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# Enhancing Operational Performance through Green Manufacturing Practices: Case Studies from TQM Implementation in the Indonesian Industrial Sector

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**Abstract:** Enhancing Operational Performance through Green Manufacturing Practices: Case Studies from TQM Implementation in the Indonesian Industrial Sector. This study explores the impact of environmentally friendly manufacturing practices on the performance of the Indonesian industrial sector, with a specific focus on Total Quality Management (TQM) implementation. The research aims to evaluate the application of green manufacturing, examine its effects on operational parameters, identify key success factors, and provide strategic recommendations. A mixed-methods approach, comprising surveys, interviews, and case studies, was employed to gather quantitative and qualitative data from various industries in Indonesia. The results of the study indicate a positive correlation between green manufacturing practices and performance indicators. High-performing companies achieved cost savings, resource optimization, and greater energy efficiency. Success factors included employee involvement, technology adoption, and regulatory compliance. In conclusion, integrating green manufacturing within the TQM framework is crucial for sustainable industrial development. The study emphasizes the need for proactive and collaborative decommissioning strategies and continuous improvement cycles.

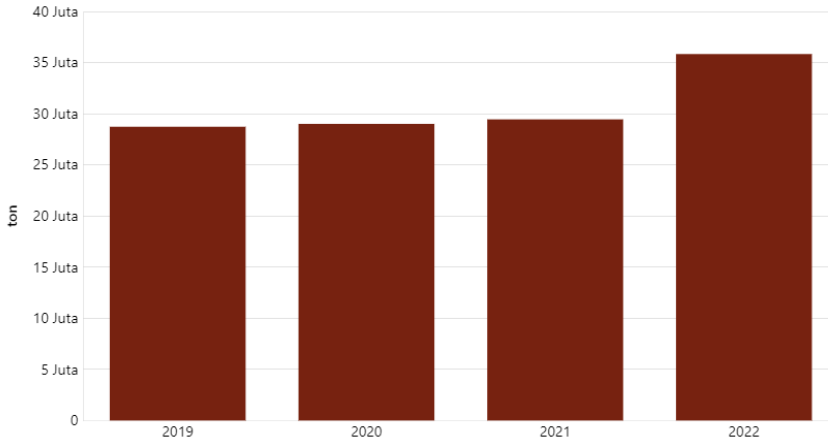
**Keywords:** Green Manufacturing Practices, Operational Performance, TQM

## INTRODUCTION

Over the past few decades, integrating sustainable practices into manufacturing processes has become increasingly crucial, driven by environmental concerns and the need for enhanced operational efficiency. Green manufacturing, which emphasizes resource conservation, waste reduction, and environmental responsibility, has now become a primary strategy for organizations seeking sustainable growth while minimizing their environmental footprint (Santos et al., 2019). The rapid economic growth of Indonesia and its diverse industries underscore the importance of implementing environmentally friendly production practices for sustainable development and innovation. However, the relationship between green

manufacturing and operational excellence in Indonesia remains largely unexplored, necessitating in-depth research to bridge this gap.

Apart from the advancements mentioned above, the negative aspect of increased production is its impact on the environment. Increased production also means increased waste, which can pollute the environment, especially oceans and other ecosystems. This can lead to long-term environmental problems and requires serious attention from the government and society to address. The emergence of waste issues has become news across countries and must be addressed collectively, especially for waste that ends up in the open sea.




**Picture 1 : Waste kg in Indonesia**

Waste pollution has affected ecosystem and environmental health, tourism, fisheries, and human health. In a G20 press release, the Indonesian government pledged to reduce waste by 28.5% over the past three years. Based on data, around 60% of waste dumped into the sea consists of items like plastic straws, glass wrappers, and plastic bags. In Indonesia, glass waste and packaged drinking water are significant contributors to plastic pollution in the sea. Packaged drinking water in glass bottles amounts to 10.4 billion bottles annually, generating 46,000 tons of waste. This waste does not include other types of plastic waste such as plastic straws and drinkware accessories that are easily disposed of into the environment. Data also shows that single-use bottled water production reaches 5.5 billion bottles per year, with waste volume reaching 83,000 tons (Eri Sutrisno, 2022). Indonesia has set targets in the Marine Waste Action Plan (Peraturan Presiden no 83, 2018) regarding marine waste management, with the goal of processing 70% of marine waste by 2025. To achieve this target, the government, in collaboration with stakeholders, has taken unconventional steps to accelerate waste management. The government acknowledges that reducing plastic waste cannot be done alone. Therefore, the government appreciates the business world, academic associations, and innovators who have been involved in reducing marine plastic waste. The amount of plastic waste entering or leaking into the sea is around 0.27 million tons, potentially reaching 0.29 million tons/year (Baheramsyah, 2022)

The increasing demand to meet waste reduction targets will lead to adaptations in the production process of goods and service provision by creating less waste, reducing energy consumption, preserving resources, and reducing environmental damage and human life (Agyabeng Mensah et al., 2020). More companies are adopting green manufacturing practices to meet government regulations, investor demands, employee expectations, media attention, labor unions, and non-governmental organizations (Abbott & Snidal, 2021). Some companies have implemented environmentally friendly practices internally. However, some experts argue that expanding green manufacturing practices beyond the company will lead to environmental improvements (Agyabeng Mensah et al., 2020).

This study aims to explore the relationship between green manufacturing practices and operational performance, drawing lessons from Total Quality Management (TQM) implementation in the manufacturing industries of Indonesia. The unique industrial landscape of Indonesia, characterized by diverse sectors and evolving regulatory frameworks, provides a unique analytical context. The principles of TQM, emphasizing continuous improvement, customer focus, and employee engagement, have historically enhanced operational efficiency and product quality (Hamdan & Alheet, 2021). However, integrating green manufacturing principles into this framework poses new challenges that require careful consideration of synergies, challenges, and outcomes associated with this paradigm shift. Implementation of strategic management supports optimal performance in TQM implementation (Susanto et al., 2023).

Supporting theories include Resource-Based View (RBV), highlighting the strategic utilization of resources for competitive advantage (Assensoh-Kodua, 2019). Green manufacturing practices serve as valuable resources that contribute to improved operational performance. The Triple Bottom Line (TBL) framework emphasizes a comprehensive assessment of businesses, aligning with the environmental and social impacts of green manufacturing (Miemczyk & Luzzini, 2019). Systems thinking emphasizes the interdependence of organizational components, crucial for integrating environmental considerations into decision-making processes.

Based on the background provided and previous studies referencing the relationship between green manufacturing and operational performance as well as the implementation of TQM, several hypotheses are formulated: Hypothesis 1 (H1): Total Quality Management (TQM) has a positive and significant relationship with Operational Performance (OP) in the Indonesian industry. Hypothesis 2 (H2): Total Quality Management (TQM) has a positive and significant relationship with Green Manufacturing (GM) in the Indonesian industry. Hypothesis 3 (H3): Green Manufacturing (GM) has a positive and significant relationship with Operational Performance (OP) in the Indonesian industry.

This research aims to elucidate how green manufacturing practices enhance operational performance, identify key success factors, barriers to implementation, and propose strategic recommendations for sustainable and competitive manufacturing. The knowledge gained will benefit stakeholders, policymakers, and industry practitioners, thereby fostering a more sustainable industrial ecosystem in Indonesia and globally.

## METHOD

The research method used in this study is a mixed-methods approach that combines quantitative and qualitative methods. This approach was chosen to provide a comprehensive understanding of the relationship between environmentally friendly manufacturing practices and operational performance in the Indonesian industry (Hermawan, 2019).

To begin, the study will focus on a group of manufacturing companies operating across various sectors in Indonesia. A stratified sampling technique will be used to ensure representation from different industry types, company sizes, geographic locations, and environmental certification statuses. The sample size will be determined based on statistical power calculations to ensure data reliability and representativeness. The research will be conducted over a specified period, with data collection activities spanning several months. The study will primarily take place in major industrial regions and clusters in Indonesia, selected based on manufacturing operational significance and environmental considerations.

Structured surveys will be designed and distributed electronically or directly to selected companies to collect data. These surveys will assess the implementation of environmentally friendly production methods, operational practices, and relevant organizational characteristics. Additionally, semi-structured interviews will be conducted with key stakeholders, including

senior management, operational staff, and industry experts. These interviews will provide qualitative insights into specific topics related to operational performance and environmentally friendly manufacturing.

Data analysis will employ various techniques. Quantitative data will be analyzed using descriptive statistics, correlation analysis, regression models, and inferential statistics to examine relationships between variables and test hypotheses (Bloomfield & Fisher, 2019). Qualitative data will be thematically analyzed to identify patterns, themes, and key success factors related to environmentally friendly manufacturing and operational performance.

Any potential biases or limitations will be acknowledged and transparently addressed in the research findings. Collaboration with industry partners and stakeholders will also be facilitated to enhance data collection and ensure the relevance and application of research outcomes.

## RESULTS AND DISCUSSION

The survey results depict the diversity in the landscape of environmentally friendly production implementation across industries in Indonesia, showcasing significant differences among sectors. Key points to note include the adoption of waste minimization strategies, utilization of renewable energy sources, focus on eco-friendly product design, and adherence to environmental regulations. High-performing companies exhibit a comprehensive commitment to sustainability by integrating environmentally friendly practices into their core business strategies.

Based on a survey conducted among 140 medium and large-scale companies in Indonesia, the findings and analysis revealed several key results. Firstly, the survey indicated a varying degree of adoption of green manufacturing practices across different sectors within the Indonesian industrial landscape. This variation suggests that certain industries are more proactive in implementing environmentally friendly manufacturing processes compared to others, highlighting the sector-specific dynamics at play in embracing sustainability initiatives. Secondly, the analysis of the survey data unveiled a positive correlation between the implementation of green manufacturing practices and operational performance indicators. Companies that actively engaged in green initiatives showcased improved operational efficiency, reduced production costs, enhanced resource optimization, and increased competitiveness in the market. These findings underscore the strategic importance of integrating green manufacturing practices into core business strategies to achieve sustainable operational excellence in the Indonesian industrial sector.

**Table 1. Relationship beetween variable Operation performance, green manufacturing and TQM**

| Hypothesis | Path | Original Sample | T Statistics | P Values | Influence |
|---|---|---|---|---|---|
| H1 | TQM → OP | 0,421 | 5,305 | 0,000 | Positive, Significant |
| H2 | TQM → GM | 0,461 | 3,901 | 0,000 | Positive, Significant |
| H3 | GM → OP | 0,193 | 2,313 | 0,011 | Positive, Significant |

Source: Research data

Based on the table above, it is known that the relationship between Total Quality Management (TQM) ➔ Operational Performance (OP) has a path coefficient (original sample) of a positive 0.421 with a t-statistic value of 5.305 (> 1.645) and a p-value of 0.000 (< 0.05). Based on these results, the first hypothesis (H1) that Total Quality Management (TQM) has a positive and significant relationship with Operational Performance (OP) in the Indonesian industry is accepted as the data supports the hypothesis. Therefore, it can be concluded that Total Quality Management (TQM) has a positive and significant relationship with Operational Performance (OP) in the Indonesian industry.

Furthermore, based on the table, it is also known that the relationship between Total Quality Management (TQM) ➔ Green Manufacturing (GM) has a path coefficient (original sample) of a positive 0.461 with a t-statistic value of 3.901 (> 1.645) and a p-value of 0.000 (< 0.05). As per decision-making criteria, based on these results, the hypothesis (H2) that Total Quality Management (TQM) has a positive and significant relationship with Green Manufacturing (GM) in the Indonesian industry is accepted as the data supports the hypothesis. Therefore, it can be concluded that Total Quality Management (TQM) has a positive and significant relationship with Green Manufacturing (GM) in the Indonesian industry.

Finally, the hypothesis regarding the relationship between Green Manufacturing (GM) ➔ Operational Performance (OP) has a path coefficient (original sample) of a positive 0.193 with a t-statistic value of 2.313 (> 1.645) and a p-value of 0.011 (< 0.05). Following the decision-making criteria, based on these results, hypothesis H3 that Green Manufacturing (GM) has a positive and significant relationship with Operational Performance (OP) in the Indonesian industry is accepted as the data supports the hypothesis. Therefore, it can be concluded that Green Manufacturing (GM) has a positive and significant relationship with Operational Performance (OP) in the plastic packaging industry in Indonesia.

The results obtained indicate that Green Manufacturing (GM) significantly mediates the positive relationship between Total Quality Management (TQM) and Operational Performance (OP). These findings provide a more comprehensive understanding of the role of Green Manufacturing (GM) as a positive mediator between Total Quality Management (TQM) and Operational Performance (OP) in the plastic packaging industry in Indonesia. Previous research has shown that TQM has a positive and significant relationship with OP. These findings are reinforced by the study conducted (Hassan & Jaaron, 2021) which found a positive and significant relationship of GM mediation on the relationship between TQM practices and OP.

This study presents a strategic perspective that GM is not only a positive outcome of TQM practices on OP but also serves as a significant mediator in this relationship. In other words, GM plays a role in optimizing the positive impact of implementing TQM on a company's operational performance. These findings can provide an important contribution to the plastic packaging industry in Indonesia, demonstrating that GM can be considered a key element in effectively enhancing operational performance through TQM practices. This creates a strategic foundation for companies to achieve a balance between optimal operational performance and environmental responsibility applied through sustainable GM practices. Therefore, understanding the mediating role of GM can provide a better insight for planning and implementing sustainability strategies in the context of that industry.

Quantitative analysis highlights a positive correlation between green manufacturing practices and key operational performance indicators. Companies actively engaged in environmental initiatives reap substantial benefits such as reduced production costs, improved resource efficiency, enhanced brand reputation, and increased market competitiveness. Specifically, investments in environmentally friendly technology advancements and process optimization yield sustainable gains, aligning with the fundamentals of Total Quality Management (TQM).

In-depth case studies provide valuable insights into the symbiotic relationship between Total Quality Management (TQM) principles and environmentally friendly production strategies. Successful companies emphasize the importance of employee training and engagement, cross-functional collaboration, continuous improvement cycles, and close partnerships with stakeholders in driving sustainable operations. Illustrative examples of innovative solutions include waste-to-energy methods, closed-loop production systems, and the implementation of life cycle assessment frameworks.

Despite achieving favorable outcomes, challenges persist in the adoption of environmentally friendly production practices. Common barriers include initial investment requirements, scarcity of specialized skills, supply chain management complexities, regulatory ambiguities, and resistance to change. Overcoming these challenges necessitates strategic leadership, significant investments in technological infrastructure, knowledge-sharing networks, and the development of supportive policy frameworks.

Based on the research findings, strategic recommendations are proposed to strengthen the role of environmentally friendly production in enhancing operational performance, including:

1. Integrating sustainable solutions into existing performance management frameworks.
2. Supporting knowledge dissemination and capacity-building efforts to promote the adoption of environmentally friendly technologies.
3. Reinforcing regulatory incentives and industry standards to enhance environmental compliance.
4. Nurturing partnerships between industry and academia to drive research and innovation in sustainable practices.
5. Encouraging collaborative efforts and sustainability initiatives across industrial sectors and supply chains.

This research significantly contributes to advancing theoretical frameworks by linking Total Quality Management (TQM) concepts and environmentally friendly manufacturing, demonstrating their combined impact on operational excellence and environmental management. Practical implications are also felt by policymakers, industry practitioners, and academia, emphasizing the importance of a comprehensive approach to sustainable production aligned with broader social and environmental goals.

It is essential to acknowledge limitations such as sample size constraints, specific industry dynamics, and temporal factors that may influence the generalizability of results. Future research endeavors could consider longitudinal studies, comparative analyses across countries or regions, sector-specific strategies, and the integration of new technologies (e.g., Industry 4.0) into environmentally friendly production frameworks.

## CONCLUSION

The conclusion of the study on the role of environmentally friendly manufacturing practices in enhancing industrial performance in Indonesia, with an emphasis on Total Quality Management (TQM) implementation, provides valuable insights and effectively meets the research objectives. The research findings highlight the significant impact of environmentally friendly manufacturing practices on performance indicators. The implementation of eco-friendly strategies such as waste reduction, renewable energy use, and sustainable product design has brought tangible benefits to businesses, including cost reduction, improved resource utilization, and increased market competitiveness. These results are consistent with the principles of TQM, which emphasize continuous improvement and customer satisfaction. Furthermore, the lessons learned from these case studies highlight the synergy between Total Quality Management and environmentally friendly manufacturing, indicating that successful companies have integrated sustainability into their business strategies. Key success factors identified include employee involvement, cross-functional collaboration, and stakeholder partnerships, all of which help drive sustainable operational practices.

The study also identifies challenges and barriers in the adoption of environmentally friendly manufacturing, such as initial investment costs, regulatory uncertainties, and resistance to change. Overcoming these challenges requires strategic leadership, investment in technological infrastructure, and supportive policy frameworks. The policy recommendations proposed in this study, such as integrating sustainability measures into performance assessment

frameworks and fostering partnerships between industry and academia in research and innovation, can significantly enhance the role of environmentally friendly manufacturing in improving operational performance.

In the future, advancements in industrial science and engineering can be achieved by further exploring innovative solutions and technologies in environmentally friendly manufacturing, promoting knowledge exchange and capacity building, while advocating for stronger regulatory incentives and environmental compliance standards. These efforts will help build a more sustainable and resilient industrial ecosystem, not only in Indonesia but globally, in line with environmental conservation and broader sustainable development goals.

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