBV), which posits that firm-specific resources and capabilities that are valuable, rare, inimitable, and non-substitutable constitute the foundation of sustainable competitive advantage in both domestic and

international markets [8,22]. From an RBV perspective, green technology represents a strategic technological capability that enhances resource efficiency, environmental compliance, and innovation potential [8], while company green commitment reflects an organizational-level intangible resource embedded in managerial values, routines, and long-term strategic orientation [23,24].

The study moves beyond direct-effect explanations and provides a more precise account of how green-oriented capabilities are converted into value-creating outcomes in international markets. Furthermore, recognizing that SMEs operate within heterogeneous institutional environments, this study incorporates government support programs as a moderating factor that conditions the effectiveness of green technology and company green commitment. Focusing on Chinese SMEs, the study offers a context-sensitive and theoretical explanation of sustainable internationalization, thereby contributing to green innovation, international business, and the SME literature by clarifying distinct capability roles, identifying an innovation-based mechanism, and highlighting institutional boundary conditions [5].

The objective of this study is to examine how green technology and company green commitment influence the internationalization performance of Chinese SMEs, with emphasis on the mediating role of eco-innovation and the moderating effect of government support programs. Building on the gaps mentioned, this study provides a more nuanced and mechanism-based understanding of how green technology and company green commitment translate into internationalization performance under institutional conditions. First, it conceptually and empirically demonstrates that these two green-oriented resources represent different foundations with distinct implications for eco-innovation. Second, drawing on the resource-based view, this study identifies eco-innovation as a key mediator through which green technology and company green commitment are converted into internationalization performance. By explicitly modeling and testing this mediating process, the study extends existing work that has largely focused on direct relationships between environmental practices and firm performance. Third, this study introduces government support programs as a moderating condition that shapes the effectiveness of green technology and company green commitment in international markets. The findings show that institutional support strengthens the contributions of green technology and company green commitment to internationalization performance, underscoring the contingent role of government support programs in SMEs development.

2. Literature Review and Hypothesis Development

2.1. Theoretical Foundations

Our theoretical framework integrates perspectives that explain how green technology and company green commitment translate into internationalization advantages for SMEs in China. The resource-based view (RBV) provides the foundational premise that green technology and company green commitment represent valuable, rare, and difficult-to-imitate resources that generate sustainable competitive advantages in international markets [8,22]. Green technologies encompass specialized equipment, processes, and knowledge systems that reduce environmental impact while potentially lowering costs and enhancing product differentiation [8,25]. Company green commitment reflects the strategic prioritization of environmental objectives throughout organizational policies, practices and culture, signaling consistency and credibility to international stakeholders [26].

2.2. Direct Effects: Green Technology, Company Green Commitment, and Internationalization Performance

Green technology refers to a firm's technological capabilities, systems, and processes that are designed to conserve natural resources, reduce pollution, and minimize environmental impacts throughout business operations. Rather than merely reflecting the adoption of specific practices, green technology embodies an organization's broader technological orientation toward environmental goals [25,27].

For SMEs pursuing international markets, green technology enhances competitiveness through multiple mechanisms. It improves operational efficiency by reducing energy, water, and material consumption, thereby lowering production costs, an advantage that is particularly valuable in price-sensitive export markets [17,21]. Green technology enables firms to comply with increasingly stringent environmental regulations in developed economies, thereby reducing regulatory barriers to foreign market entry [28,29]. In addition, green technology supports product differentiation by embedding environmental attributes into products and processes, which appeals to the growing global segment of environmentally conscious consumers [17,30].

Prior research has suggested that green technology is indeed a force on a firm's performance [31–33]. Evidence from Pakistani manufacturing SMEs found that embracing green technology innovation and environmental knowledge management practices positioned these firms to gain a competitive edge internationally, thereby enhancing their export performance [34]. The strategic adoption of green technology helps SMEs differentiate their offerings, comply with increasingly stringent international environmental regulations, and meet the growing global consumer demand for sustainable products and services [35,36]. This strategic alignment with global sustainability trends not only opens new market opportunities but also strengthens the firm's brand reputation among international customers who value environmental responsibility [8,37]. Generally, the firms that achieve considerable performance are the ones that invest extensively in green training for personnel, facility renewal, and green technology. A study of innovative Chinese enterprises found that the depth of internationalization is significantly positively correlated with innovation performance and sustainability [38]. Based on this theoretical and empirical foundation, we hypothesize:

H1a: *Green technology positively influences SME internationalization performance.*

Company green commitment extends beyond technological investments to encompass strategic, cultural, and behavioral dimensions of environmental orientation. It reflects the extent to which environmental considerations are integrated into business philosophy, decision-making processes, and stakeholder relationships [14,26]. This commitment signals authenticity and consistency to international partners, customers, and regulators, enhancing credibility and reducing the liability of foreignness that SMEs often face when entering new markets [39].

There is a contingent of research that regarded the environmental commitment to be one that increased operational costs and reduced performance [39,40]. Some also believed that it was a profitless undertaking by family firms [39]. However, over time, other scholars have demonstrated that commitment to environmental issues could, in fact, lower costs and increase performance [39,41].

Research focused on Spanish firms indicates that commitment to green innovation strategies, such as reductions in energy and water consumption, generates a premium for companies in international markets, increasing both the probability of entering and remaining in these markets [42]. The view emphasizes how committed SMEs can leverage networks and relationships to access complementary resources and knowledge [42].

Furthermore, green commitment fosters organizational learning and capability development that are transferable across international contexts [14]. Therefore, we propose:

H1b: *Company green commitment positively influences SME internationalization performance.*

Green technology positively influences eco-innovation in SMEs by providing the essential tools and operational pathways that translate sustainability goals into concrete innovations [25,43]. When SMEs adopt specific green technologies, such as renewable energy systems or cleaner production processes, they do more than just reduce their environmental footprint, embedding a framework for continuous improvement and novel problem-solving [21,27]. The United Nations Environment programmer emphasizes that eco-innovation involves a set of modifications to products, processes, and organizational structures, a transformation that is fundamentally enabled by green technology [25], which found that pre-existing pro-environmental practices—often rooted in initial technology—directly encourage further eco-innovation, particularly in processes and products/services. Thus, green technology acts as a catalyst, turning sustainability into a practical drive for eco-innovation [44].

The influence of green technology on SME eco-innovation extends beyond internal operations to reshape market engagement and create new competitive advantages. The relationship is well-established, with major literature reviews confirming that the adoption of green technology is a central driver of environmental innovation in SMEs [27]. The influence works through multiple pathways: green technology acts as a direct input for developing new, sustainable products and processes. This strategic integration is increasingly recognized as essential for SMEs to achieve long-term competitiveness while meeting evolving regulatory and market demands for sustainability [29,45].

By integrating technologies that allow for lifecycle thinking, SMEs collaborate with value chain partners to identify hotspots for improvement and develop innovative solutions, thereby strengthening their market expansion. This strategic integration leads to tangible outcomes; research confirms that green product and process innovations significantly enhance a firm's economic, environmental, and social performance [40]. Furthermore, green technology enhances the financial logic of eco-innovation by improving cost efficiency and productivity, which helps justify the initial investment and supports long-term business resilience [44]. Consequently, for SMEs, green technology is not merely an operational cost but a strategic asset that unlocks innovative potential and aligns commercial success with environmental stewardship [25]. Therefore, we propose:

H1c: *Green technology positively influences the eco-innovation of SMEs.*

A company's green commitment acts as a critical strategic catalyst that directly mobilizes resources and shapes priorities toward eco-innovation within SMEs. The commitment that is formally articulated and endorsed by leadership transforms environmental values into actionable strategic objectives. It legitimizes the allocation of often scarce resources including capital, personnel, and time toward green development and sustainable process redesign [14,39]. Research analyzing manufacturing SMEs indicates that pre-existing, formal pro-environmental practices, which are an expression of corporate commitment, create a foundational capacity and internal mindset that directly encourage the pursuit of further green innovations in products, services, and processes [40].

Furthermore, the company green commitment extends its positive influence on eco-innovation by strengthening external collaborations and enhancing market legitimacy, which are particularly vital for SME growth and competitiveness [40,46]. By publicly committing to sustainability, an SME sends a credible signal to supply chain partners, customers, and financial institutions. This signal facilitates access to green knowledge networks,

attracts partnerships for co-developing innovative solutions, and improves the terms of financing for sustainable projects. The visible commitment provides SMEs with critical insights and resources that fuel their innovation cycles [14,26]. Ultimately, the commitment-driven path to eco-innovation translates into robust business performance. Studies confirm that SMEs actively engage in green products and process innovation because of the commitment to achieve significant improvements across economic, environmental, and social performance metrics, securing their long-term resilience and market position [1,21]. Therefore, we propose:

H1d: *Company green commitment positively influences the eco-innovation of SMEs.*

2.3. Indirect Effects: The Mediating Role of Eco-Innovation

Eco-innovation refers to the development of new or significantly improved products, services, processes, marketing methods, or organizational structures that reduce environmental impacts throughout their lifecycle [1,47]. Unlike conventional innovations, eco-innovations typically address both environmental and market objectives simultaneously, creating “win-win” solutions that appeal to international stakeholders with diverse priorities [48]. For consumers and society, eco-innovation diminishes the burden on the environment. For companies, eco-innovation increases short-term and long-term competitiveness and the creation of new markets [49].

Empirical research has reported a positive association between environmental and financial performance, between green product innovation and financial performance, and between all three eco-innovation types (i.e., product, process, and organizational eco-innovation) and firm performance [3,41]. Research provides empirical evidence between eco-innovation and sustainable performance, arguing that eco-innovations improve organizations’ competitiveness in innovation, operations, and marketing [48,50]. However, because of the absence of holistic, systemic eco-innovation guidelines in SMEs, there exist inconsistent findings on eco-innovation/sustainable performance, varying from positive to no significant relationships and even negative significant relationships [47,50]. Green technology provides the foundational knowledge and technical capabilities that enable eco-innovation [44]. Company green commitment creates the organizational context necessary for eco-innovation to flourish. Committed leadership, supportive cultures, aligned incentive systems, and cross-functional collaboration foster the creativity, risk-taking, and perseverance required for successful innovation [14,26].

Eco-innovation mediates the relationship between green antecedents and internationalization by creating marketable advantages that resonate with global stakeholders [1]. Innovative green products meet regulatory requirements and consumer preferences in target markets more effectively than conventional alternatives [46]. Green process innovations reduce costs and risks associated with international operations. Organizational and marketing innovations help SMEs navigate complex international institutional environments [1,50]. Based on previous research, we hypothesize:

H2a: *Eco-innovation mediates the relationship between green technology and SME internationalization performance.*

H2b: *Eco-innovation mediates the relationship between company green commitment and SME internationalization performance.*

2.4. The Moderating Role of Government Support Programs

Government support programs encompass a range of interventions designed to encourage and facilitate environmentally sustainable business practices, particularly in the

context of international expansion, which include financial incentives (grants, subsidies, and tax benefits), informational resources (market intelligence, technical assistance), regulatory guidance, networking opportunities, and certification support [51]. Such programs address market failures and resource constraints that often hinder SMEs from pursuing green internationalization strategies [51,52].

The moderating effect of government support operates through several mechanisms. On the one hand, it reduces the financial and knowledge barriers associated with green technology, making investments more feasible for resource-constrained SMEs [53]. On the other hand, it validates and amplifies company green commitment, enhancing credibility with international stakeholders. Also, it may provide platforms for learning and network development that accelerate innovation processes [53].

Studies have shown that institutional support for green export strategies significantly enhances export performance, with the relationship mediated by green innovation, export readiness, and export activities [17,54]. This suggests that committed firms are better positioned to leverage external support and translate it into international success [9]. Empirical evidence supports the importance of institutional support in green internationalization. Research on SMEs in sustainability-focused sectors reveals significant associations between institutional support and green technology, green activities, and innovation [17,54]. Research found that the relationship with the government has a positive and significant moderating effect on the relationship between commitments and export performance only in regions where the level of marketization is high [55]. Conversely, others concluded that firm–government relationships have a significant positive impact on a firm’s innovation, indicating that the stronger the government–firm relationship, the greater the firm’s innovation output [17]. Accordingly, we hypothesize:

H3a: *Government support programs moderate the relationship between green technology and internationalization performance.*

H3b: *Government support programs moderate the relationship between company green commitment and internationalization performance.*

2.5. Integrated Conceptual Model

Building on the mentioned hypotheses, Figure 1 presents the integrated conceptual model [12]. The model depicts green technology and company green commitment as independent variables with direct effects on internationalization performance (H1a,b) and eco-innovation (H1c,d) and also indirect effects through eco-innovation (H2a,b). Government support programs are positioned as a moderator of the relationship between green technology, company green commitment, and internationalization performance (H3a,b).

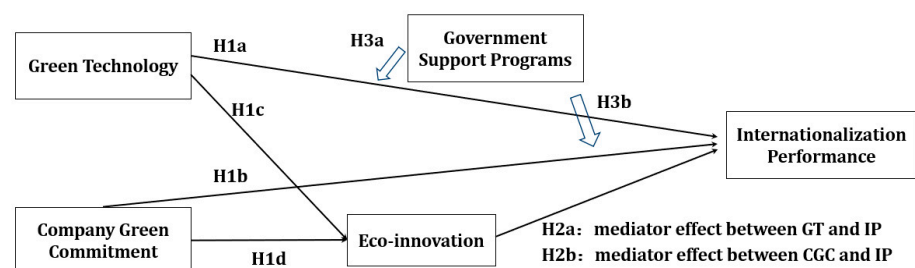


Figure 1. Conceptual research model.

3. Methodology

3.1. Research Design and Sample

This study employs a quantitative research design using cross-sectional survey data to test the proposed hypotheses (see Appendix A). The research object is the SMEs in China that conducted international business. The SMEs were defined according to the Statistical Classification Method for Large, Medium, Small and Micro Enterprises (2017), published by the National Bureau of Statistics [56]. Data was collected through a survey administered to SMEs responsible for international operations and environmental strategies. We employed random sampling to ensure representation across sectors. The researchers visited the Taiyuan Customs District China, Shanxi Provincial Department of Commerce, and obtained a list of 2051 manufacturing SMEs as the research subjects. According to the calculation of G*Power software (G*Power 3.1.9.7), the sample size needs to be 109. Considering the lower response rate, 327 questionnaires were conducted. Followed by this, this study had numbered all the 2051 manufacturing SMEs as listed from the source randomly. The sampling was then determined by dividing 2051 by 327, producing a sampling fraction of 6.27, which was rounded to 6 (the number 6.27 was rounded to the nearest whole digit). The next step was to choose a random number between 1 and 2, and the study chose number 2. Thus, number 2 on the list of export manufacturing SMEs was the first respondent. The study went on selecting every 6th SME on the list until the sample size reached 327.

Before the survey process, a formal letter request is sent to the top management of randomly selected organizations to seek permission for taking questionnaires. After getting permission, the researcher contacts the secretary of each organization to distribute the questionnaires; the cover letter and questionnaire are submitted to secretaries of the organizations. The survey was done in November 2025, and the period lasted one month; the mode of distribution is according to the result of the random sample.

From an initial list of 327 potential SMEs, 266 completed responses were returned, representing a response rate of 81.3%. Nine questionnaires were identified as having abnormal responses, and twenty-six questionnaires were found to contain inconsistent or incorrect answers. Therefore, 231 valid questionnaires were ultimately retained for subsequent statistical analysis using SmartPLS (smartPLS 4.1.0.9) and SPSS software (IBM SPSS Statistics 19) [3,51].

3.2. Measures

All constructions were measured using multi-item scales adapted from established literature instruments, as shown in Table 1. Responses were recorded on 5-point Likert scales ranging from “strongly disagree” (1) to “strongly agree” (5).

Table 1. The measurement items in this study.

Constructs	Items	Source
<i>Internationalization Performance (IP)</i>	1. Our company achieved growth in international sales.	[3]
	2. Our company achieved international net profit margin.	
	3. Our company achieved international growth profit margin.	
	4. Our company achieved growth in international operations ROI.	
	5. Our company achieved growth in the international market share.	
	6. Our international customers are satisfied with our products and services.	
	7. Our international business reputation is considered good.	
	8. Our company achieved growth in the introduction of new products and services in the international market.	
<i>Green Technology</i>	1. Our company has set specific green technology implementation goals.	[8,25]

(GT)	2. Our company has a dedicated team responsible for the implementation of green technology. 3. Our company is committed to investing in the latest green technology. 4. Our company strictly implements environmental protection standards and regulations during the production process. 5. Our company regularly evaluates and improves the implementation of green technology. 6. Our company's employees have received training related to green technology. 1. Our staff cares about the environmental concerns of our company. 2. The environmental concern of our company means a lot to our staff. 3. Our staff feel a sense of duty to support the environmental efforts of our company.	
Company Green Commitment (CGC)	4. Our staff feel as if our company's environmental problems are their own. 5. Our staff feel personally attached to the environmental concerns of our company. 6. Our staff strongly values the environmental efforts of our company. 7. Our staff would feel guilty about not supporting the environmental efforts of our company.	[14]
Eco-innovation (EI)	1. Our company is improving and designing environmentally friendly packaging (e.g., using fewer paper and plastic materials) for existing and new products. 2. Our company chooses materials for the product that consume the least amount of energy and resources for conducting the product development or design. 3. Our company uses the smallest possible amount of materials to create the product when conducting the product development or design. 4. Our company deliberately evaluates whether the product is easy to recycle, reuse and decompose when conducting the product development or design. 5. Low energy consumption such as water, electricity, gas and petrol during production use/disposal. 6. Recycling, reuse and remanufacture of material. 7. Use of cleaner technology to generate savings and prevent pollution (e.g., energy, water and waste). 8. The manufacturing process of my company effectively reduces the emission of hazardous substances or waste. 9. The manufacturing process of my company reduces the use of raw materials. 10. Our firm's management frequently utilizes innovative systems to manage eco-innovation. 11. Our firm's management often collects information on eco-innovation trends. 12. Our firm's management often actively engages in eco-innovation activities. 13. Our firm's management often communicates eco-innovation information with employees. 14. Our firm's management often invests a high ratio of R&D in eco-innovation. 15. Our firm's management often communicates experiences among various departments involved in eco-innovation.	[1]
Government Support Programs (GSP)	1. Our company believes that we have adequate financial assistance to aid SMEs. 2. Our company utilizes available credit scheme services to get supplemental financing for our business operations. 3. Our company uses the trade finance facilities from export service agents who buy products and resell them in international markets. 4. Our company believes that the government grants are easily accessible and available to provide additional finances. 5. Our company believes the National Microfinance Policy supports our firm's business operations. 6. Our company believes that there are potential agents and distributors in international markets to facilitate our business operations.	[51]

7. Our company believes that the current government policy objectives are relevant to our firm's business operations.
 8. Our company utilizes the one-stop business advice center services.
 9. Our company believes we have adequate non-financial assistance to aid SMEs.
 10. Our company utilizes services from a local trade advisor.
 11. Employees in our company regularly attend export training seminars.
-

Green Technology refers to the firm-level routines and organizational practices related to the planned implementation, resource investment, and responsibility allocation for environmentally friendly technologies. It is also essential to impart these innovative green practices that span beyond the organization and encourage other stakeholders [8,25].

Company green commitment reflects the willingness of company to contribute actively and passionately towards firm development. Factors influencing individual green commitment include job satisfaction, organizational culture, leadership, and perceived organizational support [14].

Eco-innovation represents a driver of internationalization performance, enabling companies to achieve sustainable growth, enhance competitiveness, and capitalize on global market opportunities [1].

Government Support Programs are operationalized as SMEs' access to and utilization of policy, financial, and technical support instruments provided by public authorities to facilitate sustainable practices and international market expansion. They were measured based on typologies of export promotion programs and adapted to include environmental dimensions where relevant [51].

Internationalization Performance refers to the concept of achieving strategic goals through transnational business activities, which include both financial performance and non-financial performance. This study refers to the items proposed by Rehman [3].

3.3. Analytical Approach

Initially, we conducted confirmatory factor analysis (CFA) to assess the measurement model's validity and reliability. Then, structural equation modeling (SEM) was employed to test the hypothesized relationships. Also, we performed mediation analysis and moderation effects using bootstrapping procedures [51,57].

4. Results

4.1. Descriptive Statistics

To gain a comprehensive understanding of the background of the individuals and organizations participating in this survey, we examined the basic demographic characteristics of the respondents. We analyzed several key demographic variables, including gender, age, highest level of education, years since organization establishment, and company size as a measure of the number of employees. These characteristics provide important contextual information and describe the representativeness and diversity of the sample.

Regarding gender distribution, Table 2 shows a relatively balanced sample composition. The size of the businesses, measured by the number of employees, shows that 43% have between 21 and 300 employees, and 57% have between 301 and 1000 employees. The responses are mainly gathered from the manufacturing business for steel/coal, electronic products, and others. This distribution indicates that the sample is primarily composed of SMEs, which aligns with the classification of SMEs and enhances the applicability of these businesses in assessing green entrepreneurship, eco-innovation, and internationalization performance. The proportion of foreign sales in this survey is about 40–70%. Among the respondents, the male respondents accounted for 47%, and female respondents accounted for 53%. This balanced gender composition indicates that the sample includes

perspectives from different genders, reflecting the common gender composition in management and administrative positions in SMEs, such as manufacturing SMEs related to international business.

Table 2. Descriptive analysis of the sample.

Characteristics	Category	Frequency	Percentage (%)
Establishment of Organization	1–5 years	164	71%
	5–10 years	51	22%
	>10 years	16	7%
Number of Employees	21–300	99	43%
	301–1000	132	57%
Gender	Female	122	53%
	Male	109	47%
Age	<28 years	14	6%
	29–44 years	189	82%
	45–60 years	28	12%
Highest Education Level	Bachelor's Degree	132	57%
	Master's Degree or Higher	79	34%
	Diploma	16	7%
	College Education	4	2%
Industry type	Coal/Steel	70	30.3%
	Electronic product	71	30.7%
	Others	90	39.0%

In terms of age distribution, most respondents were between 29 and 44 years old, accounting for 82% of the sample. Respondents aged 45 to 60 accounted for 12%, while those under 28 years old accounted for 6%. This distribution suggests that most participants are mid-level professionals with extensive work experience, which enhances the reliability of information regarding organizational practices.

Regarding education level, respondents generally possess a high level of formal education. A total of 57% of the sample hold a bachelor's degree, followed by 34% with a master's degree or higher. Meanwhile, 7% of respondents indicated they had completed associate's degree programs, and only 2% reported their highest level of education as an associate's degree. The dominance of bachelor's and master's degree holders reflects a high level of education among management personnel, which may have a positive impact on organizational decision-making, particularly in areas such as technology adoption, innovation, and internationalization.

Furthermore, organizational characteristics were analyzed. Regarding organizational age, a significant proportion of companies (71%) had been established for less than 5 years. Companies with 5 to 10 years of operation accounted for 22%, while those with relatively longer than 10 years comprised only 7%, which reveals that most of the SMEs surveyed are recently developed under the related policy and state.

4.2. Measurement Model Validation

Confirmatory factor analysis was conducted to assess the validity and reliability of the measurement model. As shown in Table 3, the VIFs of all items are below the threshold value of 3, indicating no multicollinearity. All of factor loadings exceeded 0.7, indicating adequate indicator reliability. Cronbach's alpha values ranged from 0.91 to 0.95, and composite reliability values ranged from 0.92 to 0.96, all exceeding the 0.70 threshold for internal consistency reliability. Average variance extracted (AVE) values ranged from 0.66 to 0.7, which were all above the 0.50 benchmark for convergent validity [3,57].

Table 3. Results of confirmatory factor analysis.

Construct	Items	Loadings	VIF	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
<i>Internationalization Performance (IP)</i>	IP1	0.828	2.484	0.933	0.944	0.68
	IP2	0.816	2.388			
	IP3	0.821	2.391			
	IP4	0.828	2.496			
	IP5	0.826	2.491			
	IP6	0.805	2.249			
	IP7	0.843	2.655			
	IP8	0.828	2.448			
<i>Green Technology (GT)</i>	GT1	0.848	2.525	0.922	0.939	0.718
	GT2	0.84	2.445			
	GT3	0.857	2.603			
	GT4	0.843	2.556			
	GT5	0.851	2.541			
	GT6	0.846	2.51			
	CGC1	0.832	2.447	0.928	0.942	0.698
<i>Company Green Commitment (CGC)</i>	CGC2	0.834	2.441			
	CGC3	0.844	2.52			
	CGC4	0.838	2.526			
	CGC5	0.842	2.455			
	CGC6	0.825	2.433			
	CGC7	0.832	2.498			
<i>Eco-innovation (EI)</i>	EI1	0.825	2.761	0.965	0.968	0.67
	EI2	0.818	2.744			
	EI3	0.789	2.403			
	EI4	0.811	2.619			
	EI5	0.829	2.819			
	EI6	0.823	2.762			
	EI7	0.815	2.656			
	EI8	0.81	2.651			
	EI9	0.822	2.761			
	EI10	0.837	2.989			
	EI11	0.802	2.529			
	EI12	0.832	2.952			
	EI13	0.8	2.485			
	EI14	0.833	2.922			
	EI15	0.826	2.852			
<i>Government Support Programs (GSP)</i>	GSP1	0.83	2.64	0.951	0.958	0.672
	GSP2	0.832	2.713			
	GSP3	0.816	2.563			
	GSP4	0.816	2.472			
	GSP5	0.803	2.471			
	GSP6	0.833	2.883			
	GSP7	0.817	2.736			
	GSP8	0.822	2.627			
	GSP9	0.812	2.481			
	GSP10	0.82	2.503			
	GSP11	0.816	2.569			

Discriminate validity was assessed using the Fornell-Larcker criterion and hetero-trait–monotrait (HTMT) ratio [3,51,58]. Table 4 presents the correlation matrix with square roots of AVE on the diagonal. All diagonal values exceeded corresponding off-diagonal correlations, supporting discriminant validity [57]. These results establish confidence in the measurement properties before proceeding with structural model evaluation.

Table 4. Results of Fornell–Larcker criterion.

Variables	IP	GT	CGC	EI	GSP
IP	0.829				
GT	0.342	0.836			
CGC	0.352	0.105	0.823		
EI	0.487	0.4	0.289	0.813	
GSP	0.156	0.064	0.1	−0.007	0.822

Note: Diagonal elements (bold) represent square roots of AVE. Off-diagonal elements represent the construct correlations matrix.

In addition, the HTMT ratio was calculated and evaluated, and the results are shown in Table 5. According to Henseler et al. (2009), an HTMT value below 0.90 indicates sufficient discriminant validity and suggests that the constructions are empirically distinguishable [58]. The HTMT values obtained a range from 0.047 to 0.511, which are all below the threshold of 0.90. Therefore, the HTMT results further reinforce the discriminant validity of all constructions in this study.

Table 5. Results of HTMT.

Variables	IP	GT	CGC	EI	GSP	GSP*GT	GSP*CGC
IP							
GT	0.266						
CGC	0.339	0.1					
EI	0.464	0.45	0.382				
GSP	0.268	0.105	0.166	0.108			
GSP*GT	0.225	0.104	0.063	0.023	0.027		
GSP*CGC	0.214	0.065	0.036	0.033	0.033	0.106	

4.3. Structural Model and Hypothesis Testing

Direct Effects: Structural equation modeling was employed to test the hypothesized relationships as follows (Table 6). Supporting H1a, green technology had a significant positive effect on internationalization performance ($\beta = 0.114$, $p < 0.05$). H1b was also supported, with company green commitment positively influencing internationalization performance ($\beta = 0.171$, $p < 0.001$). Additionally, both green technology ($\beta = 0.36$, $p < 0.001$) and company green commitment ($\beta = 0.394$, $p < 0.001$) significantly affect eco-innovation ($\beta = 0.325$, $p < 0.001$), supporting the hypotheses H1c and H1d. Furthermore, the moderating effect of GSP was preliminarily verified ($\beta = 0.209$, $p = 0.000$ for H3a and $\beta = 0.194$, $p = 0.000$ for H3b).

Table 6. Results of path analysis.

Path	Beta	SD	T-Values	p-Values	Decision
GT → IP	0.114	0.046	2.476	0.014	Significant
CGC → IP	0.171	0.039	4.326	0.000	Significant
GT → EI	0.394	0.041	9.682	0.000	Significant
CGC → EI	0.325	0.047	6.96	0.000	Significant

GT*GSP → IP	0.209	0.054	3.851	0.000	Significant
CGC*GSP → IP	0.194	0.033	5.935	0.000	Significant

Mediation Effects: Bootstrapping analysis (5000 resamples) was conducted to test mediation hypotheses [3]. The indirect effect of green technology on internationalization performance through eco-innovation was significant ($\beta = 0.123$, $p = 0.00$), supporting H2a. The indirect effect of company green commitment on internationalization through eco-innovation was also significant ($\beta = 0.101$, $p = 0.00$), supporting H2b. Since the direct effects remained significant when including the mediator, eco-innovation mediated both relationships and is significant (see Table 7).

Table 7. Indirect effects (mediation analysis).

Path	Beta	SD	T-Values	p-Values	Decision
GT → EI → IP	0.123	0.024	5.2	0	Significant
CGC → EI → IP	0.101	0.022	4.709	0	Significant

Moderation Effects: The moderating effect shows that government support programs moderate the relationship between green technology, company commitments, and international performance at high levels of government support programs, as shown in Figures 2 and 3 and Table 8. For the high-support group, the relationship between green technology and internationalization performance was stronger ($\beta_{\text{high}} = 0.323$, $p < 0.05$), supporting H3a. The relationship between company green commitment and internationalization performance was also stronger with high support ($\beta_{\text{high}} = 0.365$, $p < 0.05$), supporting H3b. Overall, the research findings confirm that government support programs are hypothesized to moderate the relationship between green technology and commitment and internationalization performance by strengthening this relationship under higher levels of institutional support. This highlights the crucial role of external policy support in promoting green innovative activities for SMEs and enhancing global competitiveness.

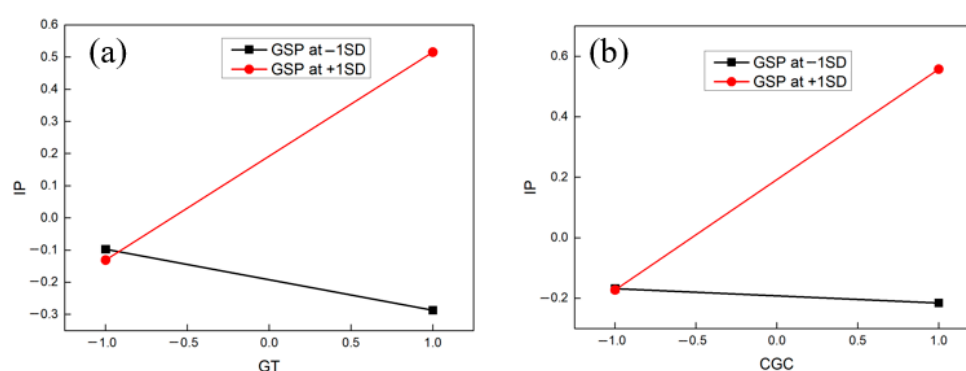


Figure 2. Moderating effect of government support programs. (a) Moderating effect of government support programs between green technology and internationalization performance. (b) Moderating effect of government support programs between company green commitment and internationalization performance.

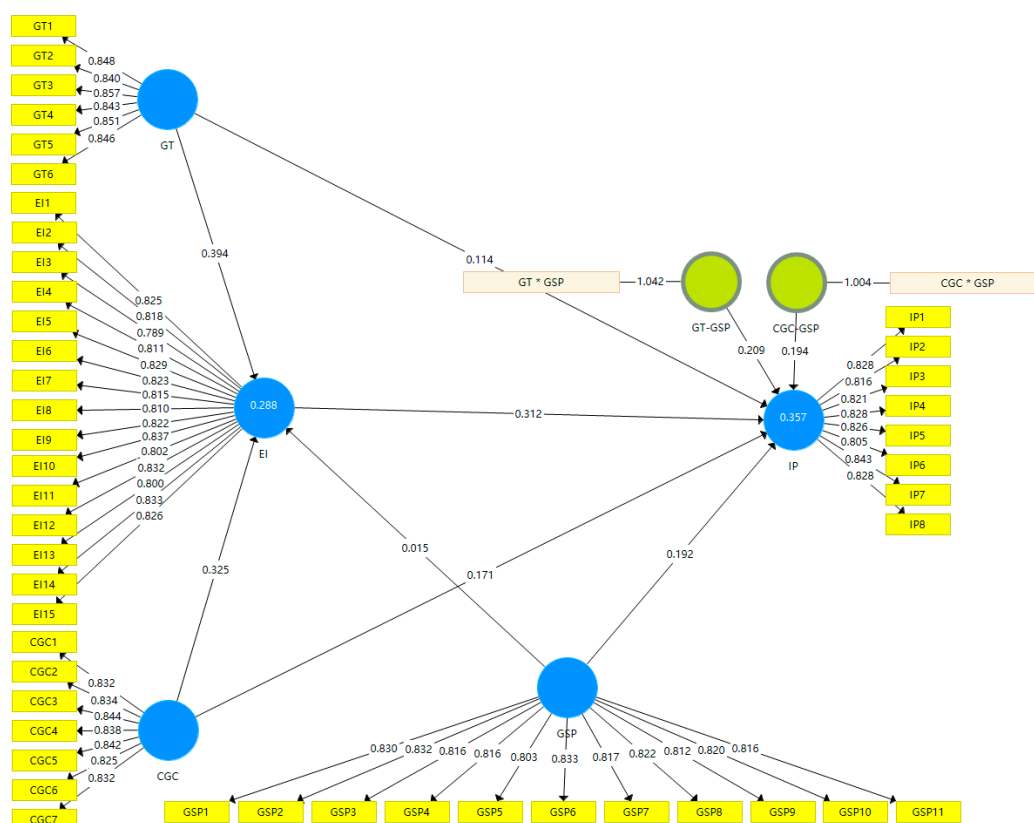


Figure 3. PLS-SEM bootstrapping moderator.

Table 8. Results of moderation analysis.

Path	Beta	SD	T-Values	p-Values	Decision
GT → IP GSP at +1 SD	0.323	0.067	4.816	0	Significant
GT → IP GSP at −1 SD	−0.094	0.076	1.242	0.214	Insignificant
CGC → IP GSP at +1 SD	0.365	0.047	7.82	0	Significant
CGC → IP GSP at −1 SD	−0.023	0.057	0.41	0.682	Insignificant

Tables 9 and 10 show the structural model explaining the substantial variance. The Q^2 values of 0.199 for eco-innovation and 0.236 for internationalization performance, both greater than zero, indicate the predictive relevance of the model. Effect sizes (f^2) were calculated to assess the substantive impact of each predictor: green technology on eco-innovation ($f^2 = 0.215$), green technology on internationalization performance ($f^2 = 0.0016$), and company green commitment on internationalization performance ($f^2 = 0.038$) and on eco-innovation ($f^2 = 0.144$).

Table 9. Construct cross-validated redundancy (predictive relevance).

Dependent Variables	Q^2
EI	0.199
IP	0.236

Table 10. Effect sizes (f^2) of the construct.

Relationships	f^2 Value	Effect Size
CGC → EI	0.144	Small to medium
CGC → IP	0.038	Small to medium
GT → EI	0.215	Medium to large
GT → IP	0.0016	Small

Note: f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effect sizes, respectively [57].

5. Discussion

The findings of this study provide important insights into how green technology and company green commitment contribute to SME internationalization performance through eco-innovation, while highlighting the role of government support programs. Consistent with the proposed framework, green technology and company green commitment both exhibit significant effects on eco-innovation, which in turn enhances the internationalization performance. These results underscore eco-innovation as a critical mechanism that transforms internal green-oriented resources into externally observable competitive advantages in international markets [46].

Specifically, the mediating role of eco-innovation suggests that green technology is effectively transformed into innovative products, processes, or environmental solutions that meet international market requirements, which indirectly affect the internationalization performance [59]. This finding aligns with prior studies emphasizing that technology must be accompanied by innovation-oriented recombination to generate performance benefits [25]. Similarly, company green commitment contributes to internationalization performance indirectly by fostering an organizational climate that supports experimentation, learning, and continuous improvement, which are essential for eco-innovation [39]. By empirically validating this mediating pathway, the present study extends existing research that has primarily focused on the direct effects of environmental practices, offering a more mechanism-based explanation of sustainable internationalization.

The moderation analysis further reveals that government support programs strengthen the positive relationship between green technology, company green commitment, and internationalization performance. This finding highlights the importance of institutional support in shaping the effectiveness of technology and commitment, particularly for resource-constrained SMEs in emerging economies. Government support programs—such as financial subsidies, tax incentives, technical assistance, and policy guidance—reduce innovation-related risks, alleviate resource constraints, and facilitate access to international markets [51]. As a result, SMEs with higher levels of green technology or company green commitment can capitalize on these external supports to enhance the internationalization performance. This result is consistent with institutional and resource-based perspectives, which emphasize that firm-level capabilities and external support mechanisms jointly determine performance outcomes [21].

Comparatively, while prior studies have documented the positive effects of eco-innovation or government support on firm performance, they often treat these factors in isolation [60]. The present study contributes to the literature by demonstrating their interactive role. Unlike studies focusing on large firms or developed economies, this research provides evidence from Chinese SMEs, thereby extending the generalizability of eco-innovation and institutional support theories to emerging economy contexts. The findings also complement earlier research suggesting that environmental strategies are particularly valuable in international markets characterized by strict environmental standards and sustainability expectations [49,50,55].

5.1. Theoretical Implications

This study makes several important contributions to the literature on sustainable international business. First, it extends the resource-based view by demonstrating how green technology and company green commitment contribute to SME internationalization success. While previous research has examined these factors separately or in different contexts, our integrated model reveals the synergistic effects, suggesting that technological investments yield greater returns when accompanied by strong organizational commitment and vice versa [39]. Second, our findings advance the understanding of the mechanisms through which environmental strategies translate into international advantages. By

identifying eco-innovation as a critical mediator, we bridge the literature on green capabilities and international entrepreneurship, addressing calls for more nuanced process models. Third, this research elucidates how government support programs moderate the internationalization process of SMEs.

5.2. Practical Implications

The findings of this study offer several actionable insights for managers of SMEs seeking to enhance internationalization performance through sustainability-oriented strategies. First, managers should treat green technology as an operational capability rather than a symbolic environmental initiative. This involves allocating dedicated budgets for green technology adoption, integrating environmental technologies into core production and logistics processes, and establishing internal teams responsible for monitoring the effectiveness of green technology deployment [33]. Second, the results highlight the importance of company green commitment as a strategic driver of eco-innovation. Managers should actively embed environmental values into corporate strategy by setting clear environmental objectives, linking green performance indicators to managerial evaluation systems, and encouraging employee participation in environmental initiatives. Such commitment fosters an organizational climate that supports experimentation and learning, which are critical for transforming green intentions into tangible eco-innovative outputs that enhance international competitiveness [14,39]. Third, given the mediating role of eco-innovation, managers should focus on converting green-oriented capabilities into market-oriented eco-innovations that align with international standards and customer expectations. This may include developing environmentally friendly products tailored to foreign markets, improving process efficiency to meet international environmental regulations, and obtaining recognized environmental certifications to signal credibility to international partners and buyers [17].

For policymakers, our study suggests several areas for program development and refinement. Rather than providing generic subsidies, policymakers should design support mechanisms that directly incentivize green-related activities, such as grants for green R&D, subsidies for eco-innovation commercialization, and tax incentives linked to verified environmental innovation outcomes. Moreover, government support programs should be structured to reduce the risks associated with eco-innovation for SMEs [51]. This can be achieved by offering technical consulting services, facilitating access to green technology platforms, and supporting collaboration between SMEs, research institutions, and international partners [30]. Such measures enhance SMEs' ability to translate green technology or company green commitment into the international market. Finally, policymakers should recognize the heterogeneous capabilities of SMEs and adopt a differentiated support approach. SMEs with higher levels of eco-innovation capability may benefit more from export-oriented and market access support, while less advanced firms may require foundational assistance in technology adoption and environmental management. By aligning policy instruments with firms' innovation maturity, government support programs can more effectively strengthen the internationalization performance of Chinese SMEs [53].

5.3. Limitations and Future Research Directions

Several limitations of this study suggest opportunities for future research. First, the cross-sectional design limits causal inferences, though our theoretical rational and analytical approaches provide some confidence in the proposed directions of influence. Longitudinal studies tracking SMEs over time would strengthen causal claims and reveal how the relationships evolve through different stages of internationalization and environmental maturation. Future studies are encouraged to employ longitudinal designs, multi-

informant data, or objective performance indicators to further strengthen causal inference and reduce potential method-related concerns. Regarding the fact that SMEs vary significantly in terms of scale, resources, degree of internationalization, and depth of green practices, this study focused on differences in cognition among respondents from different companies; the exploration of internal differentiating factors may be further deepened.

Also, bootstrapping assumes that the observed sample is a reasonable approximation of the population; if the sample is biased or not representative, bootstrapped standard errors and confidence intervals may still reflect this bias. Although bootstrapping relaxes distributional assumptions, it does not correct for model misspecification; if the measurement or structural model is incorrectly specified, bootstrapped significance tests may be misleading.

In addition, the applicability of this study faces the limitations when extended to other national institutional contexts. On the one hand, Chinese government support programs (such as special funds, tax incentives, and green certification subsidies) are deeply embedded in the socialist market economy system with national characteristics. The logic of policy formulation, implementation mechanisms, and government–business interaction models possess distinctive features of national governance. Different countries have significant differences in political systems, administrative efficiency, legal frameworks, and industrial policy orientations, which may directly affect the design, implementation methods, and incentive effects of government support programs on corporate behavior [61]. On the other hand, China often adopts multi-level, high-intensity comprehensive policy interventions in promoting the green transition, with central and local governments frequently coordinating in project implementation. Government support programs in other countries (especially those with higher market orientation or federal systems) may rely more on regulatory guidance, market mechanisms, or decentralized local initiatives, resulting in structural differences in the scope and intensity of interventions compared to China [61]. Therefore, the policy impact mechanisms may not be directly transferable. Future research could conduct contextualized comparisons of government support programs under different institutional backgrounds. While the sample spans multiple sectors and regions, certain contexts may be underrepresented. Future research could examine whether the observed relationships hold equally across different institutional environments, particularly comparing developed versus emerging economies where environmental regulations and support systems differ substantially.

5.4. Conclusions

This study provides empirical evidence that green technology and company green commitment significantly enhance an SME's internationalization performance, with these relationships mediated by eco-innovation and strengthened by government support programs. In an increasingly environmentally conscious global marketplace, SMEs that strategically integrate technological, organizational, and innovative dimensions of environmental orientation, while actively leveraging institutional support mechanisms, appear better positioned to succeed internationally. As the enterprise pursues green transitions with substantial economic implications, the alignment of environmental and internationalization strategies represents not merely an ethical imperative but a substantial competitive opportunity for SMEs.

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Abbreviations

The following abbreviations are used in this manuscript:

SME	Small and Medium Enterprises
IP	Internationalization Performance
GT	Green Technology
CGC	Company Green Commitment
EI	Eco Innovation
GSP	Government Support Programs

Appendix A

The appendix is the questionnaire used in this survey.

Particular(s)	Answer(s)
1. Gender	☐ Male ☐ Female
2. Age	☐ <28 Years ☐ 29–44 Years ☐ 45–60 Years ☐ >61 Years
3. Highest Education Level	☐ High School ☐ Diploma ☐ Bachelor's Degree ☐ Master's Degree or Higher
4. Establishment of Organization	☐ 1–5 Years ☐ 5–10 Years ☐ >10 Years
5. Number of Employees	☐ 1–20 ☐ 21–300 ☐ 301–1000
6. Engaged in International Import/Export Business	☐ Yes ☐ No
7. Industry Type	☐ Coal/Steel ☐ Electronic Product ☐ Others

Below are the measurement items

No.	Statement	1	2	3	4	5
Internationalization Performance						
1	Our company achieved growth in international sales.	☐	☐	☐	☐	☐
2	Our company achieved international net profit margin.	☐	☐	☐	☐	☐
3	Our company achieved international growth profit margin.	☐	☐	☐	☐	☐

4	Our company achieved growth in international operations ROI.	☐	☐	☐	☐	☐
5	Our company achieved growth in the international market share.	☐	☐	☐	☐	☐
6	Our international customers are satisfied with our products and services.	☐	☐	☐	☐	☐
7	Our international business reputation is considered good.	☐	☐	☐	☐	☐
8	Our company achieved growth in the introduction of new products and services in the international market.	☐	☐	☐	☐	☐

Green Technology

1	Our company has set specific green technology implementation goals.	☐	☐	☐	☐	☐
2	Our company has a dedicated team responsible for the implementation of green technology.	☐	☐	☐	☐	☐
3	Our company is committed to investing in the latest green technology.	☐	☐	☐	☐	☐
4	Our company strictly implements environmental protection standards and regulations during the production process.	☐	☐	☐	☐	☐
5	Our company regularly evaluates and improves the implementation of green technology.	☐	☐	☐	☐	☐
6	Our company's employees have received training related to green technology.	☐	☐	☐	☐	☐

Company Green Commitment

1	Our staff cares about the environmental concerns of our company.	☐	☐	☐	☐	☐
2	The environmental concern of our company means a lot to our staff.	☐	☐	☐	☐	☐
3	Our staff feel a sense of duty to support the environmental efforts of our company.	☐	☐	☐	☐	☐
4	Our staff feel as if our company's environmental problems are their own.	☐	☐	☐	☐	☐
5	Our staff feel personally attached to the environmental concerns of our company.	☐	☐	☐	☐	☐
6	Our staff strongly values the environmental efforts of our company.	☐	☐	☐	☐	☐
7	Our staff would feel guilty about not supporting the environmental efforts of our company.	☐	☐	☐	☐	☐

Eco-innovation

1	Our company is improving and designing environmentally friendly packaging (e.g., using fewer paper and plastic materials) for existing and new products.	☐	☐	☐	☐	☐
2	Our company chooses materials for the product that consume the least amount of energy and resources for conducting the product development or design.	☐	☐	☐	☐	☐
3	Our company uses the smallest possible amount of materials to create the product when conducting the product development or design.	☐	☐	☐	☐	☐
4	Our company deliberately evaluates whether the product is easy to recycle, reuse and decompose when conducting the product development or design.	☐	☐	☐	☐	☐
5	Low energy consumption such as water, electricity, gas and petrol during production use/disposal.	☐	☐	☐	☐	☐
6	Recycling, reuse and remanufacture of material.	☐	☐	☐	☐	☐
7	Use of cleaner technology to generate savings and prevent pollution (e.g., energy, water and waste).	☐	☐	☐	☐	☐
8	The manufacturing process of my company effectively reduces the emission of hazardous substances or waste.	☐	☐	☐	☐	☐
9	The manufacturing process of my company reduces the use of raw materials.	☐	☐	☐	☐	☐
10	Our firm's management frequently utilizes innovative systems to manage eco-innovation.	☐	☐	☐	☐	☐
11	Our firm's management often collects information on eco-innovation trends.	☐	☐	☐	☐	☐

12	Our firm's management often actively engages in eco-innovation activities.	☐	☐	☐	☐	☐
13	Our firm's management often communicates eco-innovation information with employees.	☐	☐	☐	☐	☐
14	Our firm's management often invests a high ratio of R&D in eco-innovation.	☐	☐	☐	☐	☐
15	Our firm's management often communicates experiences among various departments involved in eco-innovation.	☐	☐	☐	☐	☐
Government Support Program						
1	Our company believes that we have adequate financial assistance in China to aid SMEs.	☐	☐	☐	☐	☐
2	Our company utilizes available credit scheme services to get supplemental financing for our business operations.	☐	☐	☐	☐	☐
3	Our company uses the trade finance facilities from export service agents who buy products and resell them in international markets.	☐	☐	☐	☐	☐
4	Our company believes that the government grants are easily accessible and available to provide additional finances.	☐	☐	☐	☐	☐
5	Our company believes the National Microfinance Policy supports our firm's business operations.	☐	☐	☐	☐	☐
6	Our company believes that there are potential agents and distributors in international markets to facilitate our business operations.	☐	☐	☐	☐	☐
7	Our company believes that the current government policy objectives are relevant to our firm's business operations.	☐	☐	☐	☐	☐
8	Our company utilizes the one-stop business advice center services.	☐	☐	☐	☐	☐
9	Our company believes we have adequate non-financial assistance to aid SMEs.	☐	☐	☐	☐	☐
10	Our company utilizes services from a local trade advisor.	☐	☐	☐	☐	☐
11	Employees in our company regularly attend export training seminars.	☐	☐	☐	☐	☐

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