



# Transformational Leadership and Sustainability Performance: Mediating Role of Green Process Innovation

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**Abstract.** Transformational leadership has been widely studied across various contexts, yet its impact on work-related outcomes in Indonesia's manufacturing sector remains underexplored. This study investigates the influence of transformational leadership on sustainability performance, with a particular focus on green process innovation as a mediating factor. Drawing on responses from 391 managers in Indonesian manufacturing firms, the research examines how transformational leadership affects sustainability performance, as well as its relationship with green product and process innovation. The results indicate that transformational leadership positively influences sustainability performance. Moreover, green process innovation mediates the relationship between green product innovation and sustainability performance. These findings suggest that transformational leadership not only directly enhances sustainability performance but also fosters a culture of innovation that supports green initiatives. For practitioners, this study highlights the importance of cultivating transformational leadership to drive green product and process innovations. Such initiatives can lead to long-term sustainable outcomes in the manufacturing industry. Consequently, manufacturers should view green product development as a strategic pathway toward sustainability. Furthermore, managers are encouraged to deepen their understanding of the interconnections among transformational leadership, green process innovation, green product innovation, and sustainability performance to better navigate the shift toward more environmentally responsible practices.

**Keywords:** Transformational Leadership, Green Product Innovation, Green Process Innovation, Sustainability Performance, Manufacture.

## 1 Introduction

Several scholars argue that companies that embrace environmentally friendly and resource-efficient practices, along with fostering green creativity and innovation, will gain competitive advantages, including enhanced corporate reputation and increased market share [1,2,3]. Environmental sustainability is crucial and presents opportunities to boost competitiveness through mutually beneficial strategies [4].

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However, there is a lack of literature examining how different leadership styles impact corporate sustainability. Some studies have indicated that the attitudes of leaders and organizations toward environmental issues influence the development of innovative and eco-friendly ideas. Transformational leadership encourages and motivates employees to adopt environmentally friendly behaviors, such as being mindful of water and paper usage and maintaining sustainable practices. We propose that manufacturers should cultivate transformational leadership alongside green product and process innovations to enhance sustainability performance. While previous literature has extensively addressed these topics, the relationship between transformational leadership, green product innovation, green process innovation, and sustainability performance requires empirical validation.

Research by [5] found that high levels of transformational leadership positively influence the development of green products. Green innovation enables companies to align environmental objectives with their business goals [6]. It refers to the creation of hardware or software aimed at developing environmentally friendly products or processes, including technological advancements that promote energy conservation, pollution prevention, waste recycling, green product design, and corporate environmental management. Implementing environmentally conscious innovations through green practices offers companies long-term financial benefits and a competitive sustainability advantage. Green innovation drives economic growth and progress, encompassing changes in products, processes, technologies, and services to reduce environmental harm and optimize resource use [7].

Green product innovation aims to modify product designs by incorporating non-toxic substances or biodegradable materials during manufacturing to reduce disposal impacts and enhance energy efficiency [8]. Previous studies have demonstrated that transformational leadership can significantly enhance innovation performance within organizations [9]. Additionally, transformational leadership positively influences organizational innovation [10].

Green product innovation necessitates a fresh perspective on the entire product lifecycle, which includes manufacturing, distribution, usage, disposal, and reuse/recycling. Essentially, it calls for a comprehensive "cradle-to-grave" approach [11]. This type of innovation can also be seen as a means to improve companies' environmental management processes, encompassing any technological, organizational, sociological, or institutional changes that reduce environmental impacts. Examples of environmental practices include waste management, energy efficiency [12], environmental training programs, sustainable procurement, and pollution reduction [13,14]. Furthermore, [8] conducted research in the automotive industry, showing that green product innovation positively influences business performance.

[15] emphasizes that the focus on sustainable transitions has become a significant area of research within socio-technical systems and technological innovation, outlining the shift towards sustainable alternatives. Literature on strategic sustainability behavior indicates that many organizations are eager to embrace new concepts like sustainability and actively adjust their business practices to align with these ideals. Companies leading the way in developing innovative green technologies can achieve and sustain various competitive advantages, attaining both cost efficiency and profitability [16,17].

Previous research has shown a strong correlation between a company's process innovation and its product innovation [18]. We propose a positive relationship between

green process innovation and green product innovation for several reasons. Green process innovation requires comprehensive improvements in operational and managerial practices to optimize resource efficiency [19]. This, in turn, supports the development and production of environmentally friendly products and creates a framework for implementing green product innovation. According to [20], adopting green process innovations can help companies succeed in creating new eco-friendly products by establishing a competitive advantage in the green market. Furthermore, process innovation can assist companies in improving product quality, expanding their product lines, or developing entirely new products, thereby increasing their market share [21,22]. Thus, process innovation is crucial for driving product innovation.

Green process innovation is typically derived from internal sources and tends to be more costly to implement; however, it has proven to be more effective than other green initiatives. This type of innovation improves existing production processes or introduces new ones to reduce negative environmental impacts, thereby enhancing a company's environmental compliance and providing benefits through competitive differentiation [23]. Previous research has shown that implementing green process innovations positively affects sustainability performance [6,23].

Green process innovation emphasizes reducing energy consumption during manufacturing and converting waste into valuable products [24]. While green process innovation typically originates from internal sources and can be more expensive, it has demonstrated greater effectiveness compared to other green initiatives. This type of innovation requires systematic improvements across all operational and managerial processes [19].

Green process innovation improves current production processes or introduces new methods to minimize environmental impacts, thereby enhancing a company's environmental compliance and providing competitive differentiation. Consequently, product innovation is significantly influenced by process innovation. Furthermore, prior studies have shown that implementing green process innovation enhances organizations' competitive advantage and sustainability.

Based on the theoretical framework and prior empirical findings, the following hypotheses are proposed:

- H1: Transformational leadership is positively correlated to green product innovation.
- H2: Green product innovation is positively correlated to sustainability performance.
- H3: Green product innovation is positively correlated to green process innovation.
- H4: Green process innovation is positively correlated to sustainability performance.
- H5: Green process innovation mediates the relationship between green product innovation and sustainability performance.

## 2 Methods

This study uses a quantitative methodology to collect data to build linkages between constructs and demonstrate the links among the variables being investigated. The population is defined by a representative subset known as a sample and exhibits characteristics that are representative of the entire population. Given the constraints of time and resources, it was not feasible to gather information from the entire population. Hence, a random sampling technique was employed to gather and scrutinize the data [25].

The research data was collected from 392 leaders of manufacturing businesses in Indonesia. We utilized a stochastic sampling technique to select the organizations that were surveyed. The survey began in January 2024 and ended in April 2024, lasting for four months. The data was gathered at a certain moment, suggesting that the study is cross-sectional.

The variables in our study were assessed using established and reliable measures consisting of multiple items. Each scale adhered to a Likert 5-point scale, where a rating of 1 represents strong disagreement and a rating of 5 represents strong agreement.

Transformational leadership (TL) was measured using the framework established by [26, 27, 28], which included eight items covering idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. The measurement of sustainability performance (SP) was conducted using an established scale that comprises three components. The measurement of green product innovation (GPD) was carried out using the scale developed by [6], which includes four components. The Green Process Innovation (GPI) scale was also utilized from [6] and included four items.

## 3 Results and Discussion

A total of 400 questionnaires were distributed through on-site surveys, WhatsApp, and email, resulting in 392 valid responses. Among the 392 participants, 48.3% were female and 51.7% were male. In terms of age distribution, 28.6% of individuals were between 20 and 30 years old, 47.6% were between 30 and 40, and 21% were between 40 and 50. Regarding work experience, 12.3% of individuals had less than three years of experience, approximately 30.9% had 3 to 5 years, and 51.7% of respondents had between 5 and 10 years of experience.

Four distinct criteria were used to analyze both the direct and indirect effects of the SEM. The initial stage involves assessing the  $R^2$  level for endogenous latent constructs to determine the extent to which all factors account for the variance [29].

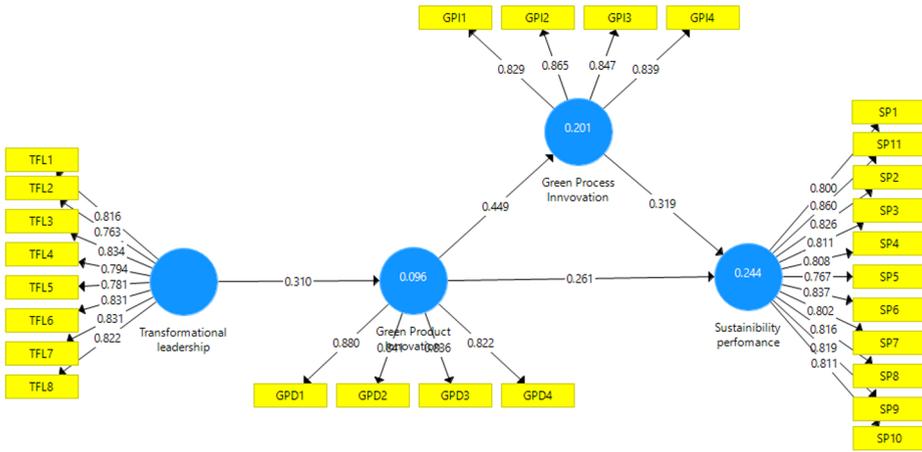


Fig. 1. Measurement results

Table 1. Coefficient of determination in the PLS method

	Green Process Innovation	Green Product Innovation	Sustainability Performance	Transformational Leadership
Green Process Innovation				
Green Product Innovation	0.515			
Sustainability Performance	0.473	0.442		
Transformational Leadership	0.316	0.335	0.676	

Table 2. Results of the structural equation model

Hypothesis		B	Mean	Standard Deviation	t-values	p-values
<b>Direct Effect</b>						
H1	TFL -> GPD	0.310	0.314	0.068	4.571	0.000
H2	GPI -> SP	0.261	0.259	0.075	3.476	0.001
H3	GPD -> GPI	0.449	0.453	0.052	8.851	0.000
H4	GPI -> SP	0.319	0.321	0.066	4.850	0.000
<b>Indirect effect</b>						
H5	GPD->GPI->SP	0.143	0.416	0.036	3.965	0.000

Note(s): Abbreviation: Transformational Leadership (TFL), Green Process Innovation (GPI), Green Product Innovation (GPD), Sustainability Performance (SP)

This study investigates transformational leadership's direct and indirect impacts on sustainability performance and has derived the following findings. Starting with the direct effects, we find that transformational leadership has a highly significant influence on green product innovation. This suggests that increasing transformational leadership will considerably boost green product innovation. This finding aligns with the research of [9] which shows that transformational leadership can successfully enhance an organization's innovation performance. Employees are required to actively engage in the development of new environmentally friendly products or the enhancement of existing products using sustainable methods to achieve green product innovation.

Additionally, we find that green product innovation has a significant positive impact on sustainability performance. An increase in the development of green product innovation greatly enhances sustainability performance. The main goal is to reduce adverse environmental impacts throughout the product life cycle. Organizations that adopt a sustainability-oriented approach and lead in developing innovative green technologies can achieve and maintain various competitive advantages [16].

Second, the results indicate that green product innovation positively and significantly affects green process innovation. This suggests that enhancing green product innovation will substantially improve green process innovation. These findings correspond with previous research indicating that green process innovation requires significant improvements in operational and managerial practices to optimize resource efficiency [19]. Third, green process innovation is shown to significantly impact sustainability performance. Enhancements in green process innovation will markedly affect sustainability performance. This finding is consistent with earlier studies [6, 23] demonstrate the positive influence of green process innovation on sustainability performance.

The analysis of indirect effects reveals that green product innovation has a strong positive indirect impact on sustainability performance through green process innovation. This indicates that green product innovation fosters green process innovation, which, in turn, significantly enhances sustainability performance. This aligns with [20], who noted that implementing green process innovation can provide companies with a competitive advantage in producing new green products.

## 4 Conclusions

This study confirms both the direct and indirect effects of transformational leadership on sustainability performance through the mediating roles of green product and green process innovation. The findings highlight that transformational leadership significantly fosters green product innovation, which in turn directly enhances sustainability performance and indirectly boosts it by stimulating green process innovation. Moreover, the study establishes that green product innovation not only contributes to sustainability outcomes but also acts as a driver for green process innovation, which itself has a substantial impact on sustainability performance. These results emphasize the strategic importance of cultivating transformational leadership to promote innovation practices that align with environmental sustainability goals. By understanding these relationships, organizations—particularly within the Indonesian manufacturing sector—

can better leverage leadership and innovation capabilities to achieve long-term sustainable performance and gain competitive advantages in green-oriented markets.

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