Strategic Thinking as a Catalyst: Linking Green Competency to Green Innovation in the Malaysian Manufacturing Sector

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ABSTRACT

This study examines the mechanisms through which employee green competency (GC) translates into green innovation (GI) within the Malaysian manufacturing sector. It specifically investigates the dual role of strategic thinking (ST) as a mediator and moderator in the relationship between GC and GI. A quantitative, cross-sectional survey was conducted among 300-350 employees in Malaysian manufacturing firms with ISO 14001 or other green certifications. The collected data were analysed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the proposed hypotheses concerning the direct, indirect, and conditional effects among the variables. The results confirm that Green Competency positively influences both Green Innovation (β = 0.409) and Strategic Thinking (β = 0.319). Strategic Thinking, in turn, is a strong predictor of Green Innovation (β = 0.431). Crucially, the findings support the dual role of Strategic Thinking. It acts as a significant mediator, with an indirect effect of 0.137, suggesting it is a key pathway through which GC influences GI. Furthermore, Strategic Thinking positively moderates the GC-GI relationship (β = 0.227), indicating that the effect of green competencies on innovation is amplified when employees possess higher levels of strategic thinking. For manufacturing firms aiming to enhance sustainability, this research underscores the need to cultivate not only green skills but also strategic thinking capabilities among their employees. Fostering a workforce that can anticipate long-term environmental trends and align sustainability goals with innovative actions is critical for maximizing the return on investment in green competencies. This study provides a nuanced understanding of the GC-GI link by being one of the first to empirically validate the dual role of strategic thinking as both a cognitive bridge (mediator) and an amplifier (moderator). It offers a comprehensive model grounded in the Resource-Based View and Dynamic Capabilities Theory, providing actionable insights for the Malaysian manufacturing sector.

Keywords: Green Competency, Green Innovation, Strategic Thinking, Malaysian Manufacturing, Dynamic Capabilities Theory

INTRODUCTION

Amid mounting global environmental pressures, manufacturing firms are increasingly compelled to integrate sustainability into their core strategies, with green innovation (GI) emerging as a critical pathway to achieving this (Ashraf et al., 2024). Green innovation refers to the development of new products, processes, and organizational practices that reduce environmental impact and enhance long-term sustainability. The foundation for such innovation lies within a firm's human capital, specifically the green competencies (GC) of its employees, the knowledge, skills, and attitudes necessary for environmentally responsible performance (Yahya et al., 2022). While a direct link between GC and GI is established in the literature, the cognitive processes that convert employee potential into tangible innovation remain underexplored.

This study addresses this gap by proposing that strategic thinking (ST), the ability to anticipate, analyse, and act on complex environmental dynamics—is a critical catalyst in this relationship. This study seeks to achieve several interconnected objectives. Primarily, it aims to confirm the direct, positive influence of employee Green Competency on Green Innovation within the Malaysian manufacturing sector. Building on this, the study further investigates the role of Strategic Thinking by first establishing its relationships with both Green Competency and Green Innovation. The core of the research, however, is to explore the nuanced, dual role of

Strategic Thinking. It will be analysed first as a mediator that explains how Green Competency is transformed into Green Innovation, and second as a moderator that clarifies when the relationship between Green Competency and Green Innovation is at its strongest.

The research is grounded in the Resource-Based View (RBV), which posits that unique internal resources like GC are a source of competitive advantage (Hart, 1995), and Dynamic Capabilities Theory, which argues that firms need higher-order capabilities to reconfigure resources in response to changing environments (Teece et al., 1997). We conceptualize ST as a micro-level dynamic capability that enables employees to leverage their GC effectively. This study contributes a more nuanced model of green innovation, providing empirically validated, actionable insights for the Malaysian manufacturing sector, a vital economic pillar facing significant sustainability imperatives (Imran et al., 2024).

LITERATURE REVIEW

Green Competency and Green Innovation

Green competency encompasses the collection of knowledge, technical skills, behaviors, and attitudes that enable employees to contribute to environmental sustainability. Prior research consistently demonstrates that firms with a highly competent workforce in green domains are better positioned to innovate sustainably. Ashraf et al. (2024) and Yahya et al. (2022) found that GC is a direct and significant driver of GI, as competent employees are the primary source of sustainable solutions. Furthermore, green competencies enhance an organization's absorptive capacity, enabling it to better recognize and utilize external environmental knowledge for innovation (Qu et al., 2022). This leads to our first hypothesis:

H1: Green Competency positively influences Green Innovation.

Green Competency, Strategic Thinking, and Green Innovation

Strategic thinking is a cognitive process involving foresight, systems thinking, and the alignment of long-term goals with current actions (Goldman & Scott, 2016). In a sustainability context, it enables employees to translate broad environmental goals into concrete innovative practices. Research has shown that leadership which fosters green thinking—a form of strategic cognition—leads to higher green innovation (Begum et al., 2022). Strategic thinking empowers organizations to convert sustainability awareness into tangible outcomes by improving foresight, planning, and adaptability (Gorondutse et al., 2024).

H2: Strategic Thinking positively influences Green Innovation.

Furthermore, green competencies are foundational to developing strategic thinking. Environmental knowledge provides the necessary context for long-term planning and scenario analysis. Wiek et al. (2011) identified sustainability competencies like systems-thinking and anticipatory thinking as core to strategic action. Therefore, GC provides the analytical raw material necessary for the sustainability-driven decision-making that defines strategic thinking.

H3: Green Competency positively influences Strategic Thinking.

The Mediating Role of Strategic Thinking

While GC provides the necessary "what" (knowledge and skills), ST provides the "how" (the cognitive bridge connecting knowledge to innovative outcomes). Employees with GC can identify environmental problems, but it is through ST that they connect these problems to market opportunities and devise long-term solutions. Without this forward-looking cognitive process, the potential of green competencies may remain unrealized. Gorondutse et al. (2024) identified ST as a key mediator between green capabilities and sustainability outcomes. This aligns with Dynamic Capabilities Theory, where ST is the capability that reconfigures internal resources (GC) to generate innovation.

H4: Strategic Thinking mediates the relationship between Green Competency and Green Innovation.

The Moderating Role of Strategic Thinking

Beyond its mediating role, strategic thinking can also amplify the impact of green competency. The effectiveness of an employee's green knowledge is contingent on their ability to apply it strategically. When employees exhibit high levels of ST, they are better able to leverage their competencies to formulate effective innovation strategies, thereby strengthening the GC–GI link. This aligns with Contingency Theory (Fiedler, 1964), which suggests that the impact of a resource depends on contextual factors, in this case, the cognitive capacity for strategic thought. When ST is low, the potential of green competencies may be underutilized, leading to weaker innovation outcomes.

H5: Strategic Thinking moderates the relationship between Green Competency and Green Innovation, such that the relationship is stronger at higher levels of Strategic Thinking.

METHODOLOGY

Research Design

A quantitative, cross-sectional survey design was employed. The target population was employees of manufacturing companies in Malaysia holding ISO 14001 or other recognized green certifications, ensuring a baseline level of environmental engagement. A stratified random sampling method was used to ensure representation across different manufacturing sub-sectors. An estimated sample of 300–350 managers and employees were targeted to ensure sufficient statistical power for structural equation modeling. Participants were assured of anonymity and confidentiality to encourage candid responses.

Measures

A structured questionnaire was developed using validated scales from prior research, with all items measured on a Likert-type scale.

- Green Competency (GC) was measured with five items assessing employees' knowledge, skills, and behaviors related to environmental sustainability.
- Strategic Thinking (ST) was measured with three items assessing an individual’s capacity for foresight, systems thinking, and long-term planning.
- Green Innovation (GI) was measured with three items evaluating the extent of eco-product and eco-process innovation within the respondent's scope of work.

Result and data analysis

Measurement Model

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used via SmartPLS software. The measurement model was assessed for reliability and validity. All item factor loadings exceeded the recommended 0.70 threshold, ranging from 0.767 to 0.933. As shown in Table 1, the Cronbach’s alpha, composite reliability, and Average Variance Extracted (AVE) values for all constructs surpassed the required thresholds of 0.70 for reliability and 0.50 for convergent validity, confirming the quality of the measures.

Table 1: Reliability and Convergent Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Green Competency	0.948	0.949	0.960	0.827
Green Innovation	0.920	0.921	0.949	0.861
Strategic Thinking	0.729	0.734	0.803	0.577

Discriminant validity was established using the Heterotrait-Monotrait (HTMT) ratio. All HTMT values were below the conservative threshold of 0.85, confirming that the constructs were distinct from one another.

Structural Model and Hypothesis Testing

The structural model was assessed to test the proposed hypotheses. The results are summarized in Table 2. The direct relationships proposed in H1, H2, and H3 were all significant and in the expected direction. Green Competency had a significant positive effect on Green Innovation ($\beta = .409$, $p < .001$) and Strategic Thinking ($\beta = .319$, $p < .001$). Strategic Thinking also had a significant positive effect on Green Innovation ($\beta = .431$, $p < .001$).

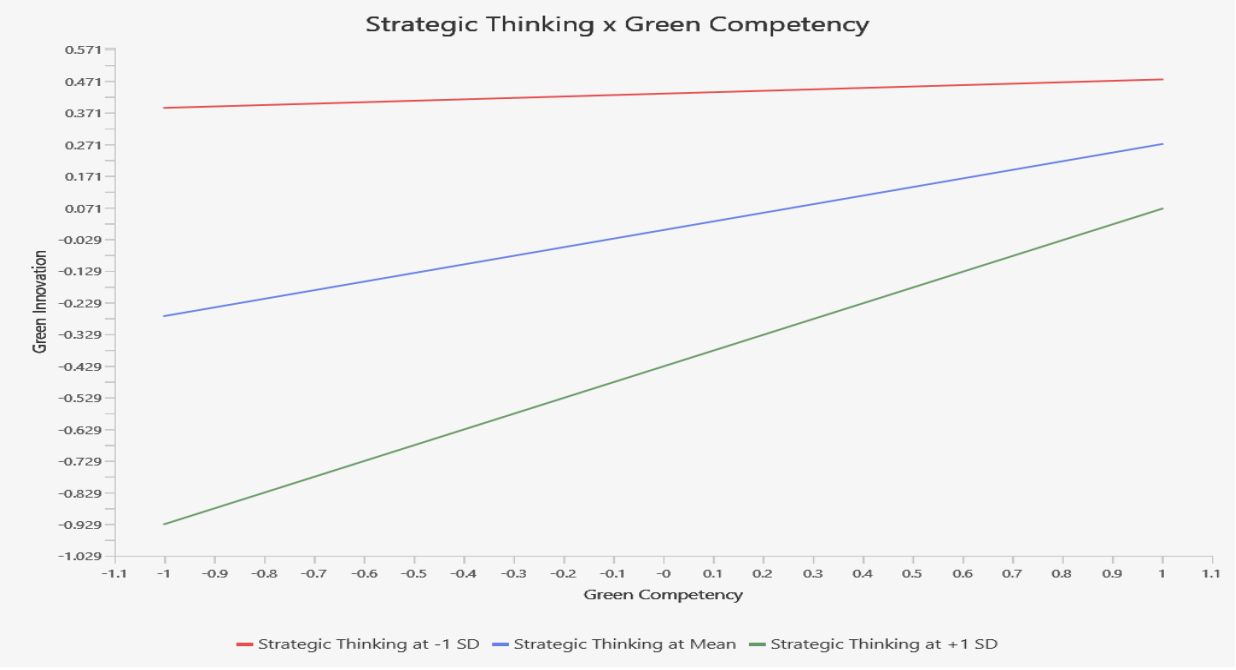
To test for mediation (H4), the indirect effect was examined. The analysis revealed a significant indirect effect of Green Competency on Green Innovation via Strategic Thinking ($\beta = .137$, $p < .001$), supporting H4.

To test for moderation (H5), the interaction term (ST × GC) was added to the model. The interaction was significant and positive ($\beta = .227$, $p < .001$), supporting H5. As illustrated in Figure 1, the positive relationship between Green Competency and Green Innovation is strongest when Strategic Thinking is high.

Table 2: Results of Hypothesis Testing

Hypothesis	Path	Path Coefficient (β)	T-Value	P-Value	Result
H1	Green Competency → Green Innovation	0.409	8.007	0.000	Supported
H2	Strategic Thinking → Green Innovation	0.431	10.179	0.000	Supported
H3	Green Competency → Strategic Thinking	0.319	5.331	0.000	Supported
H4	GC → ST → GI (Mediation)	0.137	4.385	0.000	Supported
H5	ST × GC → GI (Moderation)	0.227	5.749	0.000	Supported

Figure 1: Moderating Effect of Strategic Thinking on the GC-GI Relationship



Note. The plot illustrates that the positive relationship between Green Competency and Green Innovation is steeper (stronger) at high levels of Strategic Thinking (+1 SD) compared to mean or low levels (-1 SD).

DISCUSSION

Measurement Model

This study's findings provide robust empirical support for the critical role of strategic thinking as a catalyst in transforming green competencies into green innovations. The support for H1, H2, and H3 confirms the foundational direct relationships, showing that green-competent employees are more innovative, and strategic thinking is a key ingredient in that process.

The confirmation of H4 (mediation) reveals one of the primary pathways through which GC influences GI. Strategic thinking is the cognitive mechanism that translates passive knowledge into forward-looking, actionable strategies. It allows employees to connect their specific skills to the organization's broader sustainability goals. Most critically, the support for H5 (moderation) highlights that the value derived from green competencies is not fixed; it is amplified by strategic thinking. Employees with high GC and high ST are best equipped to drive transformative innovation, whereas those with high GC but low ST may see their potential underutilized.

Theoretical Implications

This research contributes to the RBV by demonstrating that the value of a resource (GC) is contingent on its interaction with other capabilities (Teece, 2007). Our main contribution is to Dynamic Capabilities Theory, where we position strategic thinking as a micro-level dynamic capability. It enables employees to sense opportunities (anticipating environmental trends), seize them (formulating innovation strategies), and reconfigure the firm's resource base (applying green skills effectively) to achieve sustainable competitive advantage.

Managerial Implications

The findings offer clear guidance for managers in the Malaysian manufacturing sector. First, organizations should pursue dual competency development, investing in training that builds not only technical green skills but also strategic thinking capacities like systems thinking and scenario planning. Second, managers should foster a culture that encourages employees to connect their daily work to long-term sustainability goals. Finally, recruitment and performance management systems should be aligned to identify, hire, and reward individuals who exhibit both environmental awareness and strategic foresight.

CONCLUSION

This study successfully demonstrated that strategic thinking is a powerful catalyst that both mediates and moderates the relationship between employee green competency and green innovation. For organizations aiming to lead in sustainability, fostering a workforce that is not only skilled but also strategic is paramount.

However, the study has limitations. Its cross-sectional design limits causal inference, and its reliance on self-report data may introduce common method bias. The focus on the Malaysian manufacturing sector may limit generalizability. Future research could address these issues through longitudinal designs to track competency development over time. Qualitative case studies could provide richer insights into the cognitive processes involved, while comparative studies across different industries and national cultures could test the broader applicability of the model.

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