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Green Innovation and Firm Performance: A Systematic Literature Review

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Abstract.
The rise of industrialization has brought significant side effects, notably climate change and global warming. In response, green innovation has emerged as a crucial strategy for industrial firms to mitigate these negative environmental impacts. However, many firms, particularly in developing countries, perceive green innovation as offering limited benefits to their performance, leading to its underutilization. This study systematically reviews the literature on green innovation and firm performance, aiming to clarify the definitions, dimensions, and relationship between these two variables. Data were collected from peer-reviewed articles published between 2014 and 2024 in reputable databases such as Emerald and ScienceDirect. The findings reveal the following: (1) Definition: green innovation is defined as environmentally oriented process and product, while the definition of firm performance varies considerably; (2) Dimensions: green innovation is commonly categorized into Green Process Innovation and Green Product Innovation, while profitability is the most frequently used indicator of firm performance; (3) Relationship: the majority of studies find a positive relationship between green innovation and firm performance, although some report that green process innovation may negatively affect firm performance.

Keywords: green innovation, firm performance, PRISMA flow

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1. INTRODUCTION

Industrialization, which began in the 19th century, has generally been perceived as a panacea, leading many countries to promote industrialization as a means to accelerate economic growth (1,2). However, the extensive development of industrialization has also triggered side effects, such as environmental degradation, climate change, and global warming. If these issues are not addressed, they may threaten sustainable performance at both macro and micro levels (3–6). The negative consequences of

industrialization have become a significant topic of study for society, academics, and governments, culminating in the implementation of the Paris Agreement by the United Nations in 2015 (5,7,8). The heightened focus on environmental issues has resulted in increased pressure on firms worldwide to mitigate their environmental impacts through the adoption of sustainable development practices (6,8,9). Sustainable development, which emphasizes environmental considerations, presents a significant challenge for firms, as it necessitates not only a commitment to ecological sustainability but also an enhancement of financial performance to meet shareholder interests (4,10). To achieve these dual objectives, optimal financial performance and sustainable development, many firms have adopted green innovation, a concept that has attracted considerable attention in recent literature (3,11–13).

The designation of the green innovation concept arises from the understanding that conventional innovations, while capable of enhancing productivity and firm performance, often entail the extensive exploitation of natural resources, leading to inevitable environmental degradation (14,15). Therefore, the concept of green innovation can be regarded as the antithesis of conventional innovation, characterized by innovative practices such as waste recycling, energy conservation, non-polluting production, and other methods that promote sustainable development (16,17). Moreover, green innovation is viewed as a concrete effort to comply with environmental regulations established by the state, and it is also perceived as a fulfillment of corporate social responsibility aimed at fostering a clean environment (9,18).

Through green innovation, firms also obtain various strategic benefits, including enhanced reputation and legitimacy in the market, which signals that the firm is committed to long-term sustainability (6,11,19). However, despite the positive impact of green innovation on firm performance, several previous studies have indicated otherwise. The negative relationship between these two variables may arise from the complexities, costs, and high uncertainty risks associated with the implementation of green innovation, which can potentially erode firm profitability significantly (8,9,13). In developing countries, the implementation of green innovation is particularly challenging, as consumers tend to be more price-sensitive to environmentally friendly products that are often more expensive (3,20).

Furthermore, a review of existing literature on green innovation and firm performance reveals a lack of systematic studies examining this relationship through literature reviews. Consequently, this study was developed to address this gap. Based on this

background, the aim of this study is to analyse the definitions, dimensions, and the relationship between these two variables.

2. METHODOLOGY

The method employed in this study is descriptive qualitative, utilizing a literature study approach. In conducting the literature review, we applied the PRISMA Flow model to select the articles under review, which involves identifying, screening, and assessing the eligibility of relevant studies (21,22). The selection of the PRISMA Flow model was motivated by its widespread use among scholars conducting literature reviews and its ability to ensure that the description of objectives is directed, focused, and systematic (22,23).

In selecting articles using the PRISMA Flow model, we initially determined that only articles published in two major databases, ScienceDirect and Emerald, between 2014 and 2024 would be included. Subsequently, we identified articles by entering the keywords “Green Innovation” and “Firm Performance” in the ScienceDirect database and “Green Innovation” AND “Firm Performance” in the Emerald database. In the second stage of the PRISMA Flow process, we screened the articles selected in the previous step. In conducting this screening, we established inclusion and exclusion criteria for article selection, which include:

TABLE 1: Screening Stage - Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Article only	Non-article publications were not reviewed
The search was entered only in the Title column	The search in non-title columns (e.g., All Fields, Abstract) was not reviewed
Relates to green innovation and/or firm performance	Articles unrelated to Green Innovation and/or Firm Performance were not reviewed
Publication period 2014-2024 only	Publications not within the 2014-2024 period were not reviewed
English only	Non-English articles were not reviewed

In the final stage of the PRISMA Flow model, we assessed the eligibility of the articles selected from the previous process. In conducting this assessment, we included only those articles that contained one or more definitions, dimensions, and relationships pertaining to the two variables. Upon completion of all these stages, we identified a

total of 12 articles that met the criteria of the PRISMA Flow model, which subsequently served as the foundation for achieving the objectives of this study (see Figure 1).

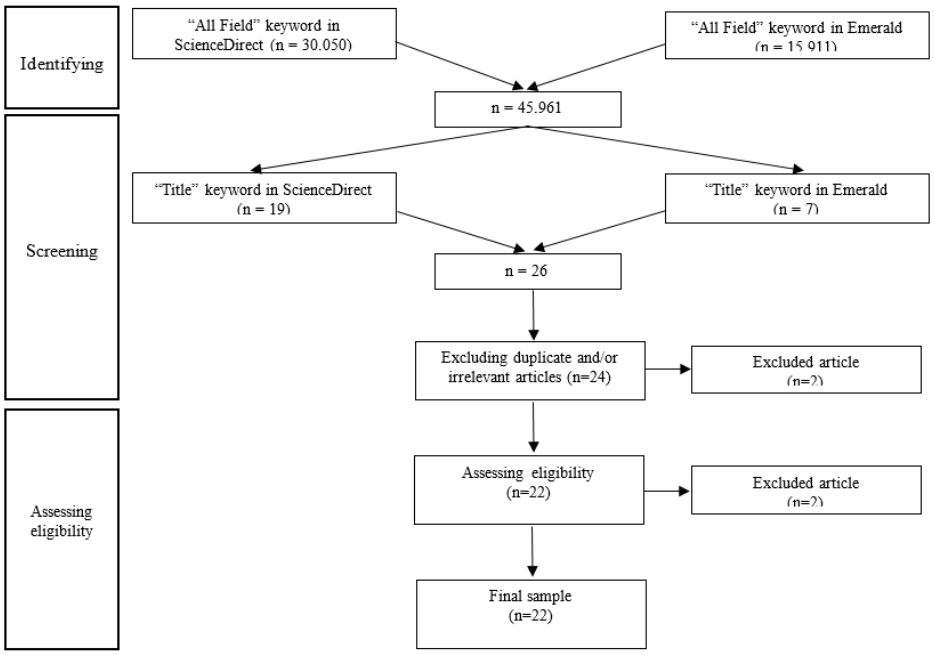

Figure 1: Sample Selection in PRISMA Flow Model.

3. RESULTS & DISCUSSIONS

This chapter presents the findings and discusses them in relation to the study's objectives, beginning with the definitions, followed by the dimensions, and concluding with the relationships between the two variables, which will be elaborated upon in the subsequent sections.

3.1. Definitions of Green Innovation and Firm Performance

Based on our findings, 10 articles have discussed the definition of green innovation (see Table 2). Although green innovation encompasses various definitions, the keywords "process" and "environment" consistently appear in each definition; the term "process" is mentioned in 9 out of 10 articles, while "environment" is referenced in all ten. This suggests that firms often prioritize business objectives while neglecting their surrounding environment (3,24) Therefore, the emphasis on the terms "process" and "environment" can be interpreted as an indication that green innovation involves

conducting work and production processes in a manner that mitigates environmental damage (12,14,25)Moreover, the focus on work processes can encompass efficiency in energy consumption, pollution prevention, and waste recycling, as highlighted in various definitions of green innovation (14,26,27). It is well known that firms, particularly in the manufacturing sector, frequently consume significant amounts of energy, produce substantial pollution, and generate non-recyclable waste (3,4,28).

Table 2: Definitions of Green Innovation.

Scholars	Definitions of Green Innovation
Asni & Agustia (2022)	Innovations aimed at mitigating environmental damage encompass all aspects, from the production process to the development of environmentally friendly products (11).
Huang et al (2024)	Innovations implemented by firms to achieve profitability or to mitigate negative environmental impacts include methods, work processes, systems, equipment, and the products developed (12).
Shehzad et al (2023)	Environmentally sustainable processes designed to achieve financial benefits (4).
Chen et al (2024)	A series of innovations that encompass environmentally friendly processes and products aimed at reducing environmental damage, including the mitigation of air pollution and carbon emissions resulting from operational activities (25).
Junaid et al (2021)	Innovation that leverages technology for work processes and products, particularly in the contexts of pollution reduction, energy efficiency, green product design, environmental management, and waste recycling (26).
Le (2022)	The organization's efforts to prevent environmental degradation encompass pollution prevention, resource conservation, and waste reduction (14).
Roh et al (2022)	Innovations in processes, products, services, management methods, and business practices that are environmentally oriented (29).
Vasileiou et al (2022)	A series of innovations that span from the input process to the output, aimed at reducing the environmental impact resulting from the firm's operational activities (28).
Zhang & Ma (2021)	An environmentally oriented adaptation of processes and products that encompasses energy efficiency, pollution prevention, sustainable product design, and waste recycling (27).
Zhang et al (2019)	Innovation pertaining to the application of advanced technology in processes and products, which contributes to environmental enhancement and corporate sustainability (13).

The next keyword frequently mentioned in these definitions is "product," which appears in 7 out of 10 articles. The pairing of the terms "product" and "environment" indicates that green innovation emphasizes the need for the products produced by

firms to be environmentally oriented and sustainable (13,25,29). Therefore, in product development, firms must ensure that the products are recyclable to minimize pollution potential. Additionally, the energy sources utilized in producing these products should be more efficient and consume less energy (11,26). From these findings, it can be inferred that green innovation is generally associated with the keywords "process," "product," and "environment," suggesting that green innovation encompasses both environmentally oriented processes and products.

Furthermore, the definition of firm performance is not extensively discussed in the articles included in the sample, with only 3 out of 22 articles addressing this topic (see Table 3). Firm performance is fundamentally derived from the Resource-Based View theory (11,24). Based on their definitions, the three articles offer distinct interpretations of firm performance. According to Asni and Agustia (2022), firm performance primarily pertains to economic impacts such as profitability and asset growth (11). In contrast, Amores-Salvado (2014) interprets performance as a means of evaluating management effectiveness (30), while Abbas and Khan (2023) define performance as a reflection of the firm's ability to achieve targets set by shareholders (31).

Table 3: Definitions of Firm Performance.

Scholars	Definitions of Firm Performance
Asni & Agustia (2022)	The economic impact resulting from the strategic policies implemented by the firm (11).
Amores-Salvado (2014)	A method for historically assessing how a firm has adapted to its operational challenges to maximize shareholder wealth (30).
Abbas & Khan (2023)	A reflection on the firm's capacity to mobilize all its resources to achieve the targets established by shareholders (31).

3.2. Dimensions of Green Innovation and Firm Performance

Regarding the dimensions of green innovation, out of the 22 articles reviewed, 15 contain dimensions related to green innovation. Our analysis indicates that the most widely used dimension, as reported in 5 articles, is the number of green innovation patents, which refers to the total patents granted annually. Moreover, the dimension of Green Process Innovation is utilized in 4 articles. The emphasis on the term "process" aligns with our earlier discussion on the definition of green innovation. The dimension of Green Process Innovation can be further delineated into various indicators, including pollution reduction, electricity and water efficiency, utilization of recycled materials,

minimal energy consumption, conducting environmental campaigns, and the adoption of cleaner technologies (11,26,29).

In the assessment of green innovation, Green Process Innovation is often paired with Green Product Innovation, as observed in 3 articles. However, in the study by Junaid et al. (2024), this dimension is specifically coupled with Green Managerial Innovation (26). If examined in greater detail, Green Product Innovation can encompass several indicators, such as designing environmentally friendly production materials, utilizing biodegradable product packaging, modifying product designs for energy efficiency, and employing non-hazardous raw materials (11,29).

Table 4: Dimensions of Green Innovation.

Scholars	Dimensions of Green Innovation
Asni & Agustia (2022)	- Green Product Innovation - Green Process Innovation (11)
Khancel et al (2023)	- Number of green innovation patents (19)
Maldonado-Guzman et al (2019)	- Investments in eco-innovation - Awareness of eco-innovation - Ownership of eco-innovation information distribution - Regular eco-innovation training - Participation in eco-innovation project development - Consistent implementation of eco-innovation - Encouragement of eco-innovation among vendors (3)
Shehzad et al (2023)	- Exploitative green innovation - Exploratory green innovation (4)
Chen et al (2024)	- A dummy variable that assumes a value of 1 if the firm engages in innovation and a value of 0 if it does not (25)
Cheng et al (2024)	- Number of green innovation patents (7)
Junaid et al (2021)	- Green Process Innovation - Green Managerial Innovation (26)
Le (2022)	- Increased research on green standards - Energy-efficient production processes - Environmentally friendly packaging - Utilization of renewable energy in production activities - Implementation of waste processing technology in accordance with international standards (14)
Li et al (2023)	- The logarithm of the green innovation levels of peer firms (32).
Rehman et al (2021)	- Green Product Innovation - Green Process Innovation (33)
Roh et al (2022)	- Green Product Innovation - Green Process Innovation (29)
Vasileiou et al (2022)	- Environmental Innovation Supply Sides - Environmental Innovation Demand-Side (28)
Zhang & Ma (2021)	- Number of green patents (27)
Zhang et al (2019)	- Number of green innovation patents - Number of green innovation citations (13)
Yang et al (2023)	- (Log) Number of green innovation patents (16)

Meanwhile, regarding firm performance, we identified 14 articles (out of the 22 reviewed) that delineate the dimensions of this variable. The most frequently utilized dimension is profitability, referenced in 11 articles. We categorize Return on Assets (ROA) and Return on Equity (ROE) as dimensions of profitability, as both metrics serve

as tools for measuring how effectively a firm manages its assets and capital to generate returns over a specified period. The prevalent use of the profitability, ROA, and ROE dimensions as indicators of firm performance indicates that the establishment of a firm is fundamentally aimed at achieving profitability to maximize shareholder wealth. However, profitability is not the sole criterion for assessing firm performance; other dimensions, such as Tobin's Q, sales growth, cash flow enhancement, market share, and Return on Capital Employed (ROCE), may also be employed as evaluative measures.

Table 5: Dimensions of Firm Performance.

Scholars	Dimensions of Firm Performance
Khancel et al (2023)	- Return on Assets (19)
Asni & Agustia (2022)	- Return on Assets - Return on Equity (11)
Maldonado-Guzman et al (2019)	- Increased economic benefits - Increased profits - Increased return on investment - Increased sales volume - Increased sales performance - Increased cash flow (3)
Abbas et al (2024)	- Customer interaction - Market position of the firm - Financial indicators (34)
Amores-Salvado (2024)	- Return on Assets - Return on Equity - Return on Capital Employed (30)
Chen et al (2024)	- Return on Assets - Tobin's Q (25)
Cheng et al (2024)	- Return on Assets (7)
Junaid et al (2021)	- Return on Assets - Return on Equity (26)
Lee & Min (2015)	- Tobin's Q (24)
Lin et al (2019)	- Return on Assets - Return on Equity - Return on Sales (35)
Ma et al (2021)	- Return on Assets (36)
Marco-Lajara et al (2023)	- Market share - Sales revenue - Profit margin - Financial result (37)
Zhang et al (2019)	- Firm profitability - Sales growth rate (13)
Yang et al (2023)	- Tobin's Q (16)

3.3. The Relationship between Green Innovation and Firm Performance

In examining the relationship between green innovation and firm performance, we identified 6 articles from the total sample of 22. Our findings indicate that the countries represented in these 6 studies are not limited to developed nations such as the United States and China, but they also include developing countries such as Pakistan, Mexico, and various ASEAN countries. Furthermore, we observed that nearly all the articles suggest a positive effect of green innovation on firm performance. This finding highlights

that green innovation can significantly enhance firm performance, even in the context of developing countries. However, the study by Junaid et al. (2022), which divided green innovation into two dimensions, showed inconsistent results regarding their influence on firm performance (26). Specifically, while the Green Managerial Innovation dimension positively impacts firm performance, the Green Process Innovation dimension resulted in a negative effect (26).Given these ambiguous findings, further investigation into the effect of green innovation on firm performance is warranted.

TABLE 6: The Relationship between Green Innovation and Firm Performance.

No	Scholars	Locus	Countries	Findings
1	Cheng et al (2024)	3.314 public firms	United States of America	Green innovation positively impacts firm performance (7).
2	Junaid et al (2022)	296 manufacturing firms	Pakistan	Green innovation is represented by two dimensions: Green managerial innovation, which positively impacts firm performance. Green process innovation, which negatively impacts firm performance (26).
3	Zhang et al (2019)	764 manufacturing firms	China	Green innovation positively impacts firm performance (13).
4	Asni & Agustia (2022)	374 public firms	6 negara ASEAN	Green innovation positively impacts firm performance (11).
5	Khancel et al (2023)	211 firms listed on the S&P 500	United States of America	Green innovation positively impacts firm performance (11).
6	Maldonado-Guzman et al (2019)	460 firms listed on the Mexican Association of the Automotive Industry (AMIA)	Mexico	Green innovation positively impacts firm performance (3).

4. CONCLUSIONS

Many countries today are promoting industrialization to enhance their economic growth. However, rapid industrialization often results in significant negative consequences, such as severe environmental degradation, accelerated climate change, and global warming. In response to these challenges, the 2015 Paris Agreement was established to encourage countries and corporations worldwide to commit to preventing environmental harm through the implementation of sustainable development practices.

To support sustainable development and achieve optimal economic, numerous firms are adopting an innovation known as green innovation. Existing literature indicates that

many firms engaged in green innovation realize positive impacts on firm performance. However, some studies have also revealed that green innovation may have a negative effect on firm performance, particularly in developing countries where consumers are more sensitive to the costs associated with environmentally friendly products. Moreover, prior study addressing the relationship between green innovation and firm performance has not systematically examined this issue through literature studies. This study seeks to fill that gap by exploring the definitions, dimensions, and relationships between green innovation and firm performance.

In conducting this study, we employed a descriptive qualitative method utilizing a literature study approach. To facilitate the literature review, we applied the PRISMA Flow model, which is widely recognized among Scholars. The model was chosen to ensure a more directed, focused, and systematic exploration of the study objectives. The stages of the PRISMA Flow process include identifying, screening, and assessing the eligibility of relevant studies. Furthermore, this study draws data from two reputable article databases, namely ScienceDirect and Emerald, with the sample selection limited to articles published between 2014 and 2024.

The findings of this study indicate the following: (1) Definitions. The definitions of green innovation are varied, however, the keywords “process,” “product,” and “environment” are consistently emphasized, indicating that green innovation encompasses both processes and products aimed at promoting environmental sustainability. The definitions of firm performance also demonstrate diversity. The firm performance can be interpreted as the economic impact of firm policies, as well as a means of evaluating and reflecting on the ability to achieve targets set by shareholders. (2) Dimensions. The dimensions of green innovation are also diverse, but the most frequently cited dimensions among previous scholars are Green Process Innovation and Green Product Innovation. Meanwhile, the dimensions of firm performance most commonly referenced are profitability, Return on Assets (ROA), and Return on Equity (ROE). (3) Relationship. Our findings reveal that nearly all articles indicate a positive impact of green innovation on firm performance. This suggests that green innovation can significantly contribute to firm performance, even for firms operating in developing countries. However, some studies report contrasting results, indicating that green (process) innovation may negatively influence firm performance.

This study has limitations, as it exclusively examines green innovation and firm performance through literature studies. We recommend that future study investigate these two variables empirically, particularly among firms operating in developing countries.

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