

THE EFFECT OF GREEN KNOWLEDGE, GREEN AWARENESS, STRATEGIC ORIENTATION, AND GOVERNMENT REGULATION ON BUSINESS SUSTAINABILITY OF CULINARY MSMEs IN BOGOR CITY

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Abstract:

Background: Climate change has become a pressing global concern, including in Indonesia. Bogor City, home to 26,696 culinary MSMEs, faces challenges such as carbon emissions from production processes that disregard environmental considerations. Addressing these challenges requires a more sustainable production approach, one of which is the implementation of green manufacturing.

Purpose: This study aimed to analyze the effect of green knowledge, green awareness, strategic orientation, and government regulation on the business sustainability of culinary MSMEs in Bogor City, with green manufacturing as a mediating variable.

Methodology: A quantitative approach was employed to assess the perceptions of culinary MSME actors toward the variables of green knowledge, green awareness, strategic orientation, government regulation, green manufacturing, and business sustainability using a questionnaire instrument. A survey was also conducted to identify the factual conditions of MSMEs. The study was carried out from February to June 2025, involving 155 respondents, and was analyzed using SEM-PLS with SmartPLS 4.0.

Findings: The results showed that environmental awareness and knowledge, business strategy, and government regulation played significant roles in promoting green manufacturing (GM) and strengthening business sustainability. GM practices included energy efficiency, waste management, and eco-friendly raw materials. The study highlights the importance of synergy between environmental understanding, public policy, and strategic orientation in encouraging culinary MSMEs to adopt greener, more adaptive, and sustainable business practices.

Conclusion: Green knowledge, green awareness, and government regulation significantly and positively influenced the implementation of green manufacturing, highlighting the critical role of environmental understanding, awareness, and policy support in promoting eco-friendly production. However, strategic orientation showed no significant effect, as many culinary MSMEs remain focused on short-term goals rather than sustainability-oriented strategies. Although green manufacturing had a positive but insignificant impact on business sustainability, this suggests that while it supports efficiency and competitiveness, it has not yet been fully integrated into MSMEs' core strategies. This occurs because culinary MSME actors in Bogor City are still oriented toward short-term profits to meet their daily operational needs. Therefore, further training, mentoring, and supportive policies are essential to strengthen the connection between green practices and long-term business sustainability.

Originality/value (State of the art): This study emphasizes the implementation of green manufacturing within the culinary MSME sector, linking it to green knowledge, green awareness, government regulation, and strategic orientation as determinants of sustainability performance. However, the diversity of practices among these MSMEs indicates varying levels of understanding and only partial implementation of green manufacturing principles.

Keywords: green awareness, green knowledge, green manufacturing, business sustainability, culinary MSMEs

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INTRODUCTION

Climate change and environmental degradation have emerged as pressing global concerns across all sectors. Global temperatures have risen by approximately 1.1°C since the late 19th century and are projected to reach 1.5°C between 2030 and 2052 without concrete mitigation actions (IPCC, 2021). Climate change has intensified the frequency and severity of extreme weather events, leading to substantial and escalating economic losses worldwide (IPCC, 2021; World Bank, 2020), and ranking as the greatest global risk in 2024 (World Economic Forum, 2024).

Indonesia faces compounded environmental challenges. In 2024, the country recorded net deforestation of approximately 175,400 hectares, with the forestry sector alone contributing 60% of total national greenhouse gas emissions (Ministry of Environment and Forestry, 2025). Indonesia generates approximately 7.8 million tons of plastic waste annually, yet 40% of urban residents lack basic waste collection services, around 85% of rural plastic waste is not formally collected, and 4.9 million tons of waste are mismanaged each year, with 83% of plastic debris entering marine environments through rivers (World Bank, 2021). It's also exposing citizens to up to 90 microplastic particles daily (IPEN, 2023). These pressures confirm that sustainability challenges extend beyond large industries to smaller business units whose cumulative activities significantly contribute to waste, emissions, and resource inefficiency.

Micro, Small, and Medium Enterprises (MSMEs) are central to both this challenge and Indonesia's economy, contributing 61% of GDP (IDR 9,580 trillion) and absorbing 97% of the national workforce across 66 million units (Ministry of Cooperatives and SMEs, 2023), with West Java recording the highest number of business units nationally (Putri, 2023). Despite their strategic economic role, Indonesian MSMEs face mounting pressure to address environmental impacts, particularly waste disposal and unsustainable production practices (Alfarizi & Sari, 2024). The food industry, predominantly driven by MSME actors, is of particular concern: Indonesia generates approximately 14.73 million tons of food waste annually, the largest in Southeast Asia with food waste comprising 39.36% of total national waste (UNEP, 2024; Ministry of Environment and Forestry, 2024). Culinary MSMEs contribute across multiple operational stages,

generating both organic and inorganic waste in solid and liquid forms (Zebua et al. 2025).

Bogor City exemplifies this dynamic, as reflected in its economic performance, with a growth rate of 5.15% in 2024 according to official statistics. The city's economy is primarily driven by trade and manufacturing sectors, which are closely linked to the development of micro, small, and medium enterprises (MSMEs), particularly in consumer-oriented activities such as culinary businesses that support tourism and local demand (BPS Kota Bogor, 2025). As a satellite city of Jakarta, Bogor's economic and environmental significance is amplified. Food waste alone accounts for approximately 6% of global greenhouse gas emissions, three times that of the aviation sector (Poore & Nemecek, 2018) reflected locally in the weekly disposal of roughly 10 million units of baked goods, generating 292,000 tons of CO₂ (Susilo et al. 2021). Operational activities such as cooking, refrigeration, and packaging further intensify energy consumption, while landfilled culinary waste accelerates methane emissions. These conditions make culinary MSMEs a highly relevant sector for examining green manufacturing practices emphasizing resource efficiency, waste reduction, and energy conservation (Primandaru et al. 2023) which are increasingly recognized as critical for both environmental mitigation and long-term business performance (Mohd Zain et al. 2024).

Green manufacturing which encompassing energy efficiency, waste reduction, and the use of environmentally friendly materials represents a viable and increasingly recognized solution to environmental challenges, particularly within the MSME context where it enhances resource efficiency, reduces environmental impact, and strengthens long-term competitiveness (Primandaru et al. 2023). Green manufacturing emphasizes the integration of energy-efficient and low-carbon technologies in production and consumption systems. Empirical studies show that biogas systems significantly reduce greenhouse gas emissions through waste-to-energy conversion, while induction stoves improve end-use energy efficiency by reducing direct combustion losses. Together, these technologies support circular and low-carbon manufacturing systems by decreasing reliance on fossil fuels and enhancing overall energy efficiency (Haryanto et al. 2017; Weyant et al. 2019; Damayanti et al. 2025). In culinary MSMEs specifically, green practices are closely linked to waste reduction, green innovation, and sustainable business

performance (Alfarizi & Sari, 2024), yet their adoption remains constrained by limited knowledge, insufficient information sharing, resource limitations, and the need to balance production performance with sustainability requirements (Mohd Zain et al. 2024). Against this backdrop, the present study examined four exogenous variables: green knowledge, green awareness, strategic orientation, and government regulation as internal and external organizational drivers theorized to influence business sustainability through the mediating role of green manufacturing. Although prior studies have confirmed linkages between green manufacturing and sustainable SME performance (Thekkoote, 2022; Primandaru et al. 2023), the direct relationship within the specific context of Indonesian culinary MSMEs remains empirically underexplored, underscoring the need for context-specific investigation where environmental pressures, resource constraints, and regulatory dynamics differ markedly from those of larger enterprises.

The successful implementation of green manufacturing is fundamentally contingent upon the collective green knowledge and environmental awareness of the workforce. Evidence from Indonesian MSMEs suggests that adoption requires not only individual knowledge, but also organizational capabilities, resource adequacy, top management support, and government backing (Primandaru et al. 2023), which in culinary MSMEs must be translated into practical routines through informal learning and adaptive green practices (Wolor et al. 2025). Nevertheless, information provision alone is insufficient; as green motivation and behavioral intention serve as critical psychological mediators (Yudanto & Martdianty, 2024), MSME actors must first internalize environmental knowledge and develop genuine intent before it manifests as concrete green behaviors, such as waste reduction or energy conservation. In essence, knowledge constitutes the necessary foundation, yet without the internal drive and conscious commitment to act, the technical goals of sustainable manufacturing cannot be fully realized in practice.

This study is expected to reveal the factual conditions of green manufacturing implementation among culinary MSMEs in Bogor City, and to empirically examine the extent to which green knowledge, green awareness, strategic orientation, and government regulation influence business sustainability, with green manufacturing as a mediating variable. The findings

are further anticipated to serve as substantive input for relevant stakeholders in formulating evidence-based policies and programs aimed at strengthening green practices among culinary MSMEs in Bogor City.

The implementation of green manufacturing practices enables culinary MSMEs not only to reduce their environmental impact, but also to improve operational efficiency and market competitiveness. Regulatory support and fiscal incentives have been shown to further facilitate the adoption of such practices (Yudawisastra et al. 2023). Against this backdrop, this study aimed to analyze the effects of green knowledge, green awareness, strategic orientation, and government regulation on business sustainability, with green manufacturing serving as a mediating variable, in the context of culinary MSMEs in Bogor City.

METHODS

This study employed a quantitative approach, utilizing both primary and secondary data collected in Bogor City from February to May 2025. Primary data were obtained directly from culinary MSME actors through questionnaire surveys, capturing respondents' perceptions and behaviors related to green manufacturing and business sustainability. Secondary data were drawn from government statistical reports, institutional records, and prior empirical studies to provide contextual grounding and theoretical support. These secondary sources encompassed national and regional data on MSME development, environmental regulations, and green manufacturing policies issued by relevant government bodies, as well as findings from prior empirical literature on the study variables. The triangulation of primary questionnaire responses with established institutional records and scholarly literature was intended to minimize potential response bias and strengthen the overall credibility of the findings.

The research instrument utilized a five-point Likert scale (Sugiyono, 2021), validated through Pearson correlation analysis and Cronbach's Alpha (Sekaran & Bougie, 2020; Ghozali, 2021), with preliminary testing on 30 respondents confirming satisfactory psychometric standards. Data were collected using a multistage proportionate random sampling technique, combining cluster and purposive sampling, while a pilot study of 40 respondents was conducted to

determine the minimum path coefficient (p_{min}) for statistical significance within the SEM-PLS framework. Based on the pilot study findings, the minimum path coefficient (p_{min}) was established at 0.191. The minimum required sample size was then determined by reference to the threshold table developed by Hair et al. (2022), as presented in Table 1.

At a significance level of 5% and a p_{min} value falling within the range of 0.11–0.20, the minimum required sample size was 155 respondents. This total was subsequently allocated proportionally across districts based on the number of culinary MSMEs in each area using cluster sampling, as detailed in Table 2.

Respondents were further selected through purposive sampling based on the following criteria: (1) food and culinary MSMEs operating within Bogor City; (2) enterprises that had been in operation for at least six months and whose owners, managers, supervisors, or employees possessed an initial understanding of green manufacturing practices; (3) MSMEs actively engaged in waste reduction or raw material efficiency efforts; and (4) MSMEs that had implemented at least one environmentally friendly practice in their supply chain, such as the use of local materials, eco-friendly packaging, or production waste management.

This study employed both descriptive and inferential statistics through a Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach to examine hypothesized relationships among latent constructs, including green knowledge, green awareness, strategic orientation, and government regulation as exogenous variables, green manufacturing as the mediator, and business sustainability as the dependent variable. SEM-PLS was selected for its capacity to simultaneously evaluate measurement and structural models, its robustness with moderate sample sizes and non-normal data distributions, and its suitability for complex

mediation analysis in MSME-based research (Hair et al. 2022; Sarstedt et al. 2022). Analysis was conducted using SmartPLS 4, wherein the four exogenous variables—representing both internal and external organizational forces—were theorized to influence business sustainability through the mediating role of green manufacturing implementation. This structural design allowed for a comprehensive assessment of how organizational knowledge and external pressures are transformed into long-term corporate viability through sustainable operational practices, bellow:

1. Green Knowledge refers to an individual's knowledge of environmentally friendly products, awareness of environmental issues, understanding of eco-friendly practices, knowledge of environmental regulations and standards, and awareness of the environmental impact of consumption (GK1–GK5) as described by Khaleeli et al. (2021).
2. Strategic Orientation refers to a firm's implementation of strict environmental awareness policies, environmental preservation actions in business operations, collaborative efforts to ensure employees understand sustainability, as well as its customer and operational orientation (SO1–SO5) as described by Tseng et al. (2019).
3. Government Regulation refers to environmental protection regulations, the implementation of green supply chain management initiatives as a form of corporate responsibility, and the availability of waste management and transportation facilities (GR1–GR3) as described by Setyawan et al. (2022).
4. Green Awareness refers to top management commitment to allocating resources for green initiatives, communication of environmental policies to stakeholders, participation in environmental programs, and adoption of green technology (GA1–GA4) as described by Selamat et al. (2025).

Table 1. Minimum sample size for various levels of path coefficients (p_{min}) and significance levels

Pmin	Significance level		
	1%	5%	10%
0.05 – 0.1	1004	619	451
0.11 – 0.2	251	155	113
0.21 – 0.3	112	69	51
0.31 – 0.4	63	39	29
0.41 – 0.5	41	25	19

Source: Hair et al. (2022)

5. Green Manufacturing refers to producing products using recycled materials, minimizing energy consumption in production and distribution, implementing environmental management systems, and ensuring products are free from hazardous materials (GM1–GM4) as described by Afum et al. (2020).
6. Business Sustainability - Economic Performance refers to a firm's revenue growth and profitability, operational cost efficiency, supply chain sustainability, and eco-friendly product and service innovation (BS1–BS4) as described by Nafisah & Ratnamurni (2025).
7. Business Sustainability - Social Performance refers to employee welfare, corporate social responsibility (CSR), relationships with local communities, and customer satisfaction and loyalty (BS5–BS8) as described by Oduro et al. (2022).
8. Business Sustainability - Environmental Performance refers to waste management and carbon emission control, efficient use of energy and natural resources, the use of environmentally friendly raw materials, and compliance with environmental regulations (BS9–BS12) as described by Muñoz Pascual et al. (2020).

This study examined green knowledge, green awareness, strategic orientation, and government regulation as independent variables, business sustainability as the dependent variable, and green manufacturing as the mediating variable. The hypotheses were formulated based on an extensive review of prior literature examining the relationships and effects among the independent, mediating, and dependent variables, which were subsequently integrated into a unified research model. The hypotheses proposed in this study are as follows:

1. H1: Green awareness has a positive effect on green manufacturing. This hypothesis is supported by Primandaru et al. (2023), who found that higher levels of green awareness encourage entrepreneurs to implement environmentally friendly manufacturing practices.
2. H2: Green knowledge has a positive effect on green manufacturing. This hypothesis is supported by Rasyid & Stepanus (2024), who demonstrated that green knowledge plays a crucial role in enhancing green innovation within production processes.
3. H3: Strategic orientation has a positive effect on green manufacturing. This hypothesis is supported by Habib et al. (2021), who found that a firm's strategic orientation toward environmental concerns significantly contributes to the adoption of green manufacturing practices.
4. H4: Government regulation has a positive effect on green manufacturing. This hypothesis is supported by Aditya and Alhazami (2020), who reported that government regulations encourage MSMEs to implement reverse logistics and green manufacturing practices.
5. H5: Green manufacturing has a positive effect on business sustainability. This hypothesis is supported by Afum et al. (2020) and Puspita et al. (2020), who demonstrated that green manufacturing enhances competitiveness and business sustainability through improved operational efficiency and enhanced environmental reputation.
6. H6: Green awareness has a positive effect on business sustainability. This hypothesis is supported by Xie et al. (2024), who examined the influence of stakeholder pressure and found that green managerial awareness significantly promotes the adoption of environmentally responsible production practices.

Table 2. Distribution of samples in each district of Bogor City

District	MSMEs numbers	Proportion (%)	Sample numbers
Bogor Barat	5,340	21%	33
Bogor Selatan	5,435	21%	33
Bogor Tengah	3,414	13%	20
Bogor Timur	2,487	10%	16
Bogor Utara	4,262	16%	25
Tanah Sereal	4,953	19%	29
Total	26,696	100%	155

7. H7: Green knowledge has a positive effect on business sustainability. This hypothesis is supported by Hossain et al. (2025), who emphasized that the three dimensions of environmental knowledge systems, action, and effectiveness knowledge are strongly associated with SMEs' ability to adopt sustainable practices, indicating that entrepreneurs' understanding of green concepts directly influences sustainability-oriented decisions and strategies.
8. H8: Strategic orientation has a positive effect on business sustainability. This hypothesis is supported by Habib et al. (2021), who demonstrated that firms with a sustainability-oriented strategic orientation are better positioned to adapt to market dynamics and sustain long-term competitiveness.
9. H9: Government regulation has a positive effect on business sustainability. This hypothesis is supported by Aditya and Alhazami (2020), who found that government regulations encourage entrepreneurs to adopt environmentally friendly processes, which ultimately enhance both organizational reputation and business continuity. Government promotion and regulation are further regarded as important policy instruments for supporting sustainability efforts in SMEs, encompassing incentives, infrastructure support, waste management, recycling regulations, and improved access to eco-friendly technologies (Abdullah et al. 2023).

The hypothetical model was developed on the basis of the theoretical framework discussed in the preceding sections, with the aim of empirically examining both the direct and indirect relationships among the relevant variables. The model was constructed with explicit consideration of the potential mediating role of green manufacturing in transmitting the effects of the exogenous variables on business sustainability, as illustrated in Figure 1.

RESULTS

Characteristics of Culinary MSMEs Actors in Bogor City

The age distribution of respondents shows that the majority are 21–30 years old (38.1%), followed by 31–40 years (23.9%), 41–50 years (16.8%), over 50 years (14.8%), and 15–20 years (6.5%), representing the most productive age group and one that is highly adaptive to emerging business trends (BPS, 2023). Most respondents were married (60.6%), suggesting a higher degree of economic responsibility (Tambunan, 2019). Male respondents predominated (68.4%), consistent with the national pattern of male dominance among MSME actors (BPS, 2022).

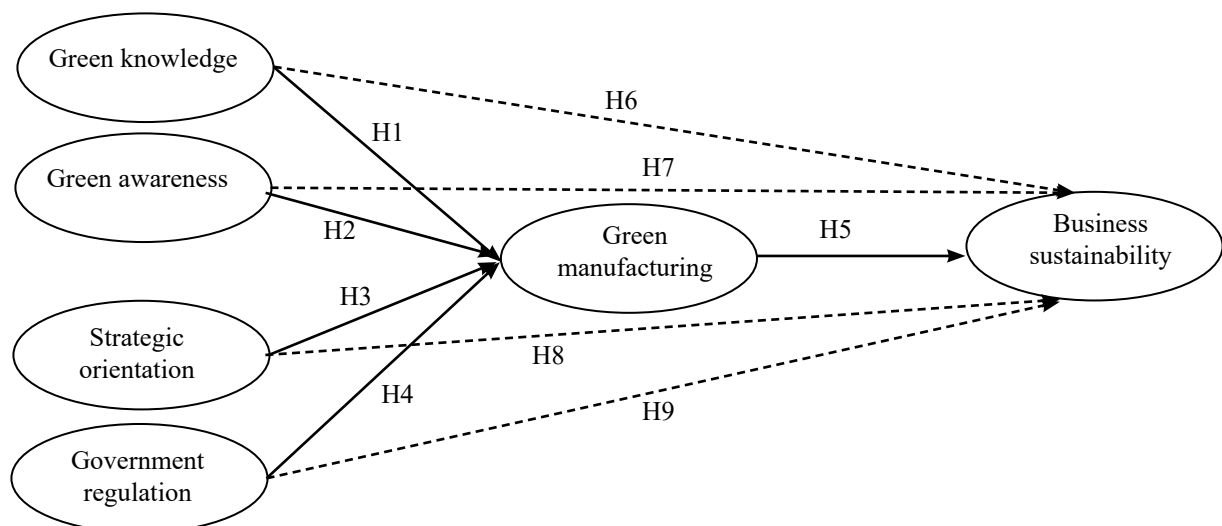


Figure 1. Hypothetical model

The education level of respondents is dominated by senior high school graduates (43.9%), followed by junior high school (18.7%), elementary school (15.5%), bachelor/master/doctoral degrees (11.0%), diploma (9.7%), and a small proportion with no schooling or incomplete elementary education (1.3%). The most prevalent educational attainment was senior high school or vocational school (43.9%), indicating that secondary-level education constitutes a sufficient foundation for engaging in entrepreneurial activity (BPS, 2021). The distribution of respondents by district shows that most are from Bogor Selatan (20.8%) and Bogor Barat (20.5%), followed by Tanah Sereal (19.0%), Bogor Utara (16.4%), Bogor Tengah (13.2%), and Bogor Timur (9.8%). The largest proportion of respondents resided in Tanah Sereal District (30.3%), an area characterized by strategic market access. Food businesses constituted the dominant business type (65.8%), attributable to stable and consistent market demand (Ministry of Cooperatives and MSMEs, 2023), while 78.7% of respondents employed fewer than four workers, a characteristic consistent with micro-enterprise classification (Ministry of Cooperatives and MSMEs, 2023).

Business Profile of Culinary MSME Actors in Bogor City

Among the 155 culinary MSME respondents in Bogor City, the majority operated businesses that had been established for less than six years (34.8%), reflecting post-pandemic entrepreneurial trends (OECD, 2021). Food businesses accounted for the largest share (65.8%) owing to sustained market demand, and 78.7% of respondents employed fewer than four workers, further confirming the micro-enterprise character of the sample (Ministry of Cooperatives and MSMEs, 2023).

Environmentally friendly practices had generally been in place for less than one year (24.5%) and were carried out directly by business owners (83.2%), indicating that green awareness among SMEs is still at an early stage of development, while their managerial structures tend to be relatively simple and less formalized, which can influence the implementation of sustainable manufacturing practices (Mintzberg, 1979; Primandaru et al. 2023). The most commonly adopted practice was the reduction of single-use plastics (44.5%), consistent with ongoing government campaigns in this area (KLHK, 2022). These patterns align with evidence from Puspitasari et al. (2021), who found that green marketing and environmental awareness positively influenced

consumer attitudes toward sustainable products. Environmental concern has further been identified as a critical driver of eco-friendly purchasing behavior, particularly among Generation Z consumers, whose intention to purchase eco-friendly packaged products is strongly shaped by sustainability values (Lianita et al. 2024). A robust environmental awareness among younger consumers not only fosters positive attitudes toward sustainable choices but also stimulates broader stakeholder engagement in promoting environmentally responsible behavior, thereby contributing to wider environmental sustainability goals. The majority of businesses operated without branches (73.5%), reflecting their small scale and local market orientation (Ministry of Cooperatives and MSMEs, 2023).

Hypothesis Testing

Hypothesis testing was conducted through the evaluation of the structural model also referred to as the inner model to validate the proposed relationships within the research framework. This process entailed an analysis of R-square (R^2) values to assess the predictive power of the model with respect to green manufacturing and business sustainability, as well as an examination of path coefficients and direct effects to determine the magnitude and statistical significance of the relationships between exogenous and endogenous variables. As illustrated in Figure 3, these metrics provided the empirical basis for accepting or rejecting each formulated hypothesis. This systematic evaluation ensured that the conclusions drawn regarding the determinants of green manufacturing were statistically sound and reliable.

Based on Figure 2, the R^2 value for Green Manufacturing was 67%, indicating that the variables of green knowledge, green awareness, government regulation, and strategic orientation collectively explained a substantial proportion of its variance, thereby demonstrating strong predictive power (Chin, 1998). The R^2 value for Business Sustainability was 81%, reflecting a very strong predictive capability of the overall model, with Green Manufacturing serving as a mediating variable. These results suggest that the model is effective in explaining both the adoption of green manufacturing and the attainment of business sustainability, and is well-suited for informing the design of environmentally oriented strategies. The results of hypothesis testing for each proposed relationship are presented below:

The Effect of Green Knowledge on Green Manufacturing

Bootstrapping results indicated that green knowledge exerted a positive and significant effect on green manufacturing (original sample = 0.320; t-statistic = 3.324 > 1.96; p-value = 0.001 < 0.05). This finding is consistent with Alfarizi and Sari (2024) and Sari et al. (2024), who empirically demonstrated that green knowledge has a positive and significant effect on green manufacturing, as firms with stronger green knowledge capabilities exhibit a greater capacity to adopt and implement environmentally friendly production practices in the culinary sector. This result was further supported by the highest outer loading for the Green Knowledge variable on indicator GK3 (understanding of environmentally friendly practices) at 0.885, and the highest outer loading for Green Manufacturing on indicator GM1 (producing products containing recycled materials) at 0.920. These findings suggest that strong environmental literacy among MSME actors regarding eco-friendly practices serves as a meaningful driver of sustainable production processes.

The Effect of Green Awareness on Green Manufacturing

Green awareness exerted a positive and significant effect on green manufacturing (original sample = 0.250; t-statistic = 2.421 > 1.96; p-value = 0.001 < 0.05). This finding is corroborated by Silverio et al. (2025), Hidayati et al. (2026), and Alfarizi and Sari (2024), who empirically demonstrated that green awareness has a positive and significant effect on green manufacturing, as higher levels of environmental awareness among culinary MSME actors are associated with greater adoption of environmentally friendly production practices. This result was supported by the highest outer loading for Green Awareness on indicator GA1 (top management commitment in allocating resources for green initiatives) at 0.948, and the highest outer loading for Green Manufacturing on indicator GM1 at 0.920. These findings highlight the pivotal role of top management commitment in this context, the business owner in efficiently allocating resources such as raw materials to support sustainable production processes.

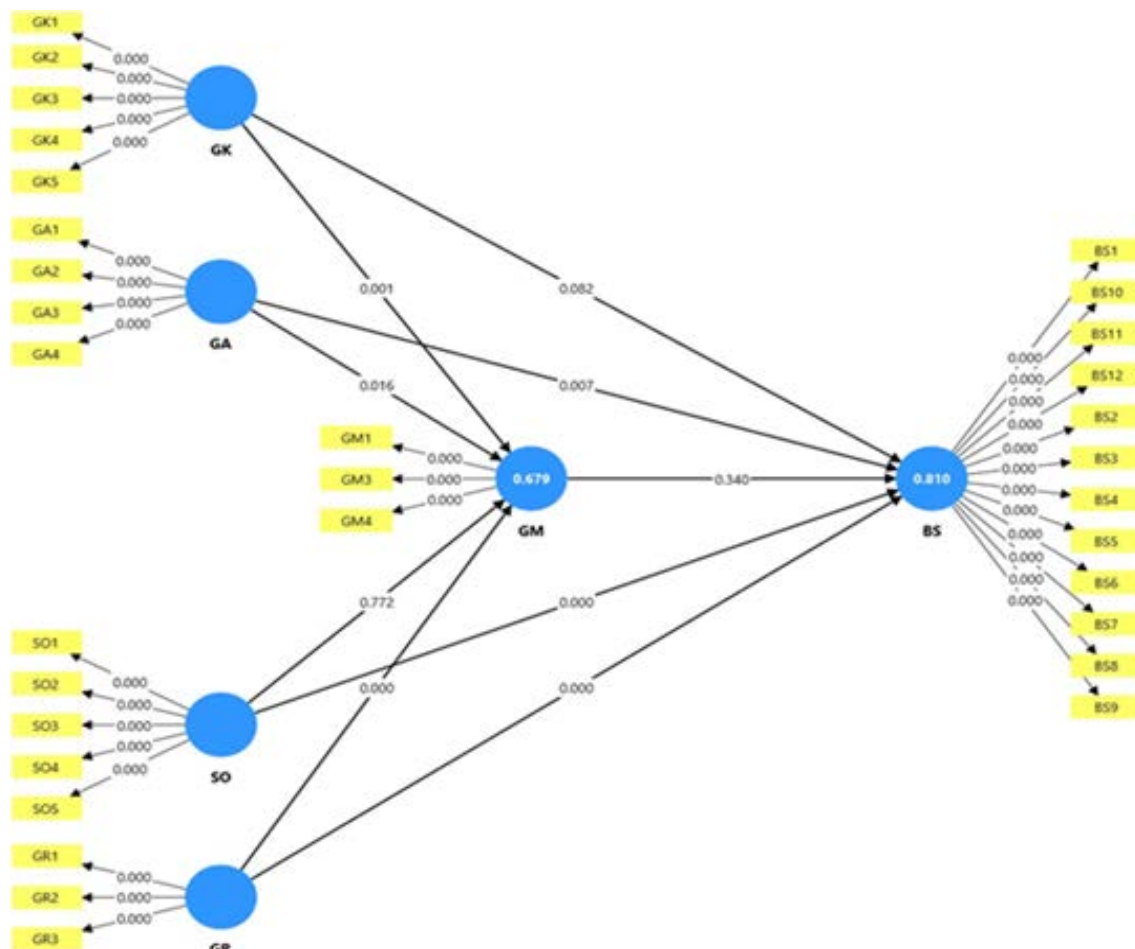


Figure 2. Bootstrap result

The Effect of Strategic Orientation on Green Manufacturing

Strategic orientation did not exert a significant effect on green manufacturing (original sample = 0.025; t -statistic = $0.290 < 1.96$; p value = $0.772 > 0.05$), a finding consistent with Silverio et al. (2025), who reported that green practice adoption among culinary MSMEs is more strongly driven by social pressure, regulatory requirements, and environmental awareness than by strategic orientation. This pattern reflects conditions in Bogor City, where culinary MSMEs remain predominantly focused on short-term profitability, leaving strategic orientation insufficiently integrated into green manufacturing practices, an observation further corroborated by Al Mamun et al. (2022), who found that strategic orientation does not consistently influence green practices in resource-constrained MSME contexts where economic survival takes precedence over environmental priorities. The non-significant relationship can also be attributed to the prevailing nature of customer orientation in this sector; as demonstrated by Jati et al. (2023), culinary MSME consumers tend to prioritize taste, price, convenience, and product variety over environmental attributes, meaning that a customer-oriented strategic approach does not automatically translate into green manufacturing adoption. This interpretation is supported by the measurement model, wherein Strategic Orientation recorded its highest outer loading on SO4 (customer orientation, outer loading = 0.915) and Green Manufacturing on GM1 (outer loading = 0.920), suggesting that while strategic orientation exists, its dominant form does not yet align with or incentivize environmentally responsible production practices.

The Effect of Government Regulation on Green Manufacturing

Government regulation exerted a positive and significant effect on green manufacturing (original sample = 0.318; t -statistic = $4.034 > 1.96$; p -value = $0.000 < 0.05$). This finding is consistent with Hermawan et al. (2024), who demonstrated that government regulation has a positive and significant effect on green manufacturing by compelling firms to comply with environmental standards and adopt more sustainable production practices. Additionally, Meng et al. (2020) highlighted that environmental regulations stimulate green innovation, thereby strengthening the

implementation of green manufacturing and enhancing overall sustainability performance. This result was supported by the highest outer loading for Government Regulation on indicator GR3 (availability of waste management and transportation facilities) at 0.871, and the highest outer loading for Green Manufacturing on GM1 at 0.920. These findings demonstrate that government regulation encourages MSMEs to adopt green manufacturing practices, particularly through the provision of adequate waste management and transportation infrastructure.

The Effect of Green Manufacturing on Business Sustainability

Green manufacturing did not exert a significant effect on business sustainability (original sample = 0.074; t -statistic = $0.954 < 1.96$; p -value = $0.340 > 0.05$). This finding is consistent with Yudawisastra et al. (2023) and Sari et al. (2024), who found that green manufacturing had a positive but statistically insignificant direct effect on business sustainability in culinary MSMEs, suggesting that green manufacturing practices in this sector may still be at an early stage of adoption and may require deeper operational integration before producing measurable sustainability outcomes. This result should not, however, be interpreted as evidence that green manufacturing is inconsequential. Thekkootte (2022) demonstrated that green manufacturing can support sustainable performance in SMEs, but its effect is contingent upon the extent to which green practices are embedded within operational systems.

The highest outer loading for Green Manufacturing was on GM1 (producing products containing recycled materials) at 0.920, while Business Sustainability's highest outer loading was on BS11 (use of environmentally friendly raw materials) at 0.978. Although GM1 and BS11 are conceptually related, their practical implementation in culinary MSMEs differs considerably. GM1 tends to be adopted because it is relatively accessible, low-cost, and visible to consumers, whereas BS11 is more demanding, costly, and not yet prioritized by business owners, resulting in the absence of a statistically significant relationship between the two. This gap may be attributed to persistent barriers confronting SMEs in implementing green manufacturing, including high initial capital requirements, limited access to new technologies, insufficient technical expertise, inadequate training opportunities, and weak regulatory enforcement

(Kushwaha & Talib, 2020; Abdullah et al. 2023). In culinary MSMEs, such barriers may prevent nascent green practices from evolving into a comprehensive and integrated sustainability strategy.

The Effect of Green Knowledge on Business Sustainability

Green manufacturing did not exert a significant effect on business sustainability (original sample = 0.074; t -statistic = $0.954 < 1.96$; p -value = $0.340 > 0.05$), consistent with Yudawisastra et al. (2023) and Sari et al. (2024), who similarly reported a positive yet statistically insignificant direct effect in culinary MSMEs, suggesting that green manufacturing practices in this sector remain at an early stage of adoption and require deeper operational integration before yielding measurable sustainability outcomes. This result should not, however, be interpreted as evidence of inconsequence; Thekkoote (2022) demonstrated that green manufacturing can support sustainable performance in SMEs, albeit contingent upon the extent to which such practices are embedded within operational systems. The measurement model revealed that Green Manufacturing's highest outer loading was on GM1 (recycled material use; $\lambda = 0.920$), while Business Sustainability's was on BS11 (environmentally friendly raw materials; $\lambda = 0.978$); although conceptually related, GM1 tends to be adopted for its accessibility and consumer visibility, whereas BS11 is considerably more demanding and costly, thus explaining the absence of a significant relationship between the two constructs. This gap is further compounded by persistent structural barriers in SME contexts including high capital requirements, limited technological access, insufficient technical expertise, and weak regulatory enforcement, which collectively prevent nascent green practices from evolving into a comprehensive and integrated sustainability strategy (Kushwaha & Talib, 2020; Abdullah et al. 2023).

The Effect of Green Awareness on Business Sustainability

Green awareness exerted a positive and significant effect on business sustainability (original sample = 0.209; t -statistic = $2.690 > 1.96$; p -value = $0.007 < 0.05$). This finding is consistent with Alfarizi and Sari (2024), Silva (2025), and Kee et al. (2023), who collectively emphasize that environmental awareness, green knowledge, and sustainability-oriented practices

constitute important foundations for strengthening sustainable business outcomes in the culinary sector. The highest outer loading for Green Awareness was on GA1 (top management commitment in allocating resources for green initiatives) at 0.948, while Business Sustainability's highest outer loading was on BS11 (use of environmentally friendly raw materials) at 0.978. Top management commitment in allocating resources for green initiatives significantly influences the adoption of environmentally friendly raw materials, as strategic decisions and budget allocation reside with senior management. Active managerial direction and support for sustainable practices — such as the procurement of eco-friendly raw materials — create an organizational climate conducive to green transition, not only facilitating access and financing but also reinforcing sustainability as a core operational priority.

The Effect of Strategic Orientation on Business Sustainability

Strategic orientation exerted a positive and significant effect on business sustainability (original sample = 0.354; t -statistic = $5.639 > 1.96$; p -value = $0.000 < 0.05$). This finding is supported by Sari et al. (2024), Marta et al. (2024), and Megawati et al. (2024), who empirically demonstrated that sustainable strategic planning and management positively influence the ecological, social, and economic performance of culinary MSMEs. The highest outer loading for Strategic Orientation was on SO4 (customer orientation) at 0.915, while Business Sustainability's highest outer loading was on BS11 (use of environmentally friendly raw materials) at 0.978. Customer orientation influences the adoption of environmentally friendly raw materials insofar as MSMEs focused on understanding and responding to consumer needs tend to be more responsive to environmentally conscious market trends. Growing consumer demand for green products incentivizes business actors to adopt more sustainable input materials as a strategic competitive response, enabling MSMEs to integrate eco-friendly raw materials into their market fulfillment and competitive positioning strategies.

The Effect of Government Regulation on Business Sustainability

Government regulation exerted a positive and significant effect on business sustainability (original sample = 0.250; t -statistic = $3.730 > 1.96$; p -value = $0.000 <$

0.05). This finding is consistent with Hermawan et al. (2024), Megawati et al. (2024), and Yudawisastra et al. (2023), who empirically demonstrated that government regulation has a positive and significant effect on business sustainability in the culinary sector, as stronger regulatory frameworks provide the necessary external pressure and institutional support for culinary MSMEs to adopt and sustain environmentally responsible business practices. The highest outer loading for Government Regulation was on GR3 (availability of waste management and transportation facilities) at 0.871, while Business Sustainability's highest outer loading was on BS11 (use of environmentally friendly raw materials) at 0.978. The availability of adequate waste management and transportation infrastructure supports the adoption of environmentally friendly raw materials by creating a more organized and resource-efficient production system. With appropriate waste management facilities in place, MSMEs are better positioned to sort, recycle, or repurpose waste as alternative input materials, thereby enhancing their technical capacity to adopt eco-friendly raw materials and strengthening the integration of circular economy principles into their operational practices.

Managerial Implications

The managerial implications of this study are formulated based on the variables that have the most significant influence, namely green knowledge, green awareness, and government regulation on green manufacturing. The most influential indicators in the implementation of green manufacturing include the understanding of environmentally friendly practices, the commitment of top management or business owners in allocating resources and supporting green initiatives, and the availability of waste management and transportation services provided by local governments.

Planning Stage

The planning stage serves as the foundation for implementing green manufacturing strategically and sustainably. Based on the findings showing the significant influence of green knowledge, green awareness, strategic orientation, and government regulation on business sustainability, culinary MSMEs should develop business plans that integrate environmental sustainability with profitability goals. This includes formulating a vision and mission that reflect environmental commitment, identifying the

need for training, resources, and green investment, such as energy efficiency, waste management, and sustainable raw materials, and establishing measurable sustainability indicators covering environmental, social, and economic aspects. In practice, active stakeholder involvement is essential. The Bogor City Office of Cooperatives and MSMEs can act as a facilitator by providing sustainability-based strategic planning training. Academics and environmental NGOs also play an important role in developing a green transformation roadmap, providing educational modules, delivering technical training, and assisting MSMEs in designing low-emission and low-waste production systems. Collaboration with financial institutions, such as local banks or cooperatives, is also needed to improve access to green financing, including low-interest credit for energy-efficient production equipment or waste management technologies.

Organizing Stage

The organizing stage plays a crucial role in ensuring the effective implementation of green manufacturing among culinary MSMEs in Bogor. The significant influence of green awareness and green knowledge highlights that successful environmental transformation requires not only individual understanding but also a supportive organizational structure. MSMEs should establish dedicated environmental teams responsible for planning, monitoring, and evaluating eco-friendly practices, such as waste management, energy efficiency, and sustainable material use, through clear Standard Operating Procedures (SOPs). Strengthening internal organization ensures consistency and measurable progress in green innovation. Collaboration with local governments, MSME associations, and green technology providers is also essential to support capacity building, promote best practices, and facilitate access to technical guidance and clean technology solutions.

Leading Stage

The leading stage in implementing green manufacturing among culinary MSMEs in Bogor emphasizes the vital role of owners and managers as drivers of change and role models in practicing sustainability within daily operations. Effective leadership is essential to translate government regulations into concrete eco-friendly actions, such as adopting green technologies, improving energy efficiency, and reducing waste, while engaging

employees in the green transformation process. Collaboration with local government, environmental agencies, and green business mentors is also crucial to guide MSMEs in gradually applying environmental policies. Furthermore, developing a participative and environmentally oriented leadership style, supported by HR consultants, can foster an organizational culture that values sustainability through regular training, employee involvement, and recognition of green innovation.

Controlling Stage

The controlling stage is a critical process to ensure that the implementation of green manufacturing among culinary MSMEs in Bogor aligns with planned objectives and contributes to business sustainability. Given the study's finding of an insignificant relationship between green manufacturing and business sustainability, it is evident that without effective monitoring and evaluation, eco-friendly practices may not yield tangible results. Therefore, MSMEs need to establish a continuous control system that assesses the effectiveness of green initiatives through environmental indicators, such as waste reduction and energy efficiency; financial metrics, such as production cost efficiency; and compliance with environmental regulations. This evaluation process not only measures progress but also identifies barriers and areas for improvement to strengthen sustainable business practices.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study concludes that green knowledge, green awareness, and government regulation significantly support the implementation of green manufacturing among culinary MSMEs in Bogor City, while strategic orientation does not exert a significant influence. Green awareness, strategic orientation, and government regulation significantly contribute to business sustainability, whereas green knowledge and green manufacturing demonstrate positive yet statistically insignificant direct effects. These findings suggest that culinary MSMEs in Bogor City possess essential internal and external foundations for green transformation; however, green manufacturing has not yet evolved into a fully integrated business capability

capable of directly reinforcing long-term sustainability. While the results broadly align with prior studies underscoring the roles of environmental awareness, knowledge, and policy support, they also reveal a distinctive insight: in this context, green manufacturing practices remain partial and have not reached a level of maturity sufficient to directly enhance business sustainability.

From a theoretical standpoint, this study highlights that the relationship between green manufacturing and business sustainability in culinary MSMEs is neither automatic nor linear. It is contingent upon the maturity of implementation, resource readiness, owner commitment, and institutional support. From a practical standpoint, the findings indicate that culinary MSMEs require more than awareness and knowledge alone. Tangible enablers, including practical training, affordable access to environmentally friendly raw materials, waste management infrastructure, financial support, and simplified monitoring systems—are necessary to translate green practices into sustainable business routines. Accordingly, multi-stakeholder collaboration among MSME actors, local government, academia, financial institutions, and environmental communities is essential to consolidate green manufacturing as an integral component of the long-term sustainability strategy for culinary MSMEs in Bogor City.

Recommendations

Although the implementation of green manufacturing is not yet optimal, the potential to enhance sustainability remains substantial if supported by strategic planning, visionary leadership, and an adaptive organizational structure. By establishing environmental teams, engaging stakeholders, and utilizing monitoring technology, MSMEs have a significant opportunity to strengthen environmentally friendly practices. A comprehensive approach through planning, organizing, leading, and controlling, as reflected in the managerial implications, can promote the development of greener and more sustainable culinary businesses. The active involvement of all stakeholders is essential in developing socialization, education, and assistance programs for MSME actors to improve the implementation of environmentally friendly business practices. Strong commitment from local governments is also key to regulating and guiding the business practices of MSME actors in Bogor City.

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