

“Antecedents of green manufacturing implementation by local MSMEs in Indonesia”

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ANTECEDENTS OF GREEN MANUFACTURING IMPLEMENTATION BY LOCAL MSMES IN INDONESIA

Abstract

This study aims to investigate the adoption of green manufacturing in the micro, small, and medium enterprises in Indonesia using the integrated framework. The paper used purposive sampling to select 258 micro, small, and medium enterprises in Indonesia that adopt green production processes to determine the supporting and inhibiting factors experienced in green manufacturing. Structural equation modeling with SmartPLS 3.0 application is used for data processing. The results show that the internal factors (organizational capabilities, internal competencies development, relative advantage, and organizational resources) affect green manufacturing implementation. This indicates that micro, small, and medium enterprises in Indonesia tend to adopt green manufacturing when they have organizational capabilities, internal competencies development, relative advantage, and organizational resources that support this practice. External factors that influence green manufacturing practices are government support. Indonesian micro, small, and medium enterprises consider that government support in the form of subsidies or regulations related to green practices will make it easier to adopt green manufacturing.

Keywords

organizational capability, internal competency
development, manager behavior, competitiveness, green
manufacturing

JEL Classification

D29, L23, L26, Q01

INTRODUCTION

Over the past few years, the paradigm of companies has begun to change, especially in the manufacturing industry, which has begun to adopt green business processes, including green manufacturing (Afum et al., 2020a). Through the Ministry of Industry, the Indonesian government has begun proactively inviting industry players to implement green industry standards. Green industry standards have been regulated in Government Regulation Republic of Indonesia Number 28 of 2021 concerning the Implementation of the Industrial Sector. The application of green industry standards also supports the manufacturing industry in fulfilling the regulations of destination countries in export activities. Green manufacturing practices emphasize the adoption of the best resources, thus leading to long-term competitive advantages through the production of high-quality products at the lowest cost (Afum et al., 2020b). Data from the Ministry of Industry show that green manufacturing creates energy and water savings, resulting in lower costs. In 2018, energy savings reached IDR 1.8 trillion, with water savings of IDR 27 billion. An increase in savings occurred in 2019, namely IDR 3.5 trillion for energy savings and IDR 228.9 billion for water savings. In 2021, energy savings of IDR 3.2 trillion and water savings of IDR 168 billion occurred.

On the other hand, managing environmental performance in manufacturing organizations has received attention from researchers and practitioners, primarily due to increasing concerns about climate change, waste disposal, pollution, and global warming (Belhadi et al., 2020). Organizations adopt green manufacturing because it can improve organizational performance and ultimately provide long-term economic benefits. Practitioners think that green manufacturing is just a cost-increasing practice. Therefore, organizations choose green manufacturing only to avoid sanctions in the form of penalties, fines, or revocation of licenses as a result of non-compliance with environmental regulations (Adebambo et al., 2014).

1. LITERATURE REVIEW AND HYPOTHESES

The success of an organization can be determined by the resources and capabilities it has so that it can turn resources into economic benefits. The resource-based view (RBV) theory explains that resources, advantages, and capabilities are related to profitability, which indicates organizational performance. Therefore, companies need to maintain their competitive advantage. The RBV focusing on sustainability is the natural resource-based view (NRBV) (Leonidou et al., 2017). Hart (1995) introduces the natural resource-based view (NRBV) in the corporate context. This theory suggests companies can achieve competitive advantage by implementing three main strategies. First, the pollution prevention strategy focuses on efforts to reduce emissions and waste by implementing improvements toward achieving clear environmental goals. Second, the product stewardship strategy refers to the introduction of processes that aim to minimize the environmental impact of products during and after use. Thirdly, the sustainable development strategy includes developing innovative technologies with low environmental impact, considering the social impact of company activities, and increasing engagement with stakeholders.

NRBV is related to the company's competitive ability to protect the environment, save energy, reduce resource use and waste, and improve quality. Researchers argue that the effectiveness of adopting green manufacturing occurs to varying degrees due to different organizational capabilities stemming from a firm's natural resource-based view (NRBV) (Ullah et al., 2022). A company can improve sustainable capabilities based on its reaction to changes in the global environment. Sustainability capabilities reflect various environmental competencies and resources initiat-

ed and developed by companies and can provide preventative solutions to sustainability problems (Aboelmagd & Hashem, 2019). NRBV explains that companies can increase competitive advantage and environmental preservation through efficient use of resources (Hart, 1995). Compared to large companies, MSMEs are considered to have difficulty adopting green processes because they have limited capabilities (Leonidou et al., 2017).

Although NRBV theory adapts the resource-based view theory, this theory also posits that firms can gain a competitive advantage by developing appropriate resources and capabilities. This theory emphasizes the three previously mentioned strategies (also known as strategic capabilities) that have an important role in dealing with changes in the natural environment. Hart (1995) suggests that some parts of his theory, such as sustainable development strategies, are challenging to test because not many companies have adopted them, while other elements appear to be more applicable to larger business units or companies. Therefore, this study still uses the original resource-based view, which focuses on the role of organizational resources and capabilities in achieving competitive advantage and superior performance through the mediation of business strategy (as argued by Barney (1991)). Moreover, the paper combined several elements of the environment obtained from Hart's theory (1995).

Organizational capability is the ability of the organization to mobilize tangible and intangible resources to achieve a competitive advantage for that organization (Helfat & Peteraf, 2003). In the era of implementing green manufacturing, if a company wants to survive and be superior to others, then this is the company's opportunity to achieve that competitive advantage. According to Loasby (2006), organizational capability is the

ability to obtain new information, knowledge, and skills (absorptive capacity) to support organizational competitiveness.

Previous research has identified aspects of technology that factor into innovation, and the focus has been on how technological features influence the adoption process. There are three attributes of innovation (relative advantage, compatibility, and complexity) put into the technological context (Angeles, 2014). This study used three innovation characteristics: relative advantage, compatibility, and complexity (Baah & Jin, 2019). MSME owners also influence the adoption of innovations by formulating policies and changing key decision-making. Top management support provides a significant factor in the adoption process (Alshamaila et al., 2013). In the environmental context, external factors such as government policies, consumers, competitors, and associations motivate the adoption of green manufacturing (Setyaningsih et al., 2019a). Government incentives are the main motivation for MSMEs to adopt green manufacturing, and government policies are considered the most important in encouraging MSMEs to adopt green manufacturing practices (Oxborrow & Brindley, 2013). Competitive pressure is also a driving factor for innovation adoption (Hwang et al., 2016).

The TOE framework is used to test the application of innovative technologies at the organizational level. The study adapted this framework with technological, organizational, and environmental factors to test the application of green technology to companies in different contexts, especially in MSMEs (Aboelmaged, 2018). Adopting green innovation certainly makes companies make significant changes, but also poses risks. The TOE framework is designed to cover three contexts in which companies adopt innovative practices. The technological context reflects the technical infrastructure, processes, and capabilities that influence the adoption of innovations. The organizational context involves the resources and interactions associated with innovations. The environmental context involves external factors such as competition, stakeholder pressure, and environmental regulations that affect innovation (DePietro et al., 1990).

According to the technological organization and environment (TOE) framework, companies can implement innovative practices effectively when there is a proper balance between internal and external factors. One of the main advantages of the TOE framework is its flexibility in reflecting the various factors that encourage or hinder the implementation of various types of innovation (Aboelmaged, 2014). Previous research on sustainable innovation shows that TOE factors, especially relative advantage, compatibility, complexity of organizational resources, top management support, government support, and competitive pressure, affect the adoption of sustainable practices (Ha et al., 2022; Bhatia & Jakhar, 2021; Burki et al., 2019; Li et al., 2019; Setyaningsih et al., 2019b). However, research that applies the TOE framework in the context of sustainability is still limited (Aboelmaged, 2018). Considering the previous arguments, the use of the TOE framework to identify the drivers of management strategy is a suitable step because of its flexibility that can be applied in various situations. This framework is also suitable as a theoretical basis for analyzing sustainable initiatives and practices (Angeles, 2012, 2014; Aboelmaged, 2018).

This study aims to examine the factors that influence green manufacturing adoption in MSMEs. This study combines the resource-based view (RBV) theory and the technological organization and environment (TOE) framework to complete the test, which incorporates internal and external factors that support and hinder the adoption of green manufacturing. Based on the literature review, the hypotheses formulated are as follows:

- H1: Organizational capability affects the adoption of green manufacturing by MSMEs.*
- H2: Internal competency development affects the adoption of green manufacturing by MSMEs.*
- H3: Manager behavior affects the adoption of green manufacturing by MSMEs.*
- H4: Competitiveness affects the adoption of green manufacturing by MSMEs.*
- H5: Relative advantage affects the adoption of green manufacturing by MSMEs.*

- H6: *Compatibility affects the adoption of green manufacturing by MSMEs.*
- H7: *Complexity affects the adoption of green manufacturing by MSMEs.*
- H8: *Organizational resources affect the adoption of green manufacturing by MSMEs.*
- H9: *Top management support affects the adoption of green manufacturing by MSMEs.*
- H10: *Government support affects the adoption of green manufacturing by MSMEs.*
- H11: *Competitive pressure affects the adoption of green manufacturing by MSMEs.*

2. METHODOLOGY

This study used a questionnaire for data collection. The question items on the questionnaire were adopted from previous research. The questionnaire uses a five-point Likert scale (1 describes “strongly disagree to 5 describes “strongly agree). A total of 258 respondents filled out online and offline questionnaires. Online questionnaires were distributed using Google Forms, while offline questionnaires were distributed when visiting MSMEs. The distribution of the questionnaire was carried out from May to June 2023. The characteristics of the sample in this study are MSME actors who apply green manufacturing to the production process.

The data obtained were processed and analyzed using the Structural Equation Model (SEM) method using the SmartPLS 3.0 application. The analysis is divided into several parts. The first part shows a descriptive analysis, namely the demographics of the respondents. The next analysis is an analysis of the outer model and inner model.

3. RESULTS

Table 1 presents the demographic information of the participants in this study. Most participants were in the age group of 30-40 years and above, indicating the significance of this age group as

the prime mover in the world of micro, small, and medium enterprises (MSMEs). On the other hand, the number of MSMEs in the age range of 40-50 years is relatively less. Regarding geographical distribution, the participating respondents comprised 114 individuals in Java and 144 individuals outside Java. Furthermore, it was found that 103 respondents had educational degrees at the associate degree level. This highlights that many successful MSMEs do not solely come from undergraduate backgrounds. Participation in the world of MSMEs involves individuals with various levels of education. However, the number of individuals holding master’s-level educational degrees is limited, reflecting a general pattern in the national education landscape where holders of tertiary degrees are generally a smaller demographic group.

Table 1. Descriptive statistics

Category	Details	Freq.	Percent
Gender	Male	175	68%
	Female	83	32%
	Total	258	100%
Age	20-30 years	54	21%
	30-40 years	90	35%
	40-50 years	52	20%
	50 > years	62	24%
	Total	258	100%
Origin	Java	114	44%
	Outside Java	144	56%
	Total	258	100%
Qualification	High School	31	12%
	Diploma	103	40%
	Bachelor	90	35%
	Master	34	13%
	Total	258	100%

Validity testing in this study was carried out using the Smart-PLS software before testing the structural model. This is done to ensure the data in this study are adequate. Table 2 provides information that all data on all variables is valid because the average variance extracted (AVE) value shows a score above 0.5.

The reliability test measures the consistency of a research instrument (Kusuma & Wardhani, 2022). Table 2 shows that Cronbach’s Alpha value for all variables has a value above 0.7. This indicates that the data on all variables in this study are reliable. Nunnally (1978) states that the standard reliability test score is above 0.7 for an adequate study.

SEM (structural equation modeling) analysis was used to test the hypotheses. The results are presented in Table 3. Table 3 shows that organizational capabilities, internal competencies development, relative advantage, organizational resources, top management support, and government support influence green manufacturing adoption because the P-value values on the variables are greater than 0.10.

Table 2. Validity and reliability test

Variable	AVE	Composite Reliability	Cronbach's Alpha
Organizational Capabilities	0.693	0.817	0.781
Internal Competencies Development	0.704	0.922	0.895
Manager Behavior	0.774	0.911	0.855
Competitiveness	0.714	0.882	0.800
Relative Advantage	0.677	0.863	0.761
Compatibility	0.761	0.763	0.844
Complexity	0.826	0.905	0.794
Organizational Resources	0.806	0.926	0.880
Top Management Support	0.784	0.916	0.862
Government Support	0.707	0.906	0.884
Competitive Pressure	0.752	0.900	0.800
Green Manufacturing Adoption	0.647	0.902	0.863

4. DISCUSSION

In the resource-based view (RBV) theory, organizational capability is one of the most important internal factors in managing the resources already owned by MSMEs to gain a competitive advantage. According to Wang and Chan (2013), green manufacturing adoption requires changes in organizational capability and the use of MSME resources. The results of hypothesis testing show that organizational capabilities in-

fluence green manufacturing. This proves that an organization's ability to protect the environment by managing resources efficiently will support the implementation of green manufacturing as well as gain a competitive advantage. The results of this study support Aboelmaged and Hashem (2019).

Internal competencies development is the ability of MSMEs to adapt to environmental conditions. Many conventional MSMEs have adopted green manufacturing practices in the entire MSME operating process. This proves that MSMEs can make changes to maintain competence in the era of green manufacturing adoption. The data processing results indicate that the development of internal competencies influences the adoption of green manufacturing. The results of this study support Qu et al. (2022) claim that the development of internal competencies influences the adoption of green manufacturing.

The manager's behavior is influenced by the character and knowledge of the person who occupies the manager's position so that it will not affect whether MSMEs adopt green manufacturing. Management aims to increase an organizational asset in maintaining a competitive advantage (Marín-Vinuesa et al., 2018). This shows that managers tend to focus more on how to maintain the competitive advantage of MSMEs than on whether MSMEs should adopt green manufacturing. The results of this study indicate that manager behavior does not affect green manufacturing adoption. Szymaniec-Mlicka (2014) also proves that there has been a shift in focus on the MSME environment to focus on internal factors in adopting green manufacturing adoption.

Table 3. Hypotheses testing results

Explanation	T statistic	β	P-value	Results
Organizational Capabilities → Green Manufacturing Adoption	2.506	0.151	0.013	Accepted
Internal Competencies Development → Green Manufacturing Adoption	1.831	0.135	0.068	Accepted
Manager Behavior → Green Manufacturing Adoption	1.434	0.098	0.152	Rejected
Competitiveness → Green Manufacturing Adoption	0.353	-0.025	0.724	Rejected
Relative Advantage → Green Manufacturing Adoption	4.314	0.254	0.001	Accepted
Compatibility → Green Manufacturing Adoption	0.886	-0.046	0.376	Rejected
Complexity → Green Manufacturing Adoption	1.634	0.102	0.103	Rejected
Organizational Resources → Green Manufacturing Adoption	1.742	0.115	0.082	Accepted
Top Management Support → Green Manufacturing Adoption	4.885	0.370	0.001	Accepted
Government Support → Green Manufacturing Adoption	1.718	0.140	0.086	Accepted
Competitive Pressure → Green Manufacturing Adoption	0.996	-0.040	0.320	Rejected

MSMEs need experience-based adaptation to create a competitive advantage in changing environmental conditions. If MSMEs want to continue to be competitive, they must be able to adapt to all conditions in the MSME environment. When adopting green manufacturing is implemented, MSMEs must adapt and adjust MSME operations. However, RBV states that to provide a competitive advantage, MSME resources must have value, be unique, and cannot be replaced (Runyan et al., 2007). This shows that when MSMEs already have a competitive advantage by having their unique values, they will not be able to influence MSME decisions on whether to adapt to environmental changes, including changes in the adoption of green manufacturing by MSMEs. Based on the hypotheses tested in this study, competitiveness does not affect green manufacturing adoption. This is supported by Chen (2017), who proves that MSMEs that want to maintain competitiveness must apply conventional models rather than environmentally friendly models.

Relative advantage refers to the extent to which an innovation is believed to bring a more favorable outcome. When a company considers that adopting an innovation will enhance its efficiency, effectiveness, and economic performance, it is more inclined to embrace that innovation. The findings suggest that the relative advantage of a green supply chain is contingent on how it is perceived in terms of compatibility and complexity. Studies have demonstrated that green supply chains not only enhance an organization's environmental performance by reducing pollution but also result in savings on environmental resources and energy consumption, leading to reduced costs and improved financial outcomes. However, when evaluating potential financial gains, companies must account for the tangible and intangible costs associated with addressing compatibility and complexity issues while adopting a green supply chain. Semiconductor manufacturing, characterized by its expense and intricacy, demands a high level of compatibility between manufacturing equipment and processes. Yong et al. (2022) prove that relative advantage affects the adoption of green manufacturing in an industry.

Compatibility is the perception that adopters see whether the innovation is suitable and does not conflict with the conditions of their environment, where the more compatible (suitable) an innovation is ap-

plied, the greater the chance for the innovation to be adopted. Compatibility in implementing green manufacturing is also defined as the ability of a business industry to adopt green manufacturing. Kuosar et al. (2017) prove that compatibility does not affect green manufacturing adoption.

Complexity is the difficulty of MSMEs adjusting their production processes in green manufacturing adoption because the process differs from ordinary manufacturing MSMEs. This difficulty usually lies in applying environmentally friendly production processes, starting from selecting raw materials to moderating emissions in the MSME production process. If MSMEs focus on implementing environmentally friendly production processes, they will ignore the difficulties they face. So, MSMEs can focus on environmentally friendly production. This statement supports the results that complexity does not affect green manufacturing adoption.

Resources in the RBV theory can be classified in several ways, such as land, equipment, labor, capital, and other things that provide value benefits for MSMEs (Kor & Mahoney, 2004). The RBV theory states that maintaining competitive advantage lies in the ownership of resources. MSMEs must be able to optimize human resources to be able to maximize the value of their MSMEs. The involvement of MSME-owned resources can encourage green manufacturing adoption. If MSME resources are environmentally friendly, the production process will adopt green manufacturing. This can prove that the existence of organizational resources influences the adoption of green manufacturing. The results indicate that organizational resources influence the adoption of green manufacturing.

Mittal and Sangwan (2014) state that top management commitment is the most critical factor driving green manufacturing. In changing environmentally friendly conditions in the industry, to assist top management in making MSME value creation policies, full support from top management greatly influences green manufacturing adoption in MSME (Saputra & Nasution, 2022). Suppose MSME owners provide much knowledge about green manufacturing and give more trust to employees to have a responsibility in contributing to the MSME business in implementing green manufacturing in their work environment. In that case, it will be easier for these

MSMEs to adopt green manufacturing. The results of this study prove that top management support influences green manufacturing adoption. These findings support Kearns and Sabherwal (2006) and Tseng et al. (2013), who stated that the active role of top managers is critical in adopting green manufacturing in their SMEs.

From previous research on the adoption of green manufacturing, most of the obstacles to implementing green manufacturing are weak regulations and enforcement of rules and a lack of knowledge about green manufacturing, especially for small and medium industries. The assumption that the application of green manufacturing only causes high production costs with benefits that do not directly affect the profits of MSMEs causes MSMEs to be less serious about implementing green manufacturing. Therefore, it is necessary to improve the implementation of legislation regarding the environment that must be obeyed by all industries with clear rules or implementation mechanisms (Amaranti et al., 2017). The results of this study indicate that government support affects green manufacturing adoption. This finding supports Dornfeld (2014), who proves that the motivation that encourages MSMEs to implement green manufacturing includes pressure from the government with regulations, penalties, and taxes.

Boone and Kurtz (2000) has proven that competitive pressures cannot always increase the level of product innovation in industries that focus on environmental friendliness. This is because the effect of competitive pressure on the MSME scale is highly dependent on the choices made by the MSME, whether in the form of self-satisfaction, enthusiasm for competition, struggle, or even giving up in the face of the conditions at hand. These factors are then determined by the relative efficiency of MSMEs against their competitors. The findings indicate that competitive pressure does

not have a significant effect in the context of green manufacturing adoption.

As a follow-up study, Noerirawan and Muid (2012) found that internal factors, apart from external pressure, also play a key role in driving green manufacturing adoption. In their analysis, support from top management was identified as one of the most effective internal drivers. When the top management of an organization provides strong support for the implementation of green manufacturing adoption practices, this can motivate the entire organization to adapt and innovate to run a more environmentally friendly operation. In addition, employee commitment is also considered an essential factor influencing the adoption of green manufacturing adoption. When employees feel involved and committed to sustainable practices, green manufacturing adoption implementation tends to be more successful.

Overall, these studies show that a combination of external and internal factors influences green manufacturing adoption. Competitive pressures have varying impacts depending on the industry context and the characteristics of MSMEs. In this case, internal factors such as top management support and employee commitment have a significant role in driving the successful implementation of green manufacturing adoption. The combination of influences from these various factors is vital for understanding and designing effective strategies to encourage adopting sustainable practices in the business environment.

These findings can guide practitioners, researchers, and policymakers to design strategies supporting sustainable economic growth in a greener and more environmentally friendly business environment. In the research context, the role of people around, such as family, relatives, and friends, can be tested in adopting green manufacturing, such as subjective norms. This is because people tend to behave according to the views of the people around them.

CONCLUSION

In order to increase the sustainability and competitiveness of MSMEs, policy measures that support green manufacturing adoption and the development of internal resources should be prioritized. The results of this study provide valuable insights for MSMEs and other interested parties in supporting the transformation toward more environmentally friendly business practices. To continue the green process in business, MSMEs need to improve internal capabilities by training employees, improving infra-

structure, and adjusting production processes. MSME top management plays a vital role in the adoption of green manufacturing, namely by making policies that support sustainable practices, such as efficient use of resources and environmental impact monitoring. Governments can also support green manufacturing practices by creating sustainable policies and programs. This can help in financing the necessary equipment and investment for green manufacturing. Future researchers can conduct in-depth case studies on several MSMEs that have successfully adopted green manufacturing, which can provide richer insights into the challenges, benefits, and best practices implemented by these MSMEs. In addition, researchers can make comparisons with other countries that adopt green manufacturing in MSMEs.

AUTHOR CONTRIBUTIONS

Conceptualization: Noormalita Primandaru, Manggar Wulan Kusuma, Olivia Barcelona Nasution.

Data curation: Olivia Barcelona Nasution.

Formal analysis: Manggar Wulan Kusuma.

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