

แรงกดดันภายนอกกับการนำนวัตกรรมสีเขียวมาใช้ในวิสาหกิจขนาดกลางและขนาดย่อม (SMEs):
บทเรียนจากบริบทประเทศไทย

EXTERNAL PRESSURES AND GREEN INNOVATION ADOPTION
IN SMES: INSIGHTS FROM THE THAI CONTEXT

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บทคัดย่อ

การนำนวัตกรรมสีเขียวมาใช้มีความสำคัญมากขึ้นต่อวิสาหกิจขนาดกลางและขนาดย่อม (SMEs) เพื่อรักษาความสามารถในการแข่งขันและรับมือกับความท้าทายด้านความยั่งยืน การศึกษานี้มุ่งวิเคราะห์อิทธิพลของแรงกดดันจากผู้มีส่วนได้ส่วนเสียภายนอก ได้แก่ แรงกดดันจากลูกค้า ภาครัฐ และคู่แข่ง ต่อการนำนวัตกรรมสีเขียวมาใช้ใน SMEs ของไทย โดยเก็บข้อมูลจากผู้บริหารระดับตัดสินใจของ SMEs จำนวน 420 ราย ผ่านแบบสอบถามเชิงโครงสร้าง และทำการวิเคราะห์ด้วยวิธีการถดถอยพหุคูณ ผลการวิจัยชี้ให้เห็นว่าแรงกดดันทั้งสามรูปแบบมีอิทธิพลในเชิงบวกและมีนัยสำคัญต่อการนำนวัตกรรมสีเขียวมาใช้ โดยแรงกดดันจากลูกค้ามีอิทธิพลสูงสุด รองลงมาคือแรงกดดันจากคู่แข่ง ขณะที่แรงกดดันจากภาครัฐมีอิทธิพลน้อยที่สุด แบบจำลองสามารถอธิบายความแปรปรวนได้ร้อยละ 38.9 แสดงถึงพลังการอธิบายในระดับปานกลาง ผลการวิจัยยืนยันทฤษฎีผู้มีส่วนได้ส่วนเสียในบริบทของ SMEs และตอกย้ำบทบาทที่เพิ่มขึ้นของแรงขับเคลื่อนจากตลาดต่อการดำเนินงานด้านความยั่งยืน ข้อเสนอเชิงปฏิบัติแนะนำให้ผู้จัดการใช้แรงกดดันจากลูกค้าและคู่แข่งเพื่อกระตุ้นนวัตกรรม ขณะที่ผู้กำหนดนโยบายควรสนับสนุน SMEs ผ่านกรอบการทำงานที่เอื้อต่อการปฏิบัติและกลไกจูงใจ

คำสำคัญ: นวัตกรรมสีเขียว, แรงกดดันจากผู้มีส่วนได้ส่วนเสีย, วิสาหกิจขนาดกลางและขนาดย่อม (SMEs)

ABSTRACT

Green innovation adoption is increasingly vital for small and medium-sized enterprises (SMEs) to remain competitive while addressing sustainability challenges. This study examines the influence of external stakeholder pressures—customer, government, and competitive—on green innovation adoption among SMEs in Thailand. Data were collected from 420 SME decision-makers using a structured questionnaire, and multiple regression analysis was conducted to test the hypothesized relationships. Results indicate that all three pressures significantly and positively affect green innovation adoption, with customer pressure having the strongest effect, followed by competitive pressure, while government pressure was the weakest. The model explained 38.9% of the variance, demonstrating moderate explanatory power. The findings validate stakeholder theory in the SME context and emphasize the increasing role of market-driven forces in shaping sustainability practices. Practical implications

suggest that managers should leverage customer and competitive signals, while policymakers should support SMEs through facilitative frameworks and incentive mechanisms.

Keywords: Green Innovation, Stakeholder Pressure, Small and Medium Enterprise (SMEs)

Introduction

Green innovation adoption has emerged as a critical strategy in addressing global environmental degradation and climate change, particularly as nations pursue ambitious targets like carbon neutrality and net-zero emissions (Cuerva, Triguero-Cano, & Córcoles, 2014; Tariq, Badir, & Chonglertham, 2019). The urgency is amplified by mounting ecological crises, rising regulatory scrutiny, and shifting consumer expectations, which collectively demand sustainable transformation across all levels of industry. For small and medium-sized enterprises (SMEs), the adoption of green innovation is not only an ethical imperative but also a strategic necessity to remain competitive in increasingly sustainability-driven markets (Jun, Ali, Bhutto, Hussain, & Khan, 2019). In Thailand, SMEs account for over 99% of all registered businesses, contributing roughly 35%–40% of national GDP and employing the majority of the workforce (Arunmas, 2024). SMEs serve as foundational nodes in domestic supply chains and maintain critical linkages with larger firms, positioning them as essential actors in facilitating the nation's broader green transition. Yet, SMEs often struggle to meet environmental expectations due to limited financial, technological, and managerial capacities, as well as weak institutional support and market incentives (Cuerva et al., 2014; Tariq et al., 2019).

Stakeholder pressure plays a pivotal role in driving green innovation among SMEs, particularly when internal motivations are insufficient. Pressure from customers, regulatory bodies, and competitors serves as a critical external catalyst that can overcome the inertia often associated with limited resources and short-term survival priorities (Chu, Wang, & Lai, 2019; Dai, Xie, & Chu, 2021). In many cases, SMEs may not recognize the urgency or strategic benefit of investing in environmental practices unless they are actively compelled by market expectations or policy requirements. This form of pressure can stimulate organizational reflection, elevate environmental awareness, and create normative pressures that encourage alignment with evolving standards. Its relevance is even more pronounced in emerging economies, where institutional voids and resource scarcity hinder voluntary sustainability transitions. Importantly, stakeholder influence not only drives adoption behavior but also supports internal capability development, encouraging firms to embrace learning-oriented approaches that embed sustainability into their operations over time (Lee, 2008; Tariq et al., 2019).

Previous research has established links between green innovation and firm performance (Lin & Ho, 2011; Tariq et al., 2019), and has explored internal drivers such as

absorptive capacity, environmental orientation, and organizational learning. However, many of these studies center on large manufacturing, service industries or logistics firms in developed or semi-industrialized contexts, limiting their applicability to smaller, resource-constrained firms in emerging contexts (Cuerva et al., 2014; Weng, Chen, & Chen, 2015). While a few studies have addressed Thai SMEs—such as studies by Charoenrat, Harvie, & Amornkitvikai (2013) and others exploring green capabilities in manufacturing sectors—the emphasis has often been on conceptual development, internal capabilities, or government policy. For instance, Jun et al. (2019) proposed a model of green innovation and stakeholder relationships in Thai SMEs, yet their scope was limited to semi-structured interviews within a single industry cluster. Likewise, Lee (2008) proposed a conceptual model that links stakeholder pressure and organizational learning to proactive environmental strategy, but empirical validation in the SME context remains limited. This study therefore addresses these gaps by quantitatively examining the role of stakeholder pressure—specifically customer, government, and competitive pressure—on green innovation adoption among Thai SMEs across diverse industries. By extending existing conceptual frameworks into an empirical setting, this research contributes to a more comprehensive understanding of external pressures shaping sustainability adoption in SMEs and provides insights for policy and practice in developing economies. As a result, this study reveals two crucial questions: What forms of stakeholder pressure most significantly influence green innovation adoption among Thai SMEs? And how can stakeholder dynamics be harnessed to accelerate sustainable transformation within resource-constrained business environments? These questions are essential for understanding stakeholder-driven behavior in the evolving landscape of sustainability adoption.

1.1 Objective of the Study

1. To examine the influence of stakeholder pressure—including customer, government, and competitive pressure—on green innovation adoption among SMEs in Thailand.
2. To provide actionable insights for policymakers to strengthen institutional support and regulatory frameworks, and for SME managers to facilitate the adoption of green innovation in Thai SMEs.

1.2 Benefits of the Study

This study offers both theoretical and practical contributions to the field of green innovation, particularly in the context of SMEs in developing economies. From a theoretical perspective, it extends stakeholder theory by empirically examining how distinct forms of stakeholder pressure influence green innovation adoption. Practically, the findings provide actionable insights for SME managers to better navigate stakeholder expectations and integrate green practices into their operations. Policymakers can also use the results to design targeted support measures and regulatory frameworks that foster green innovation at the SME level.

Literature Review and Hypothesis Formulation

Green innovation refers to the development and implementation of products, processes, services, or business models that reduce environmental harm while promoting sustainability and resource efficiency (Schiederig, Tietze, & Herstatt, 2012). The concept, often used interchangeably with eco-innovation, gained traction in response to rising environmental degradation and the growing global commitment to sustainable development (Bansal, 2002; Chen, 2008). Over the past two decades, research on green innovation has evolved from broad environmental concerns toward more structured analyses of green technologies, circular economy practices, and firm-level capabilities (Chang, 2011; Dangelico, Pujari, & Pontrandolfo, 2017). However, adopting green innovation remains challenging—especially for SMEs—due to financial constraints, limited expertise, and uncertainty over market acceptance (Horbach, Rammer, & Rennings, 2012; Xiang, Liu, & Yang, 2022). Among the various drivers, stakeholder pressure has emerged as a critical external influence, encompassing regulatory mandates, customer expectations, and competitive dynamics that compel firms to integrate sustainability into their operations (Guoyou, Saixing, Chiming, Haitao, & Hailiang, 2013; Singh, Del Giudice, Chiappetta Jabbour, Latan, & Sohal, 2022). Governance actors, including government agencies and trade associations, often set the tone through environmental regulations, while consumers increasingly favor businesses with demonstrable green practices (Qi, Jia, & Zou, 2021; Zhang & Zhu, 2019). For SMEs, adopting green innovation under such pressure not only enhances environmental performance but also strengthens competitive positioning, improves cost efficiency, and reinforces legitimacy among eco-conscious stakeholders (Khanra, Kaur, Joseph, Malik, & Dhir, 2022; Qiu, Hu, & Wang, 2020).

Despite the growing literature, future research could delve deeper into the effects of stakeholder pressure—particularly differentiating between customer, regulatory, and competitive drivers—on SME green innovation adoption. This is especially pertinent for SMEs in developing economies, where institutional limitations and resource constraints may reshape how stakeholder demands are interpreted and responded to. A thorough investigation of these dynamics can offer valuable implications for both theory and practice. SMEs can leverage stakeholder insights to build internal learning capabilities and green-oriented strategies that align with evolving market expectations and compliance demands. Simultaneously, policymakers can use such findings to tailor support mechanisms that reinforce stakeholder engagement, ensuring that environmental objectives are met without overburdening resource-constrained firms. Ultimately, leveraging stakeholder pressure can drive firms—especially in emerging markets—to adopt green innovation more proactively, aligning environmental goals with strategic business outcomes.

1. Theoretical Foundation: The Stakeholder Theory

Stakeholder theory, first formalized by Freeman (1984), conceptualizes organizations as embedded in a network of relationships with multiple stakeholders—including customers, regulators, communities, employees, and shareholders—whose interests must be considered in strategic decision-making. Evolving from early work by the Stanford Research Institute in 1963 and further developed across disciplines such as strategic planning, corporate social responsibility, and systems theory, the stakeholder theory has since shifted toward a more pragmatic and strategic perspective (Fassin & Van Rossem, 2009; R. Edward Freeman, 2010; Helmig, Spraul, & Ingenhoff, 2016). The theory asserts that firms are not only accountable to shareholders but also to those who affect or are affected by organizational outcomes, and that each stakeholder group holds intrinsic value (R.E. Freeman, 1984). This framework has been widely adopted in sustainability research, where stakeholder pressure—defined as the power of external actors to influence corporate behavior—plays a critical role in shaping environmental strategies and green innovation adoption (Arulrajah & Opatha, 2016; Guoyou et al., 2013; Kassinis & Vafeas, 2006). Recent studies have linked stakeholder expectations to firm-level adoption of green innovation initiatives, particularly through mechanisms such as customer demand, regulatory compliance, and competitive positioning. Although findings vary by context, evidence consistently suggests that stakeholder demands are central to the adoption of green innovation (Connelly, Ketchen, & Slater, 2011; Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010). In the context of SMEs, where proactive sustainability efforts may be constrained by limited resources, stakeholder theory helps explain how external pressures catalyze learning and capability development for green innovation.

2. Customer Pressure

Customer pressure refers to the growing influence of environmentally conscious consumers who demand sustainable products, services, and practices from businesses. As environmental awareness rises, customers increasingly factor ecological impact into their purchasing decisions, often favoring brands that align with green values and social responsibility (Huang, Chang, Wang, & Li, 2023; Qiu et al., 2020). This pressure drives firms to develop eco-friendly innovations, invest in cleaner technologies, and ensure transparency in sustainability reporting to avoid reputational risks such as greenwashing (Ren, Huang, Liu, & Yan, 2023). Companies recognize that meeting customer expectations for sustainability is not just a marketing tactic but a strategic necessity that can drive long-term profitability and resilience (De Medeiros, Vidor, & Ribeiro, 2018). Moreover, customer pressure extends beyond individual firms to reshape supply chains and industry norms by encouraging sustainability across the entire product lifecycle (Sarkar, Ullah, & Sarkar, 2022). Within green innovation research, customer pressure has been recognized as a critical external driver prompting organizations—

particularly SMEs—to integrate environmental considerations into product design, operational processes, and strategic decision-making, thereby supporting broader sustainability transitions (Dangelico, 2017; J. Lin, Lobo, & Leckie, 2019).

3. Government Pressure

Government pressure refers to regulatory and policy-driven demands placed on organizations by national and international authorities to adopt sustainable practices and pursue green innovation. This pressure stems from environmental legislation, global agreements, and policy frameworks targeting climate change mitigation, pollution control, and resource conservation (Li, Dong, Wang, & Dong, 2023; Qiu et al., 2020). It typically materializes through compliance requirements such as emission caps, environmental disclosures, and waste reduction mandates that compel organizations to integrate ecological considerations into core operations (Bodansky, 2016; Shamil, Shaikh, Ho, & Krishnan, 2022). For SMEs in developing economies, government pressure plays a dual role—both as a constraint due to limited financial and technical capacity, and as a catalyst that accelerates the adoption of cleaner technologies and eco-innovative processes. In response, SMEs are increasingly seeking external support, forming alliances, and leveraging government incentives to enhance compliance and competitiveness. Effective regulatory frameworks can stimulate green innovation by lowering adoption barriers, reducing uncertainty, and creating market opportunities for sustainable products and services (Dechezleprêtre, Nachtigall, & Venmans, 2023; Seidel, Recker, Pimmer, & Brocke, 2010). Within green innovation literature, governance pressure is widely acknowledged as a critical driver shaping firm behavior and capability development, particularly in resource-constrained settings where regulatory compliance becomes a strategic pathway toward operational efficiency, market access, and long-term sustainability.

4. Competitive Pressure

Competitive pressure refers to the influence exerted by rival firms and evolving market dynamics that compel organizations to adopt environmentally sustainable practices and pursue green innovation (Jing Dai, Cantor, & Montabon, 2015; Yalabik & Fairchild, 2011). In increasingly eco-conscious markets, businesses—particularly SMEs—face mounting pressure to align their strategies with industry trends and sustainability benchmarks to remain competitive (Tu & Wu, 2021). This pressure often manifests through the need to match or exceed the green initiatives of competitors, spurring firms to invest in environmentally friendly technologies, develop sustainable products, and embed sustainability into their supply chains (Agyabeng-Mensah, Afum, & Baah, 2023; Qi et al., 2021). For SMEs, which often operate with limited resources, competitive pressure can serve as both a challenge and a motivator to

innovate, adopt leaner green processes, and gain differentiation in niche markets. Green innovation, under such pressure, becomes a strategic response that enhances brand reputation, operational efficiency, and market positioning (Dong, Wu, Lin, Sun, & Liang, 2024; Wong, Wong, & Boon-itt, 2020, p. 202). Moreover, competitive pressure fosters a culture of continuous improvement, encouraging SMEs to learn from industry leaders, adapt to changing stakeholder expectations, and proactively contribute to sector-wide sustainability transitions (Mao, Wang, & Sun, 2019; Shafait & Huang, 2024). As a result, it is recognized in the literature as a critical external force shaping green innovation behavior, particularly in emerging market contexts where institutional support may be weaker but market-based competition is intensifying.

5. Hypothesis development

Customer pressure represents a critical form of stakeholder influence that compels organizations to respond to increasing environmental expectations from the market. As consumers become more aware of sustainability issues, their preferences increasingly favor products and services that minimize ecological harm (Huang et al., 2023; Qiu et al., 2020). This demand not only drives firms to invest in eco-friendly technologies but also encourages transparency and accountability in sustainability practices (Ioannou, Kassinis, & Papagiannakis, 2023). Moreover, customer pressure has been found to influence firms to adopt sustainability as a core strategic objective, recognizing that meeting such expectations contributes to long-term competitiveness and resilience (Chan, Lai, & Kim, 2022). Empirical research by Chan et al. (2022) demonstrated that organizations facing heightened customer pressure are more likely to embed green innovation into their business models, aligning their offerings with environmental values. This alignment enhances market positioning and fosters deeper organizational commitment to sustainability. As noted by Seroka & Stolka & Fijorek (2020), such commitment enables continuous improvement of products and services while mitigating negative environmental impacts. Therefore, the following hypothesis is proposed:

Hypothesis 1: Customer pressure positively influences green innovation adoption.

Government pressure represents a formal and institutionalized form of stakeholder influence that drives organizations to incorporate environmental objectives into strategic decision-making. Regulatory frameworks, environmental standards, and policy mechanisms compel firms to adapt their operations toward greater sustainability, not merely for compliance but also for long-term legitimacy and competitive viability (Dechezleprêtre et al., 2023; Shamil et al., 2022). For instance, Delmas & Toffel (2008) noted that such governance pressure often motivates firms to adopt proactive environmental strategies, enabling them to mitigate risks, avoid penalties, and benefit from regulatory incentives. Shahzad, Qu, Ur Rehman, Ding, &

Razzaq (2023) further highlighted that exposure to stringent regulations can enhance internal motivations for improved environmental performance. This institutional pressure becomes particularly salient for SMEs operating in emerging markets, where navigating complex regulatory landscapes requires integrating sustainability as a core strategic goal. Accordingly, government pressure is recognized as a key external driver influencing the adoption of green innovation.

Hypothesis 2: Government pressure positively influences green innovation adoption.

In competitive markets where sustainability is rapidly becoming a benchmark of performance, firms are increasingly adopting green innovation to maintain strategic parity and avoid falling behind industry norms. Unlike regulatory mandates or consumer activism, competitive pressure stems from the environmental advancements of peers—creating a dynamic in which organizations must innovate not merely to comply, but to remain relevant (Shamil et al., 2022; Singh et al., 2022). As industry leaders introduce eco-friendly technologies and sustainable products, competitors often align their innovation strategies accordingly (Xie et al., 2023). This mimetic behavior is especially evident in industries with high environmental visibility, where firms are under heightened scrutiny to demonstrate comparable sustainability credentials (Testa & Iraldo, 2010). For small and medium-sized enterprises (SMEs), competitive pressure can present both challenges and opportunities. While limited resources may constrain large-scale innovation, SMEs often respond by adopting agile, cost-effective green solutions that enhance operational efficiency and market appeal (Xie et al., 2023). By integrating green innovation into their strategic positioning, SMEs can not only differentiate themselves in saturated markets but also tap into emerging environmentally conscious customer segments. Therefore, the following hypothesis is proposed:

Hypothesis 3: Competitive pressure positively influences green innovation adoption.

The conceptual framework illustrated in Figure 1 presents the direct effects of three types of stakeholder pressure—customer, government, and competitive—on green innovation adoption. Grounded in the stakeholder theory, this framework posits that these external pressures serve as key drivers encouraging organizations, particularly SMEs, to implement environmentally sustainable innovations.

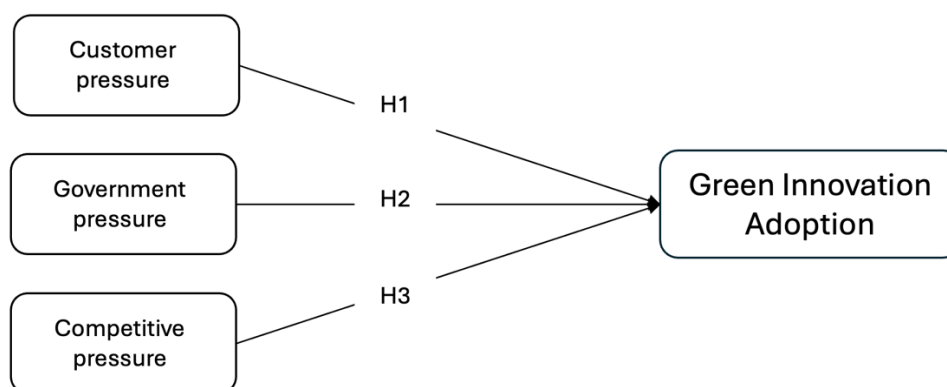


Figure 1 Conceptual Framework

Hypothesis 1: Customer pressure has a positive impact on Green innovation adoption

Hypothesis 2: Government pressure has a positive impact on Green innovation adoption

Hypothesis 3: Competitive pressure has a positive impact on Green innovation adoption

Research Methodology

1. Population and sample

This study adopts a positivist paradigm and employs a quantitative research methodology to examine the relationship between stakeholder pressure and green innovation adoption among SMEs in Thailand. The target population consisted of CEOs and senior managers from small and medium-sized enterprises (SMEs) with an interest in green-related practices. Initial participants were randomly selected from SME databases maintained by the Federation of Thai Industries and the Thai-Chinese Chamber of Commerce. To broaden the sample, the survey was also distributed through green-focused and SME-related Facebook groups, shared on the X platform (formerly Twitter), and disseminated via professional networks using peer referrals. A self-administered online questionnaire served as the primary data collection tool. Of the 552 responses received, 433 surveys were completed (78.44% response rate), with 420 retained for analysis after data screening.

2. Research instrument

The questionnaire used in this study was organized into four sections to align with the theoretical framework and support comprehensive data collection. The first two sections included screening and demographic questions to confirm respondent eligibility and gather contextual information such as age, education level, firm size, business age, and sector. The third section measured stakeholder pressure, encompassing three external forces: customer pressure, government pressure, and competitive pressure. Customer pressure was assessed using four items adapted from Chu et al. (2019), focusing on how environmentally

conscious customer expectations influence firm behavior. Government pressure was measured using four items adapted from Dai et al. (2021), capturing the influence of environmental regulations, standards, and enforcement mechanisms. Competitive pressure was evaluated with three items, also from Dai et al. (2021), reflecting the extent to which peer behavior and market competition prompt firms to adopt environmentally responsive actions. The final section assessed green innovation adoption (GIA) using seven items from Chu et al. (2019), evaluating the extent to which firms implemented eco-friendly products, processes, or practices.

All items were rated on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). To ensure linguistic and semantic equivalence, all measurement items—originally developed in English—underwent a rigorous forward-backward translation process. Content validity was further enhanced through expert review and in-depth interviews with SME executives to assess clarity, contextual relevance, and cultural appropriateness, in line with the guidance of Van Teijlingen & Hundley (2002). Prior to full-scale data collection, a pilot test involving 30 SME executives who met the study’s inclusion criteria was conducted. Based on the feedback obtained, item wording was refined to improve clarity and measurement accuracy. Final reliability testing using Cronbach’s alpha confirmed strong internal consistency, with all constructs exceeding the recommended threshold of $\alpha > .80$, as suggested by Nunnally & Bernstein, (1994).

3. Data collection

Data were collected using a convenience sampling method, supplemented by snowball sampling to broaden outreach and enhance the diversity of respondents. A self-administered online questionnaire served as the primary tool for data collection, allowing participants to complete the survey at their own pace. To maximize accessibility and reach, the survey was distributed through multiple channels, including SME-related social media groups, professional networks, and online forums. The data collection period spanned from April to June 2025.

4. Data analysis instrument

The data analysis was conducted in two main stages. The first stage involved descriptive statistics, as shown in Table 1, which presented general demographic information about the respondents, including age, education level, business age, sector, and other contextual characteristics. Descriptive statistics for the main constructs—such as mean scores, standard deviations, and reliability indicators—were reported in Tables 2 and 3. The second stage employed inferential statistics to test the hypothesized relationships within the conceptual framework. Specifically, multiple regression analysis was used to examine the direct effects of

customer pressure, government pressure, and competitive pressure on green innovation adoption. A significance level of $p < .05$ was applied throughout the analysis. The results—presented in Tables 4 and 5—included standardized regression coefficients (β), p -values, adjusted R^2 , and F -statistics, which were used to assess the explanatory power of the model and determine whether the proposed hypotheses were supported.

Data analysis was conducted using a combination of SmartPLS 4, IBM SPSS Statistics 30, and Microsoft Office 2024.

Data Analysis

This section presents the demographic and organizational characteristics of the SMEs surveyed in the study. As shown in Table 1, the sample comprised 420 respondents, with a nearly even gender distribution (50.2% male, 46.9% female). The majority were aged between 25 and 40 years (57.4%), followed by those aged 41 to 56 (37.4%). Most respondents were highly educated, with 65.7% holding qualifications beyond a bachelor's degree. In terms of organizational profiles, approximately one-third of firms had been in operation for over 20 years, while 43% were under 10 years old. Annual revenue varied, with 46.4% reporting sales below 50 million baht and 19.3% exceeding 300 million baht. The sample represented a wide range of industries, with the largest sectors being wholesale/retail (18.3%), manufacturing (16.4%), and services (14.8%), followed by construction, agriculture, ICT, logistics, healthcare, and finance. This diverse representation underscores the heterogeneity of Thai SMEs and supports the broader applicability of the study's findings.

Table 1 Demographics of the respondents (n=420)

Variable	Description	Frequency	Percentage (%)
Demographic characteristics			
Gender	Male	211	50.2
	Female	197	46.9
	Prefer not to say	12	2.9
Age	Less than 25 years old	4	1
	25-40 years old	241	57.4
	41-56 years old	157	37.4
	More than 56 years old	18	4.3
Education Level	Lower than Bachelor's degree	8	1.9
	Bachelor's degree	136	32.4
	Higher than Bachelor's degree	276	65.7

Variable	Description	Frequency	Percentage (%)
Organizational profile			
Firm Age	Less than 5 years	89	21.2
	6-10 years	91	21.7
	11-20 years	99	23.6
	More than 20 years	141	33.6
Annual sales	Less than 50 million Baht	195	46.4
	51-100 million Baht	66	15.7
	101-200 million Baht	48	11.4
	201-300 million Baht	30	7.1
	301-500 million Baht	81	19.3
Industry Sector	Agriculture and Agricultural Products	35	8.3
	Manufacturing Industry	69	16.4
	Construction and Real Estate	54	12.9
	Wholesale / Retail Trade	77	18.3
	Transportation and Logistics	26	6.2
	Information and Communication Technology (ICT)	32	7.6
	Healthcare / Medical / Pharmaceuticals	23	5.5
	Finance, Accounting, and Insurance	9	2.1
	Services (e.g., Restaurants, Hotels, Tourism, etc.)	62	14.8
	Others	33	7.9
Total		420	100

To assess the measurement model and examine its reliability and validity, a confirmatory factor analysis (CFA) was conducted. Table 2 presents the results of the CFA. All items demonstrated satisfactory factor loadings, with values exceeding the recommended threshold of 0.70 and ranging from 0.719 to 0.898, thereby confirming strong item representation of their respective constructs. Cronbach's alpha (α) values ranged from 0.820 to 0.915, and composite reliabilities (CR) ranged from 0.890 to 0.932, both of which are above the recommended level of 0.70. These results provide strong evidence of internal consistency and reliability.

Table 2 Results of confirmatory factor analysis (CFA) (n=420)

Construct	Construct identifier	Items	Factor loading	Cronbach's alpha	Composite reliability
Customer Pressure	CUS	CUS1	0.881	0.867	0.910
		CUS2	0.888		
		CUS3	0.887		
		CUS4	0.723		
Government Pressure	GOV	GOV1	0.757	0.835	0.890
		GOV2	0.845		
		GOV3	0.886		
		GOV4	0.777		
Competitive Pressure	COM	COM1	0.859	0.820	0.893
		COM2	0.898		
		COM3	0.816		
Green Innovation Adoption	GIA	GIA1	0.841	0.915	0.932
		GIA2	0.821		
		GIA3	0.768		
		GIA4	0.719		
		GIA5	0.847		
		GIA6	0.827		
		GIA7	0.868		

Table 3 presents the descriptive statistics, inter-construct correlations, and average variance extracted (AVE) values. The means ranged from 3.00 to 3.66, with standard deviations between 1.10 and 1.23, indicating moderate variation in responses. All AVE values exceeded the recommended threshold of 0.50, confirming adequate convergent validity. Discriminant validity was also established using the Fornell–Larcker criterion, as the square roots of the AVEs on the diagonal were greater than the inter-construct correlations off the diagonal. This demonstrates that the constructs are empirically distinct. The correlation analysis further showed that all stakeholder pressures were positively related to green innovation adoption (0.462–0.560), with competitive pressure demonstrating the strongest association, underscoring its critical role as a driver of green innovation in SMEs. Overall, these results provide strong evidence of convergent and discriminant validity, while also highlighting the relative importance of different stakeholder pressures in shaping green innovation adoption.

Table 3 Mean, correlation, and average variance extracted (AVE) (n=420)

	Mean	S.D.	AVE	CUS	GOV	COM	GIA
CUS	3.00	1.23	0.718	1.00			
GOV	3.32	1.18	0.669	0.472	1.00		
COM	3.47	1.10	0.737	0.538	0.655	1.00	
GIA	3.66	1.13	0.663	0.523	0.462	0.560	1.00

Table 4 summarizes the ANOVA results for the regression model. The model was statistically significant ($F = 88.238$, $p < 0.001$), indicating that the three independent variables collectively explain a significant proportion of the variance in green innovation adoption. The regression sum of squares (137.375) accounted for 38.9% of the total variance ($R^2 = 0.389$), with a mean square of 45.792 compared to 0.519 for the residuals. These findings confirm that the model provides a good fit and that stakeholder pressures, taken together, significantly contribute to predicting green innovation adoption among SMEs.

Table 4 ANOVA (n=420)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	137.375	3	45.792	88.238	<0.001
Residual	215.885	416	0.519		
Total	353.260	419			

Table 5 presents the results of the multiple regression analysis examining the direct effects of stakeholder pressure on green innovation adoption (GIA), with a sample size of $n = 420$. The overall model was statistically significant, $F(3, 416) = 88.190$, $p < .001$, indicating that the three independent variables—customer pressure, government pressure, and competitive pressure—collectively explained a meaningful portion of the variance in GIA. The model yielded an R^2 value of 0.389 and an adjusted R^2 of 0.384, suggesting moderate explanatory power.

Unstandardized regression coefficients (B), standardized coefficients (β), and relevant statistics for each predictor are presented in the table. Customer pressure had a positive and significant impact on green innovation adoption ($\beta = 0.294$, $t = 6.347$, $p < .001$), emphasizing the strong influence of environmentally conscious customer expectations on SME behavior. Government pressure, while comparatively weaker, still showed a statistically significant effect ($\beta = 0.106$, $t = 2.045$, $p = 0.041$), suggesting that regulatory forces remain relevant, albeit secondary, drivers of green practices. Competitive pressure also significantly predicted GIA (β

= 0.276, $t = 6.164$, $p < .001$), indicating that market competition and peer actions are important motivators in prompting eco-innovation among SMEs.

Importantly, multicollinearity was not a concern, as variance inflation factor (VIF) values ranged from 1.458 to 1.986, well below the commonly accepted threshold of 5. The constant term of the regression equation was $B = 1.415$ ($SE = 0.146$, $t = 9.719$, $p < .001$). These findings offer empirical support for stakeholder theory, highlighting how diverse forms of external pressure—especially from customers and competitors—shape SMEs' strategic responses to environmental challenges and foster the adoption of green innovation. Notably, customer pressure and competitive pressure emerged as strong and statistically significant predictors of green innovation adoption, thereby confirming Hypothesis 1 and Hypothesis 3. Although government pressure (Hypothesis 2) had a comparatively smaller effect size, it remained statistically significant, supporting its hypothesized positive impact as well.

Table 5 Coefficients^a (n=420)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics
	B	Std. Error	Beta			VIF
(Constant)	1.415	0.146	0.000	9.719	0.000	-
CUS	0.259	0.041	0.294	6.347	0.000	1.458
GOV	0.100	0.049	0.106	2.045	0.041	1.816
COM	0.325	0.053	0.053	6.164	0.000	1.986
a: Dependent Variable: GIA						
R Square = 0.389, Adjusted R-Square = 0.384						

Discussion and conclusion

This study investigated the direct impact of three forms of stakeholder pressure—customer, government, and competitive—on green innovation adoption (GIA) among SMEs in Thailand. The multiple regression analysis confirmed that all three pressures were statistically significant predictors of GIA, with customer pressure exerting the strongest influence, followed closely by competitive pressure. Government pressure, while still significant, showed the weakest effect among the three. These findings support the proposed hypotheses (H1–H3) and reinforce the relevance of stakeholder theory in explaining how external forces shape sustainability-oriented decisions in the SME context. They also underscore the shifting emphasis toward consumer- and market-driven imperatives over regulatory compliance in driving green initiatives among Thai SMEs.

Notably, the results suggest that market-oriented pressures—particularly customer expectations and competitive dynamics—play a more dominant role than government regulation in motivating SMEs to pursue environmental innovation. This indicates that firms may be more responsive to evolving consumer preferences and competitor actions than to formal policy mandates. The study contributes to the growing body of literature on green innovation by offering empirical evidence from a developing economy context. It highlights the importance of aligning public and private sector efforts with the actual motivations of SMEs. For practitioners and policymakers, these insights point to the need for stakeholder-specific strategies—such as customer education campaigns, green procurement initiatives, or industry benchmarking schemes—to enhance environmental performance across the SME sector.

Implications

1. Managerial Implications

The findings of this study on stakeholder pressure and green innovation adoption in Thai SMEs highlight important implications for managers and policymakers. Customer and competitive pressures emerged as the strongest drivers, showing that sustainability in SMEs is shaped more by market demand and peer competition than by government enforcement. For managers, this calls for a market-oriented sustainability strategy that leverages external signals to drive innovation. SMEs can establish simple feedback loops—through short surveys or post-purchase conversations—to capture customer expectations, while competitor-focused routines, such as regular team discussions or policy-supported exchange programs, help firms anticipate market shifts. These practices ensure that sustainability remains a structured and ongoing agenda rather than an ad hoc initiative. Progress should be tracked using clear indicators such as the number of eco-friendly products launched, efficiency gains, or customer recognition of sustainable practices. As customer and competitive drivers are highly effective, firm leaders should also use them to motivate employees, embedding sustainability expectations into daily operations and organizational culture so that external pressures translate into concrete green innovations.

From a policy perspective, the study reveals that regulatory influence, while statistically significant, remains secondary unless supported by enabling mechanisms. Policymakers should therefore prioritize building an integrated ecosystem where regulation, consumer demand, and competitive dynamics reinforce one another. Crucially, government should act as a facilitator of sustainability rather than a coercive regulator, ensuring that SMEs see compliance as an opportunity rather than a burden. A practical starting point is to provide step-by-step guidance that matches different stages of SME readiness—from awareness to experimentation and innovation—supported by accessible tools such as a “Green Start” self-assessment checklist.

To reinforce progress, governments could introduce a green labeling system, awarding firms visible recognition that can be placed on packaging or online platforms to build customer trust. In addition, SME progress should be tracked annually using digital dashboards or portals, with encouragement and support offered where improvements slow. Peer-sharing forums can also provide platforms for SMEs to exchange lessons, share mistakes, and highlight successes. Together, these measures combine structured tools, phased guidance, visible recognition, and sustained engagement—reframing policy from being a barrier to being a bridge that enables SMEs to adopt green innovation as a pathway to competitiveness, resilience, and long-term sustainability.

2. Limitations and Future Research Direction

This study is subject to several limitations. Although the sample of 420 SMEs was sufficient for statistical analysis, the reliance on self-reported measures using Likert scales may introduce common method bias and social desirability effects. Moreover, the model focused exclusively on external pressures, without considering internal organizational dynamics. Future research could examine how such pressures interact with internal factors—such as leadership orientation, organizational culture, or absorptive capacity—in shaping adoption outcomes. In particular, employee pressure could be explored, as it may influence internal decision-making processes and reveal mechanisms beyond direct external effects. The study is also context-specific, focusing solely on Thai SMEs, which may limit the generalizability of findings to other cultural, regulatory, or economic environments. Cross-country comparative studies, especially in emerging economies, would help validate and extend the model. Finally, the use of convenience sampling may limit representativeness across different regions, firm sizes, and sectors. SMEs in high-impact industries, where failure to adopt green innovation could lead to the loss of contracts, may behave differently from firms in less regulated settings. Future research should therefore adopt more rigorous sampling methods, include sector-specific analyses, and account for regional variation to strengthen the generalizability of findings. By addressing these limitations, subsequent studies can provide more robust, nuanced, and contextually rich evidence on the role of stakeholder pressure in driving green innovation adoption.

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