



Factors influencing green innovation capability and its impact on sustainable performance in Indonesian traditional food smes: A Delphi approach

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Abstract

Green innovation capabilities play a crucial role for traditional food SMEs in improving their economic, environmental, and social performance. By developing environmentally friendly products, processes, and services, traditional food SMEs can access new markets and align their business processes with consumer demand for sustainability. However, developing green innovation capabilities is a complex and multidimensional issue. This study aims to identify key elements for enhancing green innovation capabilities and their impact on the sustainable performance of Indonesian traditional food SMEs. This study used a two-round Delphi process involving a panel of 31 experts from various backgrounds, including SME owners, academics, government officials, SME associations, and community leaders. The Delphi process was conducted from September to November 2025. Data analysis revealed nine elements, six of which were highly relevant: government support, green financing, green human resource management, knowledge management, green collaboration, and green technology adoption. These findings contribute to the literature, particularly in developing a roadmap for strengthening innovation capabilities in traditional food SMEs. Policymakers and industry practitioners can focus on these six elements, as they will strengthen the innovation capabilities of SMEs, which in turn will strengthen their sustainable performance.

Keywords: Traditional food smes, green innovation capabilities, sustainable performance, delphi method

Introduction

In general, the literature recognizes that traditional food SMEs are crucial economic entities. Economically, traditional food SMEs play a significant role through their potential to increase national GDP, provide employment, support market resilience against global economic disruptions, and contribute to gastronomic tourism by providing authentic local experiences (Ghosh *et al.*, 2023)^[9]. Traditional food SMEs also contribute to social and cultural preservation through their potential to preserve traditional recipes and production methods, maintain culinary heritage and cultural values from generation to generation, and foster community bonds and social harmony. This sector also serves as a learning medium for the current generation by providing a platform for passing on local skills and wisdom, which in turn can form the basis for modern food innovation. Furthermore, traditional food SMEs also play a vital role in providing nutrition and supporting food security for local communities (Nyholm *et al.*, 2024)^[22]. Furthermore, traditional food SMEs also play a crucial role in achieving several sustainable development goals, through their potential to maintain local food availability and provide diverse nutrition (SDG 2), provide livelihoods and promote local industry (SDG 8), and promote responsible consumption and production with a focus on local procurement (SDG 12) (Nurhayati, 2024)^[21]. While some experts have identified traditional food SMEs as economic entities that play a significant role in economic and social sustainability, others have cited the sector's collective negative environmental impact. While individually, they have a low environmental impact, due to their sheer size (more than 90% of global business entities are SMEs), the sector's environmental impact is higher than that of large corporations (Hossain *et al.*, 2025)^[10]. Experts suspect that some processes in traditional food SMEs have

the potential to generate liquid waste with high biological and chemical oxygen demand, which can pollute the environment if not properly managed. Some solid waste from traditional food SMEs also has the potential to produce high levels of methane and greenhouse gases when it ends up in landfills. The use of single-use plastic packaging also contributes to environmental pollution. Traditional food SMEs often use energy inefficiently and contravene environmentally friendly production practices. Furthermore, some processes in traditional food SMEs may use chemicals in production, cleaning, and packaging, which negatively impact the environment (Puente *et al.*, 2025)^[23].

Despite these issues, several experts cite traditional food SMEs as business entities that play a crucial role in achieving greater sustainability. In this regard, the literature generally acknowledges that one prerequisite for supporting business entities' sustainability is enhancing their green innovation capabilities (Nigatu *et al.*, 2024)^[20]. Green innovation capabilities refer to the ability of business entities to create new products, processes, or services that reduce environmental damage, increase resource efficiency, and promote sustainability (Nchofoung *et al.*, 2024)^[19]. Green innovation capability is also understood as a business entity's ability to develop and implement new products, processes, and business processes that significantly minimize negative impacts while creating economic and social value (Sun *et al.*, 2023)^[26].

Furthermore, the literature generally suggests that green innovation is no longer simply a general business strategy choice, but rather a key driver of sustainable competitive advantage. By integrating environmental performance into core business strategies, companies can differentiate themselves in ways that are difficult for competitors to imitate, while simultaneously improving financial and operational performance (Huynh *et al.*, 2024)^[12].

Specifically, the literature emphasizes that the ability to develop environmentally friendly products is a unique competency that can create a distinct brand identity for a business entity. Therefore, the literature strongly recommends that businesses utilize green innovation capabilities as a key strategic choice to improve operational performance and achieve sustainability, rather than simply as a marketing tool (Li *et al.*, 2024) ^[16]. The ability to innovate in green processes, for example by developing and adopting energy-efficient technologies and a circular economy, also has positive impacts by resulting in cost savings, reduced waste, and increased resource efficiency. Furthermore, green innovation capabilities enable businesses to stay ahead of increasingly stringent environmental laws and regulations, while also increasing opportunities for businesses to attract more profitable green investments and funding sources (Mohammad *et al.*, 2024) ^[17].

On the other hand, the literature also acknowledges that traditional food SMEs face several challenges that hinder their ability to innovate greenly, including financial constraints, human capital and skills gaps, technological limitations, a lack of innovation culture and leadership, regulatory and institutional barriers, and external collaboration and networks. The literature also views green innovation as a complex and multidimensional system. In other words, green innovation is not a simple, linear process and no longer occurs in isolation. A systemic approach recognizes that green innovation encompasses diverse elements or actors that co-evolve and create shared value. Each of these elements contributes individually in response to changes in the system. A systemic approach also recognizes the interdependence of elements, meaning that the success of one element often depends on the progress of

another (da Silva *et al.*, 2023) ^[7]. This study aims to fill this gap by exploring factors that support strengthening green innovation capabilities, distinguishing the roles of each of these factors, and determining the most influential factors in strengthening green innovation capabilities. Visualizing how these factors are interconnected, and separating these factors into causal and consequential factors.

Research Methodology

1. Research Design

This study used the Delphi method to gain a deeper and more comprehensive understanding of the key elements relevant to green innovation in Indonesian traditional food SMEs. The Delphi method is a structured and iterative research process specifically designed to gain consensus among a panel of experts on key elements relevant to green innovation and its impact on strengthening sustainable performance. Referring to Galindo-Martin *et al.* (2025), this study implemented the Delphi process through several stages, including: defining the problem and objectives to be achieved, selecting a panel of experts, distributing the first questionnaire, analyzing and summarizing the results of the first questionnaire, distributing a second questionnaire including a summary of the results of the first questionnaire, analyzing and summarizing the results of the second questionnaire, and examining the level of agreement among the expert panel based on the coefficient of variation of their responses.

2. Research Variables

This study believes that identifying factors driving green innovation capabilities for traditional food SMEs is a crucial step in developing green innovation in traditional food SMEs. Table 1 shows the factors driving green innovation capabilities identified in the literature.

Table 1: Factors driving green innovation capabilities in traditional food SMEs

Coding	Key factors	References
F1	Government support	Achmad <i>et al.</i> (2023) ^[1] ; da Silva <i>et al.</i> (2023) ^[7]
F2	Green technology adoption	Khuan <i>et al.</i> (2023) ^[15] ; Varzaru & Bocean (2024) ^[27]
F3	Green human resources management	Faisal (2023) ^[8] ; Ahmad <i>et al.</i> (2025) ^[2] ; Housheya & Atikbay (2025) ^[11]
F4	Green knowledge management	Huynh <i>et al.</i> (2024) ^[12] ; Imanuddin <i>et al.</i> (2024) ^[13] ; Cristache <i>et al.</i> (2025) ^[6]
F5	Green collaboration	Sultana & Turkina (2023) ^[25] ; Nalmpanti <i>et al.</i> (2024) ^[18]
F6	Regulatory compliance	Wellbrock <i>et al.</i> (2024); Wang & Yang (2025); Knapp <i>et al.</i> (2025)
F7	Market demand	Cou & Guo (2023); Cao <i>et al.</i> (2024)
F8	Green finance	Huang <i>et al.</i> (2022); Liu <i>et al.</i> (2025)
F9	Environmental orientation	Bu <i>et al.</i> (2020); Li <i>et al.</i> (2024) ^[16] ; Novianty (2024);

Results and Discussion

1. Descriptive Analysis

Selection of the Expert Panel

The selection of the expert panel is crucial to the quality of the research results. The panel involved in this research was

composed of representatives from industry, government, academia, and local communities with specialized knowledge of green innovation. Table 2 below shows the profile of the expert panel involved in this research.

Table 2: Profile of the Expert Panel Involved in This Research

No.	Sector	Round 1	Round 2
1	Industry	10	9
2	Government	2	1
3	Academics	2	2
4	Chairman of the SMEs association	1	1
5	Community figure	2	1
	Total	17	14
	Total number of experts approached	32	17
	Response rate (%)	53,1	82,3

As shown in Table 2, the first round of the Delphi process was conducted through invitations to 32 experts, but only 17 (53.1%) responded. Of the 17 participating experts, two were academics and university researchers with educational backgrounds and research interests focused on green production systems and sustainable development; one was the head of a traditional food SME association; ten SME owners producing traditional foods; two sub-district officials overseeing the SME development section; and two sub-district community leaders with sufficient knowledge and experience in community development in the research area. The second round of the Delphi process was conducted through invitations to 17 more experts, but only 14 (82.3%) responded. According to Galindo-Martin *et al.* (2025), the small response rates in both the first and second rounds of the Delphi process are considered acceptable because the Delphi process involves several experts from a given field, but they possess sufficient knowledge and skills, compared to the broader public, who possess limited knowledge and skills.

Survey Round Validation

Before the questionnaire distribution process, this study commissioned a team of experts to review the questionnaire's structure and content. This expert team, consisting of two academics and three industry practitioners, validated the questionnaire's structure and content but did not participate in the Delphi round itself. This expert team identified several issues with the structure and content of the initial questionnaire and revised the initial questionnaire before the new questionnaire was distributed. These revisions included improvements to the list of driving elements for green innovation, the use of simpler grammar, and the appropriateness of the green innovation concept to the context of traditional food SMEs.

Measurement and Analysis

In each round, this study asked respondents to rate the relevance of nine predetermined key elements for green innovation. Furthermore, this study also asked respondents to assess the impact of green innovation capabilities on the economic, environmental, and social performance of traditional food SMEs. Respondents' responses were measured using a five-point Likert scale: 1 (very irrelevant) to 5 (very relevant). This list of elements was largely derived from literature studies on green innovation and sustainability. This area of literature is more adequate than the literature on innovation and operational performance of a business entity, and therefore has presented a more adequate initial list of green innovation elements for the green transition in the industrial sector.

Respondent Responses

Table 3 shows the mean (M) and standard deviation (SD) of respondents' assessments of the relevance of key elements supporting green innovation capabilities in Indonesian traditional food SMEs, as determined by the first round of the questionnaire.

Notes

- CV1:** coefficient of variation for the relevance of elements
α: 0.85
- CV2:** coefficient of variation for the effect of elements
α: 0.76

Table 3: Descriptive analysis of the Delphi process results

Elements	M	SD
Government support	4.73	0.70
Green technology adoption	4.53	0.82
Green human resources management	4.67	0.51
Green knowledge management	4.60	0.64
Green collaboration	4.53	0.52
Regulatory compliance	4.33	0.49
Market demand	4.27	0.88
Green finance	4.73	0.62
Environmental orientation	4.33	0.59
Green innovation and economic performance	4.53	0.64
Green innovation and environmental performance	4.73	0.46
Green innovation and social performance	4.40	0.51

As shown in Table 3, this study found a high level of agreement ($M \geq 4.50$) among respondents regarding six elements proposed as key elements supporting green innovation capabilities in Indonesian traditional food SMEs. These six elements are government support ($M = 4.73$), green financing ($M = 4.73$), green human resource management ($M = 4.63$), knowledge management ($M = 4.60$), green collaboration ($M = 4.53$), and green technology adoption ($M = 4.53$). Regarding the influence of green innovation capabilities on sustainable performance, this study found that green innovation capabilities had the highest impact on environmental performance ($M = 4.73/5$), followed by its impact on economic performance ($M = 4.53/5$), and social performance ($M = 4.27/5$). Furthermore, Table 3 also displays two statistical measures: reliability and consensus. In this case, the coefficient of variation for all elements was 0.19, and the coefficient of variation for element impact was 0.14. The coefficient of variation value ranging between 0.00 and 0.50 indicates a good level of consensus (Galindo-Martin *et al.*, 2025). Meanwhile, this study used Cronbach's alpha (α) to measure the association between expert responses. In this case, it was found that the Cronbach's alpha (α) for all elements was = 0.85 and the Cronbach's alpha (α) for the impact of the elements was 0.76. A Cronbach's alpha (α) value above 0.70 indicates a good reliability value (internal consistency) of the respondents' responses (Galindo-Martin *et al.*, 2025) regarding the proposed elements and their impact on green innovation capabilities in traditional food SMEs.

2. Analysis

The data analysis revealed that government support is a relevant factor because it influences green innovation capabilities. The government can encourage green innovation through various policies, including financial incentives, tax incentives, and technical resource support. Furthermore, the government can increase support through innovation financing with lower interest rates and insurance premiums. In general, respondents in this study believed that government support influences green innovation capabilities, and that environmental legal and regulatory pressure is considered a factor influencing the motivation of SMEs to innovate. This finding aligns with the concept proposed in the literature that regulatory pressure and green innovation are positively related (Da Silva *et al.*, 2023) [7]. The literature suggests that the government can use various financial instruments, such as direct subsidies and grants,

tax incentives, and green credit and loans, to strengthen SMEs' green innovation capabilities. This type of support will enhance the ability of SMEs to carry out various innovation activities, leading to improved environmental performance. Increasingly stringent environmental regulations have encouraged SMEs to seek innovative solutions and reengineer their product designs, production methods, and service standards to avoid sanctions and meet established environmental standards. Green certifications implemented by governments and non-governmental organizations have provided legitimacy, allowing SMEs to access the supply chains of larger companies (Achmad *et al.*, 2023) ^[1].

The second factor deemed relevant to green innovation in traditional food SMEs is the adoption of green technology. Green technology refers to the application of technologies, methods, or services that reduce the negative impact of the industrial sector on the environment (Khuan *et al.*, 2023) ^[15]. The analysis shows that the majority of respondents in this study expressed the view that technology adoption plays a crucial role in enhancing green innovation capabilities. Technology provides a means for SMEs to transition to environmentally friendly industries, assisting them in developing new solutions for sustainable business processes, and enabling them to meet increasing consumer demands and environmental regulations. This, in turn, will drive economic growth and enhance sustainable competitiveness. These findings align with expert opinion, stating that the adoption of green technology offers a fundamental solution for SMEs to develop green production processes, build circular economic models, and implement more environmentally friendly logistics systems. The development of green technology will result in increased production efficiency, reduced energy consumption, reduced waste, and reduced operational costs for businesses, thereby increasing profitability. Adopting green technology also allows for increased competitiveness, a better reputation and image, compliance with regulatory requirements, and increased market share (Varzaru & Bocean, 2024) ^[27]. These findings also support a new paradigm in the literature that states that technological progress is measured not only by its ability to drive economic and production performance, but also by its ability to support environmental performance (da Silva *et al.*, 2023) ^[7].

The third factor deemed valid and relevant to green innovation capabilities in SMEs is green human resource management. Referring to Faisal (2023) ^[8], this study defines green human resource management as practices, systems, or policies that enable employees of a business entity to be more environmentally friendly for the benefit of individuals, organizations, communities, and the natural environment. As shown in Table X, this study found that the relevance of the green human resource management factor to green innovation capabilities in traditional food SMEs was 4.00 points with a WA value of 4.00 and an LC value of 0.90. This indicates that the majority of respondents involved in this study viewed green human resource management as a relevant factor and significantly contributed to strengthening green innovation capabilities in traditional food SMEs. This study's findings confirm expert opinion stating that green human resource management is one of the main factors that significantly contributes to improving green innovation capabilities in a business entity (Housheya & Atikbay, 2025) ^[11]. Furthermore, the literature

suggests several processes that SMEs must implement to develop green human resource management in relation to efforts to increase green innovation capabilities, including recruiting employees with awareness and commitment to environmental performance, providing employee training on sustainable production and operations practices, evaluating employee performance for their contribution to environmental performance, integrating environmental responsibility into employee core duties and functions, and providing rewards and incentives for employee environmental performance achievements (Ahmad *et al.*, 2025) ^[2].

The fourth factor deemed valid and relevant to green innovation capabilities in SMEs is knowledge management. Referring to Huynh *et al.* (2024) ^[12], knowledge management is a structured process for creating, sharing, using, and managing knowledge to improve sustainable performance. The research results presented in Table X indicate that the relevance of the knowledge management factor to green innovation capabilities in traditional food SMEs is 4.00 points, with a WA score of 4.00 and a LC score of 0.90. This indicates that the majority of respondents involved in this study expressed the view that knowledge management is a relevant factor and contributes significantly to strengthening green innovation capabilities in traditional food SMEs. This research finding aligns with the notion in the literature that knowledge management plays a crucial role in green innovation. Knowledge management enables organizational knowledge (both explicit and tacit) to develop new ideas and convert them into new products, processes, and services with better environmental performance (Imanuddin *et al.*, 2024) ^[13]. In this regard, the literature generally suggests four stages of knowledge transformation for innovation: green knowledge acquisition, green knowledge storage, green knowledge sharing, and green knowledge application. The literature also suggests that the key role of knowledge management in green innovation is facilitating idea generation, capturing tacit knowledge, ensuring knowledge availability, identifying gaps, reducing product launch time, and building competencies (Cristache *et al.*, 2025) ^[6].

Collaboration, defined as a process in which two or more business entities work together to achieve a common goal (Nalmpanti *et al.*, 2024) ^[18], is one of the key factors relevant to green innovation in traditional food SMEs. As presented in Table X, the analysis results show that the relevance of the collaboration factor to green innovation capabilities in traditional food SMEs is 4.00 points, with a WA value of 4.00 and a LC value of 0.90. Thus, the majority of respondents involved in this study viewed that, both in terms of breadth and intensity, collaboration is a relevant factor and contributes significantly to strengthening green innovation capabilities in traditional food SMEs. However, the view emerged that the effectiveness of collaboration on green innovation depends on the breadth and depth of the collaboration itself. Collaboration output refers to the extent to which a business entity exchanges knowledge and resources with its innovation partners to jointly develop new and improved processes, products, and services. Meanwhile, innovation depth refers to the extent of collaboration between a business entity and a partner in its innovation process (Nalmpanti *et al.*, 2024) ^[18].

This research finding aligns with the concept put forward in the literature that collaboration is a crucial supporting factor

for strengthening green innovation capabilities. Collaboration enables the integration of diverse knowledge and skills and the shared use of resources. Collaboration leads to increased creativity, faster problem-solving, fostering novel solutions, and reducing risk. In turn, collaboration enhances competitive advantage by overcoming individual limitations and fostering a culture of shared learning and continuous improvement.

Furthermore, collaboration enables SMEs to address complex innovation challenges by combining knowledge and skills, creating synergies that would be impossible on their own, and transforming ideas into new products and services relevant to market needs (Sultana & Turkina, 2023) [25].

The sixth factor deemed relevant to green innovation is green financing. Referred to as practices that direct capital from the public and private sectors to initiatives, activities, and projects that support the green transition and provide benefits for environmental sustainability, green finance has been cited as a key driver for the development of green innovation in the industrial sector (Liu *et al.*, 2025). As presented in Table X, the analysis results show that the relevance of the green finance factor to green innovation capabilities in traditional food SMEs is 4.00 points, with a WA value of 4.00 and a LC value of 0.90. In other words, respondents involved in this study viewed green finance as a relevant factor and significantly contributed to strengthening green innovation capabilities in traditional food SMEs. This research finding supports the understanding that green finance is positively correlated with and enhances green innovation capabilities in the industrial sector. Green finance enables business entities to obtain the necessary capital and incentives to develop and implement more environmentally friendly production and operational practices. Conversely, green practices also increase opportunities for business entities to obtain capital from the public and private sectors. Specifically, green financing enables business entities to reduce financial constraints, provide incentives and policy guidance, and encourage technological advancements for innovation (Huang *et al.*, 2022).

Conclusion

The literature has specifically explored the elements influencing innovation capability and how these elements impact sustainable performance. However, recent changes (such as economic development, shifting interest in sustainability aspects, and the ways in which business entities interact) have prompted the need for a more in-depth analysis of the elements of green innovation and their impact on sustainable performance. Unlike recent research, this study conducted a Delphi process to broaden our understanding of the elements of green innovation and their impact on sustainable performance in the context of Indonesian traditional food SMEs. The data analysis revealed six relevant elements for encouraging green innovation: government support (M=4.73), green financing (M=4.73), green human resource management (M=4.63), knowledge management (M=4.60), green collaboration (M=4.53), and green technology adoption (M=4.53).

Therefore, policymakers and industry practitioners can focus on these six elements, as this will strengthen the innovation capabilities of SMEs, which ultimately strengthen their sustainable performance. While this study

has provided insights into the relevance of the nine elements to supporting innovation capability, it has several limitations, including the platform used to distribute the questionnaire in the Delphi process. This platform has fewer configurations compared to more professional paid platforms. This research could be improved by applying Structural Equation Modeling (SEM) methods to statistically test the significance of each proposed element and its impact on green innovation capability.

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