

# Systematic Literature Review on the Integration of Total Quality Management and Green Manufacturing in Enhancing Sustainable Manufacturing Competitiveness

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## ABSTRACT

*Global pressures on the manufacturing industry to enhance competitiveness while simultaneously meeting sustainability demands have intensified the need for integrated managerial approaches. Total Quality Management (TQM) has long been recognized as a fundamental driver of organizational performance through continuous improvement and customer orientation, while green manufacturing has emerged as a key strategy for reducing the environmental impacts of production processes. However, existing literature indicates that these two approaches are often implemented in isolation, limiting their potential synergy in building sustainable manufacturing competitiveness. This article aims to conduct a Systematic Literature Review (SLR) to comprehensively examine the integration of TQM and green manufacturing and its contribution to enhancing manufacturing competitiveness. The SLR method was applied by reviewing peer-reviewed and reputable scientific publications from 2021-2025, including empirical studies, conceptual frameworks, and prior systematic reviews. The findings reveal that TQM functions as an organizational capability that facilitates the adoption of green manufacturing practices through the strengthening of quality culture, leadership commitment, and employee involvement. The integration of TQM and green manufacturing is shown to have a positive impact on sustainability performance, environmental performance, green innovation, and competitive advantage in manufacturing firms. This study contributes by developing an integrative conceptual framework that positions TQM as a strategic enabler of green manufacturing within the context of sustainable manufacturing competitiveness, while also identifying research gaps and future research agendas, particularly in developing countries.*

**Keywords:** Total Quality Management, Green Manufacturing, Manufacturing Competitiveness, Sustainability, Systematic Literature Review.

## Introduction

The global manufacturing industry is currently facing increasingly complex challenges due to intensified market competition, environmental regulatory pressures, and growing stakeholder demands for sustainable business practices. Manufacturing competitiveness is no longer determined solely by cost efficiency and product quality, but also by a company's ability to manage the environmental and social impacts of its operational activities. In this context, sustainability has evolved from a mere compliance issue into a strategic factor influencing long-term performance and corporate reputation. Total Quality Management (TQM) is one of the managerial approaches widely adopted by manufacturing organizations to enhance quality, productivity, and overall organizational performance. TQM emphasizes continuous improvement, employee involvement, top management leadership, and data-driven decision-making. Numerous empirical studies have demonstrated that TQM implementation positively contributes to organizational performance, both operationally and strategically [1], [2]. Over time, TQM has not only been viewed as a quality management system but also as a dynamic capability that enables organizations to adapt to changes in the business environment. [3]

With the increasing attention to environmental issues, green manufacturing has emerged as a production approach aimed at minimizing negative environmental impacts through resource efficiency,

waste reduction, emission control, and environmentally friendly product and process innovation. The implementation of green manufacturing has been shown to generate significant benefits for environmental performance and corporate sustainability [4], [5]. Moreover, several studies suggest that green manufacturing practices can serve as a source of competitive advantage by enhancing corporate image, improving long-term cost efficiency, and enabling product differentiation. [6]

Although TQM and green manufacturing both focus on continuous improvement and long-term value creation, they are often implemented separately in industrial practice. However, recent literature indicates a mutually reinforcing relationship between TQM and environmentally friendly practices. Hasan et al. [7] demonstrate that TQM positively influences green manufacturing practices, which in turn mediate the relationship between TQM and organizational performance. Similar findings are reported by Adam et al. [8] and Munawar et al. [9], who emphasize that a strong quality management system serves as an essential prerequisite for the successful implementation of environmental sustainability initiatives.

Furthermore, recent studies highlight the importance of integrating TQM with other sustainability-related approaches, such as green supply chain management, green innovation, and digital transformation, to enhance sustainable performance and corporate competitiveness [10] For example, Masudin et al. [11] found that TQM and green supply chain management significantly contribute to SME sustainability performance through the mediation of competitive advantage. Meanwhile, Khakwani et al. [12] and Kouser et al. [13] stress the importance of green product innovation and eco-design as linking mechanisms between green manufacturing and firm performance.

Despite the growing number of studies on TQM and green manufacturing, research that systematically integrates both concepts within a comprehensive framework for enhancing sustainable manufacturing competitiveness remains limited. Most studies focus on partial causal relationships, such as the impact of TQM on environmental performance or the influence of green manufacturing on sustainability performance, without developing a holistic understanding of the integration mechanisms between the two. Existing systematic reviews tend to examine TQM [5] or green manufacturing [14], [15], [16] separately, or link them to other issues such as Industry 4.0 [17],[18] and leadership [19].

This research gap becomes even more relevant in the context of developing countries, where manufacturing industries face resource constraints, cost pressures, and organizational cultural challenges in simultaneously adopting quality and sustainability practices. Thoriq et al. [20] emphasize that although green manufacturing consistently has a positive impact on sustainability performance, significant contextual gaps remain regarding its implementation in developing countries. Therefore, a literature review that synthesizes empirical and conceptual findings is required to develop an integrated framework of TQM and green manufacturing relevant to enhancing sustainable manufacturing competitiveness.

Based on this background, this article aims to conduct a Systematic Literature Review (SLR) of recent studies addressing the integration of Total Quality Management and green manufacturing in the context of improving sustainable manufacturing competitiveness. Specifically, this article seeks to identify relational patterns, integration mechanisms, and supporting factors influencing the successful implementation of both approaches. Thus, this study is expected to provide theoretical contributions by enriching the operations management and sustainability literature, while also offering practical implications for manufacturing managers in designing integrated quality and environmental strategies. The primary contribution of this research lies in developing a comprehensive and systematic synthesis of the literature on the integration of TQM and green manufacturing, which has not been extensively addressed explicitly in previous studies. This article positions TQM as a strategic enabler and organizational capability that drives the adoption and effectiveness of green manufacturing practices, ultimately leading to enhanced sustainable manufacturing competitiveness. In addition, this study identifies conceptual and methodological gaps in the existing literature and formulates relevant future research agendas, particularly for the manufacturing industry context in developing countries.

## **Research Methods**

This study employs a Systematic Literature Review (SLR) approach to comprehensively identify, evaluate, and synthesize previous research addressing the integration of Total Quality Management (TQM) and green manufacturing in the context of enhancing sustainable manufacturing competitiveness. The SLR approach was selected because it provides a comprehensive overview of research developments, patterns of interrelationships among variables, and existing research gaps, with a higher level of objectivity and transparency compared to conventional narrative literature reviews.

The SLR process in this study was designed by adapting the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA framework was employed to ensure that each stage of the literature search and selection process was conducted systematically, documented transparently, and replicable. The focus of the review was directed toward empirical and conceptual studies that explicitly or implicitly link TQM practices and green manufacturing with sustainability performance, environmental performance, and manufacturing competitiveness.

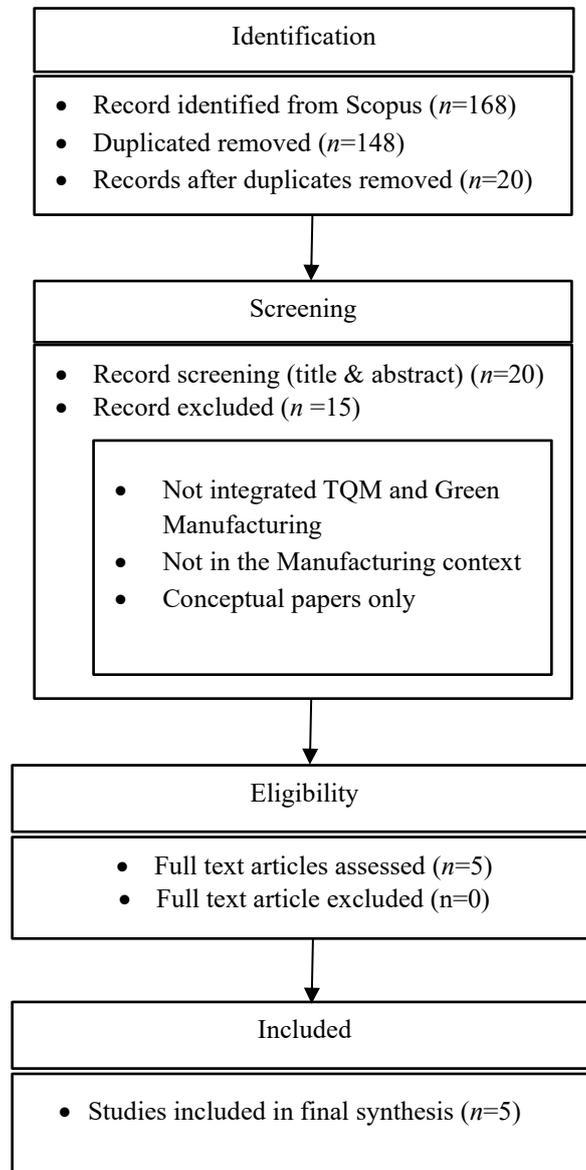


Figure 1. Prism Diagram

Table 1. Reasons for Exclusion at Screening Stage (n = 15)

No.	Reason for Exclusion	Number of Articles
1	Did not examine the integration between TQM and green manufacturing	5
2	Not conducted within a manufacturing context	4
3	Conceptual or theoretical discussion without empirical validation	3
4	Did not link variables to sustainability or competitiveness outcomes	2
5	Insufficient methodological clarity	1

<b>Total</b>	<b>15</b>
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**Table 1** presents the reasons for excluding 15 articles during the title and abstract screening stage. The majority of excluded studies did not explicitly examine the integration between Total Quality Management and green manufacturing or were conducted outside the manufacturing context. This screening process ensured that only studies directly relevant to the research objectives were included in the final synthesis.

The literature search was conducted in the Scopus database, which is widely recognized for its comprehensive coverage of peer-reviewed journals in operations management, industrial engineering, and sustainability.

The search strategy was designed using combinations of relevant keywords, such as “Total Quality Management” or “TQM,” “Green Manufacturing” or “Green Production,” “Sustainable Manufacturing,” “Manufacturing Competitiveness,” and “Sustainability Performance.” Boolean operators were applied to combine these keywords to ensure that the retrieved articles captured the interrelationships among quality management, sustainability, and manufacturing performance.

To maintain the relevance and quality of the analyzed literature, this study established clear inclusion and exclusion criteria. Articles included in this review were peer-reviewed journal publications addressing TQM, green manufacturing, or the integration of both concepts, and linking them to organizational performance, environmental performance, sustainability performance, or competitiveness. Furthermore, publications were limited to the most recent five-year period (2021–2025) to ensure the novelty and relevance of findings. Conversely, conference proceedings, books, technical reports, and non-peer-reviewed publications were excluded, as were studies lacking clear methodology or findings and those not focused on the manufacturing context.

The article selection process was conducted in stages. The initial stage involved screening titles and abstracts to assess topic relevance. Irrelevant articles were eliminated at this stage. The next stage consisted of full-text screening to ensure that the articles met all inclusion criteria in terms of context, methodology, and contribution to the topic of TQM and green manufacturing integration. Through this process, a core set of articles was identified and subsequently analyzed in depth as the basis for literature synthesis.

Data extraction was systematically conducted for each selected article by recording key information, including authors and publication year, industry context and research location, research objectives, methodological approaches and analytical techniques employed, key variables examined, and major findings relevant to the relationship among TQM, green manufacturing, and manufacturing performance. The extracted data were then analyzed using a thematic synthesis approach, in which research findings were grouped into major themes that consistently emerged across the literature. In addition to data extraction and thematic synthesis, a quality appraisal of the included studies was conducted to ensure methodological rigor and reliability of the synthesized findings.

To enhance the methodological rigor of the review, the quality of the included studies was assessed using a structured appraisal approach adapted from common systematic review practices. Each study was evaluated based on four criteria: (1) clarity of research design, (2) adequacy of sample and data collection, (3) rigor of analytical methods, and (4) clarity and consistency of reported findings. Each criterion was scored on a scale of 0–2, resulting in a total possible score of 0–8. Studies scoring 6–8 were categorized as high quality, 3–5 as moderate quality, and 0–2 as low quality.

**Table 2.** Quality Assessment of Included Studies (n = 5)

Author(s)	Research Design	Sample Adequacy	Analytical Rigor	Clarity of Findings	Total Score	Quality Level
Hasan et al. (2021)	2	2	2	2	8	High
Masudin et al. (2025)	2	2	2	2	8	High
Adam et al. (2022)	2	1	2	1	6	Moderate
Khakwani et al. (2024)	2	1	2	1	6	Moderate
Bui et al. (2024)	2	2	2	1	7	High

Overall, the included studies demonstrated acceptable methodological rigor, with three classified as high quality and two as moderate quality. Therefore, the findings synthesized in this review are considered to be based on sufficiently reliable empirical evidence.

The thematic synthesis approach enabled the integration of both quantitative and qualitative research findings, providing a more comprehensive understanding of the mechanisms underlying the

integration of TQM and green manufacturing. The main themes identified in this review include: the role of TQM as an enabler of green manufacturing adoption; the impact of green manufacturing on sustainability performance and competitiveness; the mediating role of variables such as green supply chain management, green innovation, and corporate reputation; and the influence of contextual factors in implementing both approaches, particularly in developing countries.

To enhance the validity and reliability of the review, this study relied on reputable databases and applied consistent selection criteria throughout the SLR process. Additionally, cross-study comparisons were conducted to identify recurring patterns, differences in findings, and potential biases within the existing literature. Through this approach, the review aims to provide a robust, credible, and relevant synthesis for both theoretical development and practical advancement in sustainable manufacturing management.

## **Results and Discussion**

The results of the Systematic Literature Review indicate that the integration of Total Quality Management (TQM) and green manufacturing is increasingly recognized as a strategic approach to enhancing sustainable manufacturing competitiveness. Note: Although multiple studies are referenced throughout the Results and Discussion sections, the systematic synthesis primarily relies on the five studies included in the PRISMA process. Other studies are referenced for contextualization, but they are not part of the final synthesis and analysis. Cross-country empirical studies demonstrate that TQM serves as the foundation of internal management systems, enabling organizations to adopt green manufacturing practices more systematically and consistently [21]. Hasan et al. confirm that TQM positively influences green manufacturing, which subsequently acts as a key mediator in improving organizational performance [7]. These findings suggest that quality and environmental sustainability are not separate agendas but mutually reinforcing elements within modern manufacturing management systems.

This relationship is further strengthened by studies linking the integration of TQM and green practices with sustainable performance and competitive advantage. Masudin et al. found that TQM and green supply chain management significantly contribute to the sustainability performance of manufacturing SMEs, with competitive advantage serving as a key mediating variable [22]. Within this framework, TQM establishes operational discipline and a quality-oriented culture, while green practices extend their impact to environmental and economic dimensions. This perspective aligns with systematic reviews positioning TQM as a dynamic capability that supports organizational sustainability through integration with modern management approaches [21].

In the context of small and medium-sized enterprises, the effectiveness of integrating TQM and green manufacturing is strongly influenced by supporting operational mechanisms. Adam et al. demonstrate that the influence of TQM on environmental performance becomes significant when mediated by green supply chain management, which connects internal quality systems with environmental practices across the supply chain [21]. This finding emphasizes that green manufacturing cannot be optimally implemented without a strong and integrated quality management system. Recent literature also highlights the role of digital transformation and green innovation in strengthening the impact of green manufacturing on firm performance. Khakwani et al. [12] demonstrate that the combination of digital transformation and green manufacturing enhances firm performance through green product innovation as a key mediator [23]. Furthermore, Kouser et al. show that integrating green manufacturing with green technology innovation and eco-design significantly improves environmental sustainability practices, extending green manufacturing's contribution from operational efficiency toward strategic advantage [24], [11]

Under conditions of uncertainty and regulatory pressure, internal organizational capacity becomes a determinant of green manufacturing success. Bui et al. found that green manufacturing performance is strongly influenced by environmental regulations and organizational capability in managing uncertainty, positioning green manufacturing as a long-term strategic orientation in manufacturing industries [25], [26]. This is reinforced by studies in the energy sector indicating that green manufacturing and energy management systems enhance firm performance through carbon emission disclosure, further emphasizing the interconnectedness of quality, environmental management, and performance transparency [21].

The review also demonstrates consistent positive impacts of green manufacturing on sustainability performance. Thoriq et al., through a systematic literature review, conclude that green manufacturing implementation consistently improves sustainability performance, although contextual research gaps

remain in developing countries [21]. Empirical evidence in specific sectors, such as the printing industry, supports these findings, showing that green manufacturing significantly enhances environmental performance through waste reduction and process efficiency improvements [27].

Beyond operational impacts, green manufacturing also has strategic implications for corporate reputation and market performance. Naomi et al. show that the integration of green manufacturing and corporate social responsibility improves firm performance through the mediation of corporate reputation [3]. In the SME context, Munawar et al. find that the integration of TQM and environmental sustainability positively contributes to firms' green performance, indicating that quality and environmental approaches remain relevant even for small-scale enterprises [21].

From a conceptual perspective, the literature also highlights TQM's contribution to achieving sustainable development goals. Fahmi et al. conclude that TQM supports economic, environmental, and social dimensions of sustainability, although implementation challenges related to culture and cost remain [21]. Rahman further demonstrates that the effect of TQM on green performance becomes stronger when mediated by organizational innovation [7].

Quality–environment integration should also extend to the supply chain level. Sutrisna shows that green supply chain management enhances both environmental and economic performance in manufacturing firms, reinforcing the argument that integrating TQM and green manufacturing must encompass the entire production and distribution system [21], [6]. A cross-sector perspective is presented by Wijan et al., who identify leadership, organizational culture, and capabilities as key determinants of sustainability performance [28].

Data-driven approaches in TQM implementation are receiving growing attention. Barragan developed a data-based methodology to monitor TQM effectiveness, which is highly relevant for supporting decision-making in green manufacturing contexts [29]. Furthermore, Asieh et al. show that implementing TQM practices within sustainable supply chain management enhances overall supply chain performance and sustainability outcomes [30].

Systematic reviews on TQM implementation also identify critical success factors relevant to green manufacturing integration. Susmita emphasizes the importance of top management commitment, quality culture, and employee involvement in successful TQM implementation [31]. These findings align with Alawag et al., who demonstrate that management system quality and stakeholder engagement significantly influence successful TQM implementation in industrial projects [32].

Overall, the synthesis confirms that integrating TQM and green manufacturing forms an integrated management system capable of simultaneously enhancing sustainability performance and manufacturing competitiveness. TQM functions as the cultural and capability foundation, while green manufacturing represents the operational manifestation of sustainability commitment. However, the literature also indicates the need for further empirical and longitudinal testing of this integrative model, particularly in developing country contexts.

### **Critical Analysis and Research Implications**

Although the literature generally indicates a positive relationship among TQM, green manufacturing, and manufacturing competitiveness, critical examination reveals several conceptual and methodological limitations.

First, most empirical studies adopt quantitative survey-based cross-sectional designs, limiting the ability to capture long-term and evolutionary dynamics of quality and sustainability implementation [2], [1].

Second, TQM is often treated as a homogeneous construct without considering variations in implementation maturity and organizational context. Rahman [7], for example, finds that TQM does not always significantly affect green performance without mediating mechanisms such as organizational innovation.

Third, although green manufacturing is linked to sustainability performance, most studies focus primarily on environmental and economic dimensions, with limited empirical exploration of social sustainability [20].

Fourth, research is heavily concentrated in developing Asian economies and SME contexts, limiting generalizability. [33]

Methodologically, heavy reliance on SEM and PLS-SEM and self-reported survey data raises concerns regarding subjective bias and common method bias [33].

Conceptually, integration is often treated as linear rather than reciprocal. Future models should reflect dynamic, adaptive, and reciprocal relationships between TQM and green manufacturing [5], [34].

Future research should adopt longitudinal designs, incorporate objective operational data, and consider institutional and social contexts more deeply to provide a more comprehensive understanding of quality–sustainability integration mechanisms.

Based on the thematic synthesis of this Systematic Literature Review, the relationship between TQM and green manufacturing forms an integrative mechanism that significantly contributes to enhancing sustainable manufacturing performance and competitiveness. TQM strengthens leadership, employee involvement, continuous improvement, and data-driven decision-making, thereby enabling effective green manufacturing implementation.

To clarify the conceptual relationships and contribution pathways of each element to manufacturing performance, the synthesized findings are visualized in an integrated TQM–green manufacturing model as illustrated in Figure 1.

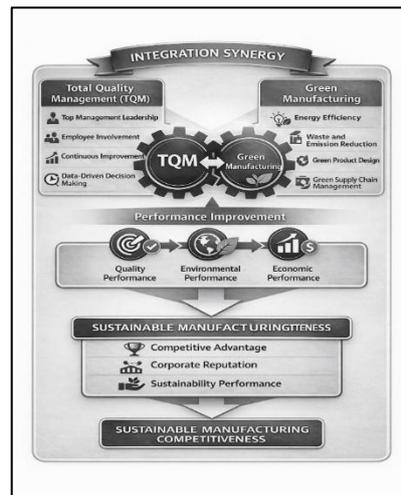


Figure 2. Integration of Total Quality Management dan Green Manufacturing

Figure 2 illustrates an integrative model that demonstrates the synergy between Total Quality Management (TQM) and green manufacturing in enhancing sustainable manufacturing performance and competitiveness. In this model, TQM and green manufacturing are positioned as two interrelated and mutually reinforcing management systems, rather than as standalone approaches. The core elements of TQM—such as top management leadership, employee involvement, continuous improvement, and data-driven decision-making—function as organizational enablers that create internal readiness for the implementation of green manufacturing practices.

On the other hand, green manufacturing is represented through practices such as energy efficiency, waste and emission reduction, green product design, and green supply chain management. The integration of these two approaches results in multidimensional manufacturing performance improvement, encompassing quality performance, environmental performance, and economic performance. These three performance dimensions simultaneously contribute to achieving sustainable manufacturing competitiveness, reflected in enhanced competitive advantage, improved corporate reputation, and overall sustainability performance.

This visual model emphasizes that the success of green manufacturing largely depends on the maturity level of TQM implementation, while the effectiveness of TQM in the context of global competition is further strengthened through integration with environmental sustainability practices. Therefore, the figure not only represents the outcome of the literature synthesis but also proposes a conceptual framework that may serve as a foundation for future empirical research and as a strategic guideline for manufacturing practitioners in designing integrated quality and environmental management systems.

#### Classification of Main Theoretical Foundations

1. Total Quality Management (TQM):  
Focuses on continuous improvement, customer orientation, leadership, and employee involvement. It is often positioned as the foundation for improving both operational and strategic performance.
2. Green Manufacturing:

Aims to reduce environmental impact, improve energy efficiency, and implement environmentally friendly practices. It is associated with sustainability performance, cost efficiency, and long-term competitive advantage.

The State-of-the-Art Table is developed to provide a concise overview of recent studies relevant to the integration of Total Quality Management (TQM) and green manufacturing.

**Table 2.** State of the art

<b>Author(s)</b>	<b>Country</b>	<b>Methodology</b>	<b>Key Findings</b>
Hasan et al. (2021)	Indonesia	Empirical Study	TQM has a positive effect on green manufacturing and sustainability performance.
Masudin et al. (2025)	Indonesia	SEM–fsQCA	TQM and green supply chain management significantly contribute to sustainability performance.
Adam et al. (2022)	Indonesia	Empirical Study	TQM enhances environmental performance through green supply chain management as a mediating mechanism.
Khakwani et al. (2024)	Pakistan	Empirical Study	Digital transformation and green manufacturing improve firm performance.
Bui et al. (2024)	Vietnam	Hierarchical Modeling	Environmental regulations and organizational capacity influence the success of green manufacturing implementation.

This article contributes to the literature by developing an integrative conceptual framework to better understand the synergy between Total Quality Management (TQM) and green manufacturing. It positions TQM as a critical enabler of the successful adoption of green manufacturing practices, offering a novel perspective within the existing body of literature. Rather than treating quality management and environmental practices as parallel or independent initiatives, this study conceptualizes TQM as a foundational organizational capability that drives the effectiveness of green manufacturing implementation.

From a practical standpoint, this study provides actionable insights for manufacturing managers, particularly in developing countries, on how to integrate TQM principles with green manufacturing practices to enhance sustainability performance, operational efficiency, and market competitiveness. The findings offer strategic guidance for aligning internal quality management systems with environmental initiatives, thereby supporting long-term competitive positioning in increasingly sustainability-driven markets.

The uniqueness of this study lies in its integrative approach, combining two domains that have traditionally been examined separately: Total Quality Management (TQM) and green manufacturing. By positioning TQM as a driver of green manufacturing implementation, this research highlights the positive impact of its synergy on manufacturing competitiveness and sustainability performance. This study addresses a gap in the literature, where TQM and green manufacturing have largely been discussed independently, and proposes a new conceptual framework that may serve as a foundation for future empirical research, particularly in the context of developing countries.

### **Conclusion**

This article presents a Systematic Literature Review (SLR) on the integration of Total Quality Management (TQM) and green manufacturing in the context of enhancing sustainable manufacturing competitiveness. Based on the synthesis of recent studies, it can be concluded that integrating these two approaches represents a relevant and increasingly important managerial strategy in responding to global competitive pressures, environmental regulatory demands, and stakeholder expectations for sustainable manufacturing practices.

The findings indicate that TQM serves as the foundation of organizational capabilities that enable the adoption and effective implementation of green manufacturing practices. Core TQM principles—such as top management leadership, employee involvement, continuous improvement, and data-driven decision-making—create an organizational environment conducive to the successful implementation of environmentally friendly production practices. In this context, green manufacturing emerges as the

operational manifestation of quality and sustainability commitment, simultaneously enhancing environmental performance, economic performance, and overall sustainability performance in manufacturing firms.

The review also confirms that green manufacturing functions as a key mechanism bridging the relationship between TQM and manufacturing competitiveness. Green manufacturing practices not only contribute to environmental impact reduction but also promote resource efficiency, green product innovation, enhanced corporate reputation, and competitive differentiation in the market. The integration of complementary approaches—such as green supply chain management, organizational innovation, and digital transformation—further strengthens the strategic impact of TQM and green manufacturing integration.

Although the literature generally supports the positive relationship among TQM, green manufacturing, and sustainable performance, this review identifies several limitations and research gaps. Most existing studies rely on cross-sectional designs and perceptual data, limiting their ability to explain long-term dynamics and complex causal relationships. Furthermore, variations in organizational context, levels of TQM implementation maturity, and institutional differences across countries remain underexplored, particularly regarding their influence on the success of quality–sustainability integration. Based on these findings, future research is encouraged to develop more dynamic and integrative models that consider reciprocal relationships between TQM and green manufacturing, as well as contextual factors such as organizational culture, leadership, regulatory environments, and technological readiness. Longitudinal studies and the incorporation of objective operational data are also necessary to capture the long-term impacts of integrating these two approaches on manufacturing competitiveness. Additionally, expanding research to include the social dimension of sustainability—such as occupational safety and employee well-being—will enrich understanding of how TQM and green manufacturing integration contribute to holistic sustainable development.

Overall, this article contributes by providing a systematic and critical synthesis of the literature on TQM and green manufacturing integration and by emphasizing the importance of an integrated management approach in building sustainable manufacturing competitiveness. The findings and proposed research agenda are expected to serve as a reference for both academics and practitioners in developing more effective and contextually grounded quality and sustainability strategies.

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