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Effecting Green Innovation on Competitive Advantage: Thailand's Manufacturing Industry

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Abstract Manufacturing firms deploy green innovation in various activities, allowing them to create a competitive advantage through green supplier development and green orientation. As such, this study aims to explore the significant effects of green innovation, green supplier development, and green manufacturing orientation toward competitive advantage and to increase manufacturing firms' awareness of the impact of green business practices on a firm's competitive advantage. The research methodology was done by (1) equally cluster sampling of the 402 target manufacturers, (2) researcher collecting online data across six regions of Thailand, (3) performing construct validity by confirmatory factor analysis, and (4) testing the two-level factor structure by PROCESS models 4 and 14 assuming that green innovation can enhance a firm's competitive advantage when green supplier development is reinforced alongside a strong green manufacturing orientation. It was found that the linkage between green innovation and competitive advantage through green supplier development is positive when a manufacturer deploys either a strong or weak green orientation. Furthermore, the result reveals that deploying a strong green orientation has a substantially greater effect on competitive advantage. Thus, the manufacturer is imperative in emphasizing green orientation to enhance its competitive advantage.

Keywords: Green innovation; Green supplier development; Competitive advantage; Thailand's manufacturing industry

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Introduction

The post–World–War–II economic expansion, also known as the Golden Age of Capitalism, is the period of high productivity growth, high employment, and low and stable inflation extending from the end of the Second World War to the early 1970s. Japan pioneered this economic boom, leading to severe pollution issues. Later, the Japanese government implemented serious environmental regulations and invested in clean technology. By the 1980s to 1990s, Japan had become a global leader in green technology (Agamuthu & Babel, 2023). Besides, by the 1980s, the European Union (EU) began to take a more active role in environmental policy, leading to a unified approach to green innovation by establishing the Single European Act in 1987, including a commitment to environmental protection (Deters, 2019). In the late 20th and early 21st centuries, Asian nations, particularly South Korea, Taiwan, Singapore, and Hong Kong, incorporated green innovation into their national development strategies (Nem Singh, 2023). In the mid-2000s, China began investing heavily in renewable energy. The Chinese government's commitment to green innovation for sustainable development and environmental protection, this commitment has also positioned China as a significant player in green innovation (Zhang et al., 2022).

In addition, Asia is at the forefront of green innovation, with significant advancements and investments in renewable energy, sustainable agriculture, and green manufacturing. Thailand started experimenting with green innovation in the late 20th century, concentrating first on environmental preservation and sustainable agriculture (Aregarot et al., 2024). The country has made significant strides in renewable energy, particularly solar and biomass (Jotaworn et al., 2023). Despite regulatory hurdles and financial constraints, Thailand continues to advance its green innovation agenda, contributing to regional sustainability efforts in Southeast Asia (Srisathan et al., 2023). Even with these advancements, there are still issues; Thai manufacturing firms need help balancing economic growth with the cost of environmental protection.

Unfortunately, beginning with the year 2019-2021 has been different from our global history. The global spreading of the novel coronavirus, or COVID-19, was declared a pandemic in January 2020 by the World Health Organization, which caused many deaths and global economic regression (Shaki et al., 2021). Its consequence caused severe damage to the worldwide manufacturing industry and Thailand's manufacturing industry. Moreover, this economic emergency had been the most severe and heavily relied on global trade, commodity exports, tourism, and financing. Despite Thailand being industrialized for several decades. According to the record of the Department of Industrial Works (2024), the annual statistics of manufacturing firms in Thailand for the year 2018 at 140,535 manufacturers and the year 2023 at 73,045 manufacturers indicates a considerable decrease of almost 50%. This implies that Thailand's manufacturing industry is unhealthy, and has not recovered. It would lead to a serious issue that needs to be addressed by the stakeholders. This study considers the issues of business sustainability and competitive advantage.

There is some point of interest that Thailand manufacturing firms are facing 2 scenarios of global economic regression and incapable competition. Besides, the eco-friendly manufacturing trends involve the green movement that makes its way into manufacturing processes for sustainability by improving efficiency and the firm's reputation. Therefore, it is rational to imply that green manufacturing orientation could be a proper solution for manufacturing firms to create competitive advantages. Moreover, an increasing proportion of manufacturing firms recognize the critical input from suppliers to provide any major competitive benefit. Strategic choice can be the proper solution by focusing on collaboration between manufacturing firms and suppliers via a supplier development program. It is consistent with the study of Handfield (2020) that the strategy of supplier development can result in significant enhancements in supplier performance~~s~~: (1) a 5-90% reduction of product defect; (2) a 6-15% enhancement on-time delivery; (3) 30-80% reduction of order fulfillment cycle time, and (4) 10-30% enhancement of product performance. Besides, the previous study reveals that supplier development is crucial for a manufacturing firm to access and benefit from supplier resources.

This could eventually lead to better firm performance and competitive advantages (Balin & Sari, 2023; Glavee-Geo, 2019).

Many manufacturing firms, unaware of environmental sustainability, are still active in achieving short-term gain, even though it would lead to business unsustainability. There is essential evidence from China that air pollution is to be considered a threat to innovation and competitive advantage (Liu et al., 2021). It is within our expectation that green initiatives within the manufacturing industry must be established by the intention of the owner/management (Qiao et al., 2020; Yacob et al., 2019). Besides, they need to be more consistency in decision-making to green procurement (Ayarkwa et al., 2020). Furthermore, the degree of green manufacturing orientation influences a firm's competitive advantage. On the other hand, not all supplier development initiatives are successful due to inefficient implementation and follow-up, including the continuous improvement of the entire supply base (Handfield, 2020). In conclusion, there might be a linkage between green innovation, green supplier development, and the degree of green manufacturing orientation toward the firm's competitive advantage.

Therefore, the research question is, "How is the existence of similarities and differences in a firm's competitive advantage when employing the different degrees of green manufacturing orientation, under the assumption of reinforcement of green supplier development on green innovation?". Although the manufacturing firms' executives are presently showing to deploy any green manufacturing orientation, there is a lack of commitments and long-term strategic environmental goals (Bai & Satir, 2020). There are also no empirical studies concerning the degree of green manufacturing orientation in Thailand's manufacturing industry when they utilize green supplier development to reinforce green innovation to achieve competitive advantages. Thus, the researcher attempts to achieve the below research objectives:

1. To explore the significant effects of green innovation, green supplier development, and green manufacturing orientation toward competitive advantage.
2. To increase manufacturing firms' awareness of the effect of green business practices on a firm's competitive advantage.

Theoretical framework and hypothesis development

Initially, the strategic choice theory focused on the issues of environmental sustainability. At the same time, the heterogeneity in firm performance in the same phenomena, a firm has performed a proactive role in making their choices independently to acquire the desired results (Astley & Van de Ven, 1983; Child, 1972). Within the 4th Industrial Revolution era and business sustainability, the strategic choice of green manufacturing orientation could be a source of competitive advantage (Seth & Rehman, 2022; Yao et al., 2019). From the perspective of strategic choice of green manufacturing orientation, a firm must reconsider and reposition itself relative to the issue of potential environmental threats and any improvement in terms of its competitive advantage.

Recently, numerous studies have focused on green orientation in the context of the manufacturing industry. In particular, an executive tends to select green innovation as a strategic choice to achieve a firm competitive advantage (Chouaibi & Chouaibi, 2021; Han et al., 2022; Li et al., 2021; Rahayu et al., 2023). There is not only green innovation, but it is also green supplier development. As mentioned by Bai and Satir (2020), green supplier development is a potential for a firm to generate more business opportunities than a competitor when it addresses environmental issues successfully, and it is a primary operational strategy in procurement. Besides, several pieces of evidence reveal that green supplier development is an essential activity for better firm performance, particularly in products and processes (Dobos & Vorosmarty, 2019). Therefore, the researcher aims to provide the best option for an executive of a manufacturing firm. This study proposes the theoretical framework of strategic choice theory to explain the positive linkage between green innovation, green supplier development,

green manufacturing orientation, and competitive advantage. Therefore, Figure 1 illustrates the overall research model.

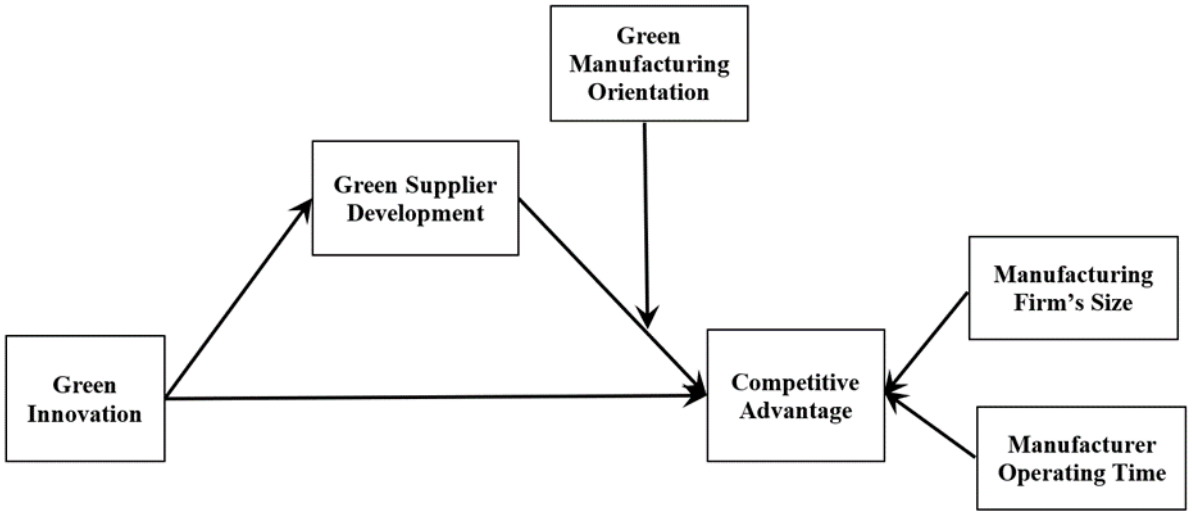

Figure 1 Research model

Competitive advantage

Competitive advantage denotes the superiority of a firm over its competitors through its competitive strategies (Porter & van der Linde, 1995). Currently, manufacturing firms use supplier relationships' power for their survival and competitive advantage in a highly volatile marketplace (Dash et al., 2018). It is also in association with the recent study that green business practice significantly and positively affects a firm's performance, leading to competitive advantage (Rachmawati, 2023). In terms of measuring competitive advantage, especially in the manufacturing sector, it can be measured by product sales expansion, product cost reduction, superior quality, responsiveness to marketing changes, capability of R&D, and corporate image (Li et al., 2018).

Positive effect of green innovation toward competitive advantage

Green innovation denotes developing new eco-friendly products, services, processes, and organizational management (Chang & Chen, 2013). Besides, some scholars refer to green innovation as an eco-innovation. Thus, many manufacturing firms have felt pressured to incorporate green innovation initiatives into their operations for several decades.

In general, green innovation falls into three categories: (1) green product innovation, (2) green process innovation, and (3) green managerial innovation. This innovation of green products aims to minimize unfriendly environmental concerns over a product's life cycle. Next, green process innovation is related to improving existing operating processes to reduce environmental impact. Lastly, green managerial innovation is associated with improving management practices by adopting an eco-friendly management process to enhance the firm's performance. Based on previous studies, green products and process innovation can improve a firm's financial performance and competitive advantage (Xie et al., 2019; Wu et al., 2022). Furthermore, from time to time, green consumers are significantly growing and moving to greener products. To satisfy them, manufacturing firms need to adopt green innovation to achieve a competitive advantage. Thus, green innovation is an essential instrument for a firm to achieve a competitive advantage in a period of environmental concern (Jianhong et al., 2020; Juo & Wang, 2022; Nguyen et al., 2023). Regarding strategic choice theory, a manufacturing firm enhances its competitive advantage by implementing green innovation into its

business operation. Besides, previous studies reveal that green innovation and green business practices positively impact competitive advantage (Hang et al., 2022; Liu et al., 2021; Zameer et al., 2022). Therefore, this study presents the hypothesis development:

Hypothesis 1 Green innovation is positively related to competitive advantage.

The mediating effect of green supplier development toward competitive advantage

A recent study reveals that manufacturing firms are more rely on suppliers and the strategy of sustainable procurement caused by the outsourcing requirement and environmental constraints to gain a better competitive advantage and business sustainability (Al Hashmi et al., 2020; He & Chen, 2023). It is a rationale that a manufacturing firm would create green supplier development to involve direct interaction and investment between a buyer firm and suppliers to enhance the products or services based on environmental issues. Besides, buyer firms may also provide their suppliers with eco-technological advice to enhance business sustainability. This implies that green supplier development is a proper activity to reinforce green innovation and achieve a competitive advantage. Based on green innovation practices, a manufacturing firm may generate its competitive advantage by seeking better ways of doing things. Then, it would implement a green supplier development program into its transformation process to minimize costs and time. Hence, a firm's competitive advantage can be perceived as derived from green innovation and green supplier development. Some recent studies are revealing that a positive linkage between green innovation and green supplier development can enhance a firm's competitive advantage (Bataineh, 2021; Sun & Sun, 2021; Yang & Wang, 2020). Thus, the hypothesis is proposed as follows:

Hypothesis 2 Green supplier development mediates a positive effect of green innovation on competitive advantage.

The moderated mediating effect of green manufacturing orientation and green supplier development toward competitive advantage

In recent years, many modern firms have focused more on environmental issues and deployed innovative strategies to accomplish them, particularly in the manufacturing industry. It aligns with Hart (1997) that deploying an environmentally sustainable strategy could create a firm's competitive advantage. On the other hand, regarding consumer demands, manufacturing firms realize the benefits of incorporating a green manufacturing orientation to provide them with greener products and processes. Thus, green manufacturing orientation denotes a managerial commitment and appreciation of environmental sustainability within the business context (Huang, 2012). Furthermore, the recent findings reveal that green transformational leadership can inspire and motivate the stakeholders, in particular suppliers, to promote green innovation by activating them in friendly environmental actions and procedures (Ahmeda et al., 2020; Begum et al., 2022; Wungkana et al., 2023).

Finally, this study explores how green orientation and green supplier development on the link between green innovation and competitive advantage, assumes that implementing a high degree of green manufacturing orientation within green supplier development under green innovation practices enhances competitive advantage. On the contrary, a low degree of green manufacturing orientation is deployed in green supplier development and may serve only as "window dressing" for its public image (Leelhaphunt & Suntayuth, 2020). It is consistent with recent studies that a firm limits its actions of corporate social responsibility as the linkage between social actions and firm reputation is also not evident (Sharma et al., 2021), and the economic and managerial barriers are the most prominent for sustainable manufacturing practices (Prasad et al., 2022). As a result, all stakeholders would doubt and distrust the firm's business practices, leading to incapable competition. In addition, previous studies reveal that green manufacturing orientation and green supplier activity could enhance its performance, which leads to a firm's competitive advantage (D'Angelo et al., 2023; Wungkana et al., 2023; Yan et al., 2022). Therefore, it is hypothesized:

Hypothesis 3 The linkage between green innovation and competitive advantage through green supplier development is positive when a manufacturing firm has deployed a strong green manufacturing orientation.

Methodology

Research design

Since there is a direct effect of green innovation, the mediating effect of green supplier development, and the moderated mediating effect of green manufacturing orientation toward competitive advantage, quantitative research is the most appropriate. Its analysis is on the organization level by exploring the manufacturers located over the 6 regions of Thailand. The research procedure had been approved by the research ethics committee of Burapha University, with the number IRB2-123/2564.

Sample and procedures

The population consisted of 73,045 manufacturers in central, eastern, northeast, northern, southern, and western regions. Cluster sampling with equal sample sizes was utilized. As a result, each region was represented by 67 samples, totaling 402 manufacturers. The industrial network facilitated data collection for academic purposes. The respondents were the key informants or manufacturers' representatives: top management, factory manager, and procurement manager.

Measurement

These variables were 12-item green innovation, 6-item green supplier development, 6-item green manufacturing orientation, and 7-item competitive advantage with a 6-point Likert scale for minimizing the hesitant opinion and ranging from 1 to 6 (extremely low to extremely high agreement). In the context of green innovation, firm size and operating time may potentially affect competitive advantage and firm performance (Duque-Grisales et al., 2020; Zhang et al., 2020). As such, they were controlled.

Data analysis

There were two levels of analysis: initial testing and hypothesis testing. On initial testing, the statistical packages for social sciences (SPSS) and the confirmatory factor analysis were utilized to validate the three predictive variables and one dependent variable and to prevent the multicollinearity problem. Hypothesis testing, the ordinary least square regression by PROCESS model 4 and 14 was utilized to examine a two-level factor structure model under the assumption that green innovation can enhance a firm competitive advantage when the reinforcement of green supplier development with a strong green manufacturing orientation is utilized.

Research results

Initial testing

Originally, this questionnaire was generated in English. The modification and back-translation were applied to the Thai questionnaire and verified by academic and professional experts. It had a pre-test of 40 samples randomly selected from all 6 regions of Thailand. The Cronbach's alpha of all scales was higher than 0.7, indicating acceptable reliability. Then, the online questionnaire collection was performed and achieved a total number of participants of 402 manufacturers, which accounted for 100.00% of the collection.

Demographic *information*

The main characteristics of the respondents indicated that 60.45% were male and 39.55% were female, whose ages were between 41-50 years at 43.78% and attained a bachelor's degree at 66.42%.

Regarding the current position, 44.03% were factory/production managers, and 29.35% were procurement managers. There was 24.38% from industrial materials; 22.89% from electronic components; 22.14% from consumer products; and the rest was from others. Besides, 56.22% were small and medium and 43.78% were large. Lastly, the majority had been in operation for 6 to 15 years, which accounted for 70.90%.

Scales validation and reliability

Construct validity was applied to prevent the multicollinearity problem and scale validation. Starting with convergent validity, factor analysis was performed using principal component extraction and varimax rotation techniques. Based on Child (2006), the criteria value of KMO is 0.70 or higher, and the significance level of Bartlett's test of sphericity does not exceed 0.05, indicating none of the multicollinearity concerns. As a result, KMO values ranged from 0.72 to 0.87 with a p-value of 0.000, indicating that it can utilize factor analysis techniques (green innovation = 0.87, green supplier development = 0.75, green manufacturing orientation = 0.78, competitive advantage = 0.72). All items' 0.50 excess extraction value was also left for further analysis. Then, the exceeding 0.70 composite reliability (CR) and the exceeding 0.50 average variance extracted (AVE) were applied to access the convergent validity (Fornell & Larcker, 1981; Hair, 2010). The confirmatory factor analysis (CFA) was performed to appraise each standardized regression coefficient of the latent and its indicator to calculate CR and AVE. As a result, the criteria for convergent validity based on CR and AVE were met as shown in Table 2.

Next, the discriminant validity, CFA with maximum likelihood technique was performed to access the latent variable correlation. The square root of AVE was calculated. As a result, in Table 1, each square root of AVE exceeded its latent variable correlation, which complied with the discriminant validity criterion (Fornell & Larcker, 1981). Therefore, construct validity was achieved.

Table 1 Convergent and discriminant validities analysis

Variables (N = 402)	CR	AVE	1	2	3	4
1. Green innovation	0.93	0.52	0.72[a]			
2. Green supplier development	0.92	0.66	0.30[b]	0.61[a]		
3. Green manufacturing orientation	0.87	0.54	0.36[b]	0.44[b]	0.74[a]	
4. Competitive advantage	0.90	0.55	0.38[b]	0.39[b]	0.54[b]	0.74[a]

Note: [a] = square root of AVE, [b] = latent variables correlation

Hypothesis testing

Analysis of the direct effect

Hypothesis 1 states that a positive effect of green innovation towards competitive advantage. Its direct effect is accessed by the regression coefficient with a 95% confidence interval. As shown in Table 2, green innovation has a significantly positive direct relationship with competitive advantage ($b = 0.16$, $p < 0.001$). Therefore, hypothesis 1 is accepted. A manufacturing firm could utilize green innovation to create its competitive advantage based on 64% prediction power with less than 0.10% significant chance of being incorrect. Furthermore, competitive advantage is more positively influenced by a more prominent manufacturer and a more extended operation ($b = 0.85$, $p < 0.001$; $b = 0.41$, $p < 0.001$).

Table 2 Result of the direct effect of green innovation towards competitive advantage

Variables	Competitive advantage				
	Adjusted $R^2 = 0.64$, $F = 239.18$***				
	b	β	SE	t	VIF
Constant (a)	1.31		0.14	9.55***	
Green innovation	0.16	0.16	0.03	5.00***	1.13
Manufacturing firm size	0.85	0.52	0.05	16.66***	1.09
Manufacturer operating time	0.41	0.46	0.03	14.96***	1.05

Note: ***$p < 0.001$ (2-tailed)

Analysis of mediating effect

Hypothesis 2 states that green supplier development will mediate a positive linkage between green innovation and competitive advantage. According to Hayes (2013), the researcher utilized model 4 of PROCESS custom dialog box for SPSS to evaluate an indirect effect of mediation. Based on multiple regression analysis, it estimated the regression coefficients and analyzed the mediating effect of green supplier development on green innovation and competitive advantage. The results, as shown in Table 3 and Figure 2 imply that 'path a' from green innovation (X) to green supplier development (M) is significant ($b = 0.37$, $p < 0.05$, $R^2 = 0.11$). The 'path b' from green supplier development (M) to competitive advantage (Y) is also significant ($b = 0.16$, $p < 0.001$, $R^2 = 0.67$). The 'path c'' is a significantly direct effect from green innovation (X) to competitive advantage (Y) ($b = 0.10$, $p < 0.05$). Therefore, hypothesis 2 is accepted. The results of the green supplier development mediation indicate that manufacturers can use green supplier development to reinforce green innovation and create a competitive advantage at 67% predicting power with less than 0.10% significant chance of being incorrect.

Table 3 The mediating effect of green supplier development

Variables	Green supplier development (M)	Competitive advantage (Y)		
	b	b	SE	t
Constant (a)	2.67	0.89	0.17	5.32***
Green innovation (X)	0.37	0.10	0.06	6.52**
Green supplier development (M)		0.16	0.36	3.00***
Manufacturing firm size		0.86	0.05	17.06***
Manufacturer operating time		0.41	0.03	15.00***
R^2	0.11	0.67		
F	15.57***	248.87***		

Note: **$p < 0.01$, ***$p < 0.001$ (2-tailed)

Furthermore, the results of path analysis by PROCESS, presented in Figure 2, show a significant indirect effect of 'path ab' on competitive advantage ($b = 0.06$, $p < 0.001$). This indirect effect is calculated by multiplying the regression coefficient of 'path a' and 'path b'. Also, the total effect on competitive advantage is significant ($b = 0.16$, $p < 0.001$). By principle, the value of the total effect's regression coefficient of mediating analysis must equal the direct effect's regression coefficient of earlier solely regression analysis ($b = 0.16$, $p < 0.001$). Interestingly, both analyses have a different constant value. The mediating analysis indicates the constant value at 0.89, while the

regression analysis indicates the constant value at 1.31. Concerning the mediating analysis, it implies that a manufacturing firm could generate its competitive advantage by concentrating on reinforcing green supplier development on green innovation and relying less on other unknown factors. On the contrary, based solely on regression analysis of green innovation, manufacturing firms are likely to rely more on other unknown factors, which may lead to a risk of firm performance.

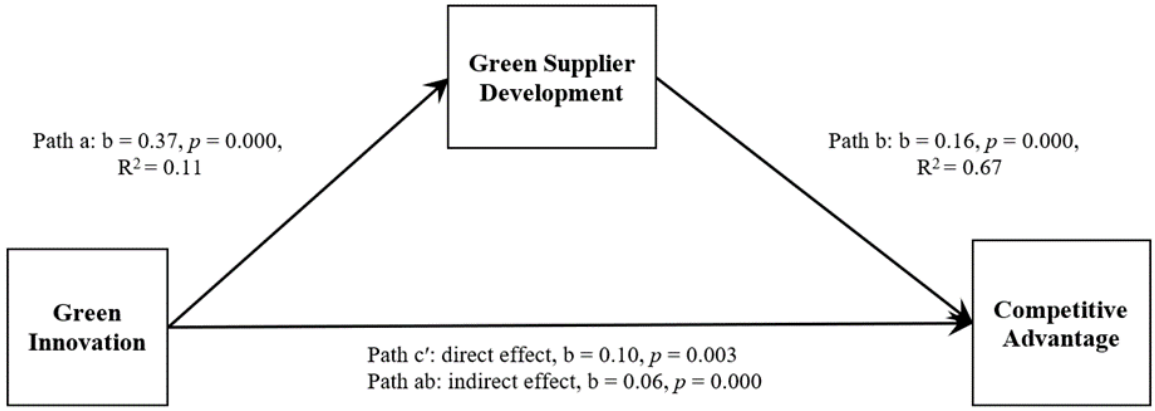

Figure 2 The mediating effect of green supplier development

New knowledge from this study regarding the mediating effect of green supplier development

After synthesization of both constant values of sole regression (a = 1.31) and mediating model regression (a = 0.89), this study demonstrated that the reinforcement of green supplier development on green innovation indicates less unknown factor leading to less risk on firm's competitive advantage in the context of Thailand manufacturing sector.

Analysis of the moderated mediation

It is to explore the conditional indirect effect of a green manufacturing orientation moderator towards a dependent variable. Hypothesis 3 states that the linkage between green innovation and competitive advantage through green supplier development is positive when a manufacturing firm has deployed a strong green manufacturing orientation. To begin with moderator identification of green manufacturing orientation, the results indicate that data distribution is normal as the skewness and kurtosis values are close to zero, which is appropriate in identifying either a strong or weak green manufacturing orientation based on the mean. Thus, any manufacturing firm with a green manufacturing orientation score greater than the mean is defined as having a "strong green manufacturing orientation" while a "weak green manufacturing orientation" is vice versa. In summary, there are 214 manufacturers, or 52.23% to be defined as a "strong green manufacturing orientation". As a dichotomous moderator, it represents a dummy variable (weak = 0, strong = 1), and all component variables of the interaction term are mean-centered. Following the mean-centered moderator, the strong green manufacturing orientation equals 0.47, and the weak green manufacturing equals –0.53.

This second-stage moderated mediating effect, PROCESS model 14 was employed with a 5,000-sample bootstrap, incorporating bias correction to establish a 95% confidence interval. The results, as shown in Table 4 and Figure 3 imply that 'path a' from green innovation (X) to green supplier development (M) is statistically significant ($b = 0.37$, $p < 0.05$, $R^2 = 0.11$). The 'path b_1' from green supplier development (M) to competitive advantage (Y) is statistically significant ($b = 0.15$, $p < 0.001$). 'Path b_2' is from green manufacturing orientation (V) to competitive advantage (Y). The interaction term is represented by 'path b_3' which is derived by M x V. Lastly, the 'path c′' is a significant direct effect from green innovation (X) to competitive advantage (Y) ($b = 0.10$, $p < 0.05$).

Table 4 Moderated mediation

Variables	Green supplier development (M)	Competitive advantage (Y)		
	b	b	SE	t
Constant (a)	-1.41	1.56	0.14	10.95***
Green innovation (X)	0.37	0.10	0.04	2.88**
Green supplier development (M)		0.15	0.03	4.46***
Green manufacturing orientation (V)		0.23	0.05	0.51
Interaction effect (M x V)		-0.09	0.07	-1.31
Manufacturing firm size		0.86	0.05	16.98***
Manufacturer operating time		0.41	0.03	14.96***
R^2	0.11	0.67		
F	15.57***	168.84***		

Note: **p < 0.01, and ***p < 0.001 (2-tailed)

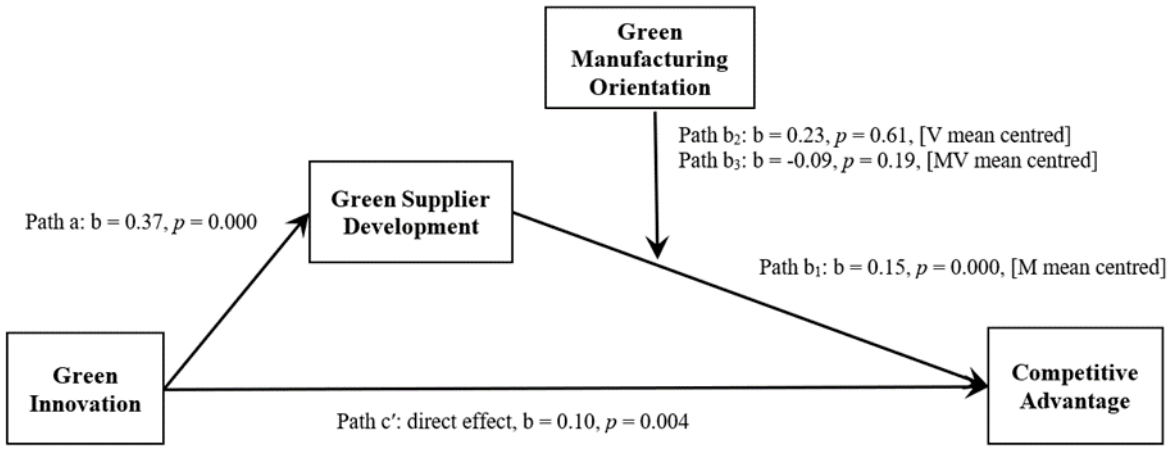

Figure 3 Results of the moderated mediating effect

Hayes's (2013) analytical approach, PROCESS, computes the total conditional indirect effect of X on Y at the value of moderated mediator. This equation derives it: $\omega = a(b_1b_3V)$, where b_3V represents the interaction term, and V represents the value of the moderator. Furthermore, based on bootstrap analysis, an absence of zero contained in the interval of confidence implies the existence of the conditional indirect effect of the independent variable (X) on the dependent variable (Y). As such, the results of path analysis, presented in Table 5, imply the significant conditional indirect effect of both strong and weak green manufacturing orientation. Therefore, hypothesis 3 is accepted ($\omega = 0.07$, CI [0.04, 0.12]). Assuming that a strong green manufacturing orientation is implemented in green supplier development under green innovation practice, we can interpret that the manufacturer could gain a more competitive advantage than a weak green manufacturing orientation ($\omega = 0.04$, CI [0.01, 0.08]) with 95% confidence interval.

Table 5 Path analysis by PROCESS, model 14

The conditional indirect effect of green innovation (X) on competitive advantage (Y) at values of moderated mediator (b_3V): $\omega = a(b_1b_3V)$				
Green supplier development and green orientation (b_3V)[a]	**Competitive advantage (Y)**			
	ω	**Boot SE**	**LLCI[b]**	**ULCI[c]**
Strong green manufacturing orientation (V = 0.47)	0.07	0.02	0.04	0.12
Weak green manufacturing orientation (V = -0.53)	0.04	0.02	0.01	0.08
Moderated mediating effect			**Competitive advantage (Y)**	
			Strong	**Weak**
Direct path ($P_{X\rightarrow Y}$) = c′			0.10**	0.10**
Total conditional indirect path of X on Y at the value of moderated mediator (M & V): $\omega = a(b_1b_3V)$			0.07*	0.04*
Total effect of X on Y			0.17	0.14

Note: *p < 0.05, **p < 0.01(2-tailed)
a = Green supplier development and green orientation were mean-centered.
b = Bootstrap lower level of 95% confidence interval
c = Bootstrap upper level of 95% confidence interval

Further analysis of similarities and differences in a firm's competitive advantage was performed based on the research question. The results of the conditional indirect effect of green innovation on competitive advantage, presented in Table 6, reveal that the reinforcement of green supplier development with either a strong or weak green manufacturing orientation has the similarities of a positive and statistically significant effect (strong: ω = 0.07, CI [0.04, 0.12], weak: ω = 0.04, CI [0.01, 0.08]). Besides, differences exist because a strong green manufacturing orientation has provided a greater effect on competitive advantage than a weak green manufacturing orientation. Concerning the total effect based on green innovation towards competitive advantage, the reinforcement of green supplier development with a strong green manufacturing orientation has a substantially greater effect on competitive advantage (strong = 0.17, weak = 0.14).

New knowledge from this study regarding the moderated mediating effect of green supplier development and green manufacturing orientation

After synthesization of both conditional indirect effects of strong green manufacturing orientation (ω = 0.07) and weak green manufacturing orientation (ω = 0.04), this study demonstrated that the reinforcement of green supplier development with strong green manufacturing orientation on green innovation provides more effect leading to a better firm' s competitive advantage in the context of Thailand manufacturing sector.

Discussion and conclusion

Thailand's manufacturing industry faces 2 scenarios: the global economic recession and competitive incapability. Moreover, some believe an eco-friendly manufacturing and green movement would enhance its competitive advantage and business sustainability. As such, a proper solution for a business executive is to apply the strategic choice of green manufacturing orientation to its business practice. It is not only to enhance competitive advantage but also to maintain the country's competitiveness. Therefore, this study seeks to understand the linkage between green innovation, green

supplier development, green manufacturing orientation, and competitive advantage for manufacturing firms in Thailand.

The construct validity, convergent and discriminant validity results indicate that all measurement scales represent all variables well. Following the theoretical framework of the strategic choice theory, especially in the context of Thailand's manufacturing industry, the finding of this study is consistent with the recent studies that an executive tends to choose green business practices to generate competitive advantage (Chouaibi & Chouaibi, 2021; Han et al., 2022; Li et al., 2021; Rahaya et al., 2023). Therefore, the strategic choice of green manufacturing orientation is a proper strategy for a manufacturing firm to enhance its competitive incapability in Thailand.

The direct effect is found in the positive linkage of green innovation to competitive advantage, which is consistent with previous studies (Hang et al., 2022; Juo & Wang, 2022; Liu et al., 2021; Nguyen et al., 2023; Zameer et al., 2022). Green innovation is essential for a manufacturer to enhance its competitive incapability and generate a superior competitive advantage. However, based on this study of small manufacturing firms and their lower operating time, green innovation might be a crucial obstacle since it requires a high investment cost. Besides, recent studies reveal that green innovation could generate a risk to a firm (Appiah, 2023; Aray et al., 2020; Yao et al., 2019). Thus, the management might penetrate a niche market of a green customer by generating any specific green innovation that could fulfill some pain points, for example, a green product of healthy food and green customer service of taking back from a consumer at the end of the product's life for recycling, reuse, or responsible disposal. Eventually, it could engage green customers leading to its competitive advantage.

Mediating effect, it is found that green supplier development mediates a positive linkage between green innovation and competitive advantage. That implies an efficient interdependence between the buying firm and supplier. Recent studies associate the linkage between green innovation and green supplier activity with enhanced competitive advantage and business sustainability (Al Hashmi et al., 2020; Bataineh, 2021; He & Chen, 2023; Sun & Sun, 2021; Yang & Wang, 2020). In general, to minimize mistakes and errors as well as time and cost, a manufacturing firm employs a green supplier development program to handle this issue. Within Thailand, small and medium manufacturing firms are the major suppliers and outsourcing for related industries. The crucial mechanism for enhancing efficiency between buyer firms and suppliers is to share value information and knowledge, complementing manufacturing flexibility and quality management. Consequently, both parties can gain mutual benefits and enjoy business sustainability. Currently, Thailand's manufacturing industry is facing competitive incapability and business unsustainability. As such, an executive could consider this strategic choice of green supplier development to strengthen from upstream to midstream productions.

Moderated mediating effect, deploying a strong green manufacturing orientation into green supplier development reinforces green innovation, leading to a superior competitive advantage (ω = 0.07). It is not beyond expectation reinforcing green supplier development with a weak green manufacturing orientation on green innovation also positively affects competitive advantage. However, it is to provide a lesser effect (ω = 0.04). Its study highlights the research gap by exploring the moderated mediating role of green supplier development with both strong and weak green manufacturing orientations to gain a greater understanding of the impact of green innovation on competitive advantage.

Furthermore, based on this empirical finding, comparing the mediating model and the second-stage moderated mediating model is provided to understand 2 dimensions better. First, the total effect of the mediating model is equal to 0.16, while the second-stage moderated mediating model (strong moderator) is equal to 0.17. To summarize, the second-stage mediating model provides a higher total effect than the mediating model. Second, based on an unstandardized regression equation by Hayes (2013), the comparison is illustrated:

$M = i_1 + aX + e_M$ ……..…… (1) Mediator regression equation

$Y = i_2 + c'X + b_1M + e_Y$ …….……...…….. (2) Mediating model regression equation

$Y = i_3 + c'X + b_1M + b_2V + b_3MV + e_Y$….. (3) Second-stage moderated mediating model regression equation

To predict equation (1), the i_1 is the constant of M on X, and a is the regression coefficient of X. To predict equation (2), the i_2 is the constant of Y on X and M, and the c' and b_1 are the regression coefficient of X and M, respectively. To predict equation (3), the i_3 is the constant of Y on X, M, and V, and the c', b_1, b_2, and b_3 are the regression coefficients when predicting Y. To compare equation (2) and equation (3), it is supposed that the other parameters are equal to zero. Although both equations provide a positive constant, equation (3) provides a higher constant ($i_2 = 0.89$, $i_3 = 1.56$). Based on this scenario, the second-stage moderated mediating model regression equation provides a greater outcome on the dependent variable than the mediating model regression equation.

In conclusion, this study provides empirical results under the strategic choice theory, which states that an executive of a firm has performed a proactive role in making choices to enhance competitive advantage and business sustainability. Furthermore, based on the research questions and objectives, deploying green manufacturing orientation in various activities, such as green innovation and green supplier development, has played an essential role in enhancing a firm's competitive advantage and business sustainability. Although both strong and weak green manufacturing orientations have provided the same positive effect, a strong green manufacturing orientation has had a greater effect on a firm's competitive advantage. Besides, the analysis of the total effect and the unstandardized regression equation demonstrates that the moderated mediating model of green supplier development with green manufacturing orientation provides a greater outcome than the mediating model of solely green supplier development.

As such, it is imperative for an executive to seriously exercise a proper degree of green manufacturing orientation in an operation; otherwise, it could lead to unforeseen risks and business unsustainability. Moreover, a manufacturing firm must reconsider and reposition itself relative to a green manufacturing orientation enhancing its competitive incapability and minimizing the risks of turbulent market circumstances. Consequently, both buying firms and suppliers could achieve a superior competitive advantage and business sustainability, leading to better competitiveness for the country.

Contributions, limitations, and future study

Academic and managerial contributions

Theoretical contribution: To fill the previous research gap, in particular in the Thailand manufacturing industry, the strategic choice theory implies the proactive commitment of an executive, resulting in a strong firm performance and environmental sustainability. The strategic choice of an executive demonstrates that the reinforcement of green supplier development with a strong green manufacturing orientation on green innovation provides a larger effect on a firm's competitive advantage. This finding can add to the supply chain management literature and reaffirm strategic choice theory's validation in Thailand's industrial sector.

Managerial contribution: As the two options are proposed, an executive may choose to separate them or keep them together:

1. Employ an association of green innovation and green supplier development with a strong green manufacturing orientation to enhance a firm's competitive advantage.

2. Not hesitate to implement a green manufacturing orientation as an essential corporate strategy. Although it requires a high investment cost, it can leverage the manufacturing cost to acquire a long-term competitive advantage and business sustainability. Currently, environmental issues strongly demand the trend of going green.

Limitations and future study

The two crucial limitations are worthy of notice. First, the participant manufacturing firms operate in different industries, and the pressure on environmental issues is different contributing to unequally green business practices. Second, the capital and executive mindset may lead to subjective bias on environmental issues. As such, future research needs to continue. First, researchers should conduct a more longitudinal study to compare the results of different contexts. Second, it should concentrate on each different industry or business nature. Understanding how each industry deploys any green manufacturing orientation activity to achieve its competitive advantage would be interesting. As a result, it would lead to the generalization of Thailand's manufacturing industry.

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