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Exploring a Pathway to Sustainable Performance in Manufacturing Firms: The Interplay between Innovation Capabilities, Green Process, Product Innovations and Digital Leadership

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Abstract: In recent years, advancing industrialization and rapid climate change have considerably influenced the global consumption pattern of natural assets. Undoubtedly, this massive utilization of natural resources and hazardous environmental emissions have profoundly curbed the worldwide socio-economic context, substantially causing this ecological burden to amplify the harmful effects on countries' prosperity. This study aims to improve the sustainable performance of manufacturing firms in Pakistan through innovation capabilities and green process innovation. The study has adopted a quantitative approach, and data has been accumulated through a structured questionnaire distributed among 299 employees working in manufacturing firms. A structural equation model using Smart PLS software was used to analyze the collected data from the respondents. The results have identified a significant correlation between innovation capabilities, green process innovation, and sustainable performance. The buffering role of digital leadership enhances the employees' creative skills and sustainable performance. Additionally, the extent that green product innovation plays a mediating role between innovation capabilities, green process innovation, and sustainable performance has been contemplated. Henceforth, the current study also analyzes the moderating role of digital leadership in sustainable performance.

Keywords: green production; green innovation; sustainability; digital leadership; manufacturing firms

1. Introduction

The current environment situation has led the leading global industries to immediately respond to the emerging environmental challenges [1], thus ensuring firms' sustainable performance. In particular, the increased social, economic, and ecological concerns have made consumers, manufacturers, and global communities realize the severity of climate change, thus leading worldwide manufacturing firms to make collective efforts to mitigate environmental damage [2]. The manufacturing division is a dominant waste-producing sector, threatening the firm's vitality. Therefore, in the industrial sector, it is important to examine and evaluate the fast-growing concept of green innovation (GI) in combating ecological challenges, thus fostering firms' sustainability [3].

The 2018 statistics revealed that the Pakistan manufacturing sector gradually raised its annual production by 4.10% [4]. The global economy is increasingly encouraging

the achievement of sustainability goals through innovative initiatives. Pakistan, being the least innovative nation, needs the most attention. Given the sector's prominence, Pakistan's manufacturing firms should heavily shoulder the burden of protecting their motherland. Accordingly, the research suggests that developing economies (e.g., Pakistan) need to provide a clear vision to manufacturers, encouraging them to adopt eco-friendly practices [5].

Indeed, the prior research shows that the green initiatives deployed in the manufacturing sector of Pakistan promote sustainability development [6]. Sustainability, a widely accepted global phenomenon, has shifted the focus of today's manufacturing enterprises toward an innovative culture. Innovation is a vital force that drives the firms' performance. The firms' innovation capabilities help the organization achieve a sustainable advantage, thus gaining long-term superior performance. Given this explanation, the research indicates that growing interest in innovation has enabled firms to integrate the key capabilities, accelerating the firms' sustainable performance [7]. These novel capabilities foster the enterprise operations, potentially ensuring firms' sustainable performance. Hence, firms' innovative capabilities are critical to achieving sustainability and GI.

Green process innovation is a strategic enabler of justifying sustainability development, fundamentally benefiting the global society. A GI process is a novel approach to maximizing the organization's performance [8]. Considering the significance of firms' sustainable performance, the focus of the modern industrial sector directs businesses to adopt green operations. The rapid upsurge of industries' sustainability has heightened the emphasis on green sustainability practices, with numerous firms addressing the accelerating issue with green process innovation [9].

In recent years, GI has become a vital area of research. In particular, the literature illustrates that sustainability as a prime determinant of GI has gained much attention in different prospects. In our study, however, we are investigating sustainability from the perspective of digital leadership and innovation capabilities, a gap in the current literature that has created the demand for investigation of the problem further in the manufacturing industry of Pakistan. As a result, the current study adopts green process innovation as a sustainable business model. GI has made numerous manufacturing firms embrace eco-friendly processes and products, thus ensuring sustainable development [10]. Additionally, given the inevitable role of GI, the technological advancement in today's world has driven businesses to turn to the concept of green product innovation. GI combines the core of green process innovation and green product innovation, thus delivering goods and services that exhibit sustainable performance [11].

This current study incorporates the effect of sustainable performance concerning two different forms of GI (i.e., green process innovation and green product innovation). Fundamentally, this notion of embracing sustainability practices has high relevance in multidisciplinary research that states that organizations should produce eco-friendly products, thus boosting firms' enduring performance [12]. This review poses a series of potential questions highlighting the research gap in the literature, substantially opening the pathway for future research [13].

Indeed, this prevailing research gap motivated us to develop a comprehensive business model. The current study demonstrates the multifaceted role of GI in Pakistan's manufacturing industry. Manufacturing firms' increasing desire to obtain green sustainable performance led this study to test the prevailing association between innovative capabilities and firms' enduring performance. Furthermore, it also investigates the mediating effect of green product innovation and the moderating role of digital leadership, influencing the firm's sustainable performance.

Significantly, our detailed analysis showed that, till now, no study has investigated the role of digital leadership in enhancing firms' performance. Accordingly, for the first time, the paper incorporates the moderating role of digital leadership in the context of sustainable performance. The research shows that digital leadership significantly influences the firms' innovation capability and performance [14]. As a result, many developing corporations

have devised novel tools for enhancing a healthier innovation climate in the context of the green paradigm. The GI process alludes to a modified production process that minimizes the environmental load. Green process innovation is a vital tool, ensuring a cleaner and safer world. The GI process tackles the growing ecological concerns, effectively adopting eco-friendly business practices [15]. Indeed, GI has become the most significant building block, playing a critical role in altering the customer demand for eco-products. For example, the changing business demand has encouraged firms to “go green” in every industry, fundamentally predicting the company’s sustainable performance.

Indeed, the research findings are imperative additions to the narrow literature on firms’ sustainable performance. Significantly, the study aims to improve firms’ sustainable performance by incorporating the consideration of variables such as innovation capability, GI (e.g., product and process), and digital leadership. The current study outcomes are of great value to the market professionals and manufacturers. It provides valuable insight regarding the increased innovative capabilities and GI (i.e., process and product), thus improving the firms’ sustainable performance. Furthermore, the study presents potential guidelines for policymakers, managers, leaders, and stakeholders, thus supporting GI practices for achieving higher sustainability.

The layout of the current paper is organized as follows. The first section of the study introduces the research topic, highlighting the study’s purpose and significance. Section 2 (i.e., the literature review), presents the background of the research, thus focusing on the hypothesis formulation. Section 3 relates to the study methodology, with Section 4 illustrating the research analysis. Section 5 discusses the study outcomes and Section 6 concludes the topic by providing future recommendations and directions.

2. Theoretical Background and Hypothesis Development

2.1. Innovation Capabilities and Sustainable Performance

In the current environment, firms’ viable innovative resources are critical regarding a country’s ability to achieve progress. Today, increased global competitiveness has produced unfavorable circumstances for businesses, thus raising numerous challenges in gaining sustainability. As such, studies suggest that natural resources (e.g., gas, oil) form an important asset that support organizations’ competitiveness and sustainability [16]. The literature indicates that organizations have widely realized the significance of innovative offerings (i.e., capabilities) as the engine for an organization’s growth [17,18]. Firms therefore develop innovation capabilities as a vital source of incrementing their business success. An organization’s innovative resources play a strategic role in fostering its progress. Indeed, to ensure sustainability in the current business environment, a study from Pakistan shows that innovative services significantly accelerate a firm’s performance [19,20].

However, due to the increasing global environmental challenges, firms have fostered their innovation capabilities based on a sustainability paradigm. The firms’ innovation capabilities offset the burdens of ecological vulnerabilities, thus exhibiting sustainable performance. The innovation capabilities create potential value for the firms’ process, leading to firms’ sustainable performance [21]. Meanwhile, the firms’ innovation capabilities ensure the company’s successful functioning. The concept of fostering the firms’ innovation encourages the firms to integrate novel capabilities (e.g., strategic and technological), bolstering firms’ long-term performance [22,23]. Hence, today, considerable attention has been given to firms’ innovation capability that establishes their performance and long-term survival.

In particular, sustainable performance does not rely on a single measure, but rather encourages a diversity of innovative resources. Hence, a sustainable business network requires the firms to strengthen their capabilities, achieving long-term economic growth. Previous findings show that businesses embrace innovative capabilities to achieve sustainable performance [24]. The dynamic capabilities (i.e., innovation) strengthen the firm’s performance [3] and competitiveness [25]. In addition, the innovative capabilities improve the firm’s offering, thus providing an incentive to interact between innovation and sustain-

ability. Therefore, a study generalizing the manufacturing sector of Pakistan demonstrates that a firm's innovation capabilities play an enduring role in an organization's performance and competitiveness [26]. Likewise, the study indicates that innovation capabilities enhance the firm's market position, thus confirming an enduring development [27]. Hence, the literature suggests that companies should grow their innovative capabilities for continued growth and survival. Indeed, based on these studies, the following hypothesis is suggested:

Hypotheses 1 (H1). *Innovation capabilities have a positive and significant impact on sustainable performance.*

2.2. Green Process Innovation and Sustainable Performance

Over the years, climate change has caused environmental problems that represent fundamental hurdles in achieving organizational sustainability. Today, growing ecological concerns demand proactive strategies for gaining enduring performance. Concerning sustainability development, green process innovation is a proactive approach to fulfilling stakeholders' needs, substantially providing firms with a continuous advantage. As such, green process innovation alludes to the collection of unique business processes that benefit the firm by subsidizing the sustainable performance of its business [28].

In particular, the significant influence of green process innovation requires firms to adopt eco-friendly procedures as a critical factor for driving the firm's sustainability. Eco-friendly practices significantly relate to the green process and products [29,30]. Green process innovation ensures the advancement in business processes, thus expanding organizational performance. A firm's highly sustainable performance forms a deep connection with the green process innovation. Significantly, green process innovation improves firms' performance by considerably enhancing the business activity. Through the lens of the green paradigm, firms' innovation process ensures the establishment of firms' competitiveness and sustainable functioning. Given this, studies show that a GI process is a strategic tool for promoting a firm's competitiveness and sustainable performance [31]. Indeed, these green initiatives enable organizations to sustain themselves in a fast-growing business environment. In response to today's business demand, firms develop innovation processes to improve products and services. The research indicates that green process innovation is a significant driver of firms' sustainable performance [32,33].

Today, green modification has pushed the industrial process and systems to reduce the effect of environmental vulnerabilities, thus contributing to greener production and sustainable performance [34]. Manufacturing organizations' integrating green practices reaps the benefits of sustainable performance. Hence, the manufacturing sector, a significant contributor to economic development, demands green process innovation to raise the industry's profitability and performance. Therefore, the research shows that green process innovation is highly beneficial for ensuring firms' sustainable development [35]. Green process innovation plays a prominent role in attaining higher sustainable performance [36], thus inclining the organization's processes to improve its social, economic, and ecological performance. Therefore, based on a detailed analysis of the prior research, the following hypothesis is suggested:

Hypotheses 2 (H2). *Green process innovation has a positive and significant impact on sustainable performance.*

2.3. Innovation Capabilities and Green Product Innovation

The rapid growth in environmental deterioration has forced companies to adapt novel business practices, mitigating ecological vulnerability. Particularly, the accelerating environmental pressure has made companies embrace green tools for fostering their performance. As such, the research indicates that firms' innovation capability ensures their green product innovation performs better than those of other firms [37]. Indeed, in the manufacturing industry, establishing an eco-friendly strategy requires a firm to embrace novel ideas and processes, thus achieving a distinctive edge. Internal resources have a profound effect on a

firm's performance. A firm's innovative resources are an efficient driver of business performance. Innovation capabilities allow firms to differentiate their offering from competitors based on eco-friendly product innovation. In explaining this notion, the research shows that eco-innovation capabilities develop significant resources that allow the organization to acquire enduring business performance and competitiveness [38].

In particular, green product innovation largely depends on a firm's capability to be innovative. Green product development in a manufacturing firm enhances its innovation capabilities [39]. The firm's innovative capabilities make the pioneer enterprises win the first-mover advantage, thus promoting green product development. Therefore, previous studies suggest that green product innovation fosters firms' innovative capabilities, thus leading this green phenomenon to achieve a competitive advantage [40–42].

Additionally, green product development is vital for accelerating the performance of manufacturing enterprises. The green abilities that have emerged as an eco-friendly practice have become a significant factor in driving firms' innovative capabilities. Indeed, the growing significance of eco-friendly capabilities demands more attention, thus promoting the integration of crucial capabilities fostering eco-friendly product innovation. Given this, the study findings indicate that to ensure eco-friendly product development, managing a firm's innovative capabilities is critical to enhancing its environmental performance [43]. Hence, the following hypothesis is proposed:

Hypotheses 3 (H3). *Innovation capabilities have a positive and significant impact on green product innovation.*

2.4. Green Process Innovation and Green Product Innovation

In today's era of progressing globalization, abrupt climate change has initiated a novel discussion on adopting innovative practices, and thus minimizing ecological damages. In recent years, environmental pollution has worsened the natural environment to a devastating effect, elevating the need for GIs as the fundamental solution. Indeed, to curb the increased ecological negativity, an eco-friendly process and products need to be developed to achieve enduring development. GI modified as the combination of business procedures and product innovation yields market benefits by creating value for an organization.

However, today, the increasing pressure from stakeholders has led firms to adopt GI activities. Prior research shows that green process innovation significantly influences firms' eco-friendly production [28]. The green process innovation provides a systemic improvement in the managerial process, thus encouraging firms to develop green products. The GI production allows management to invest considerably in GI processes, thus significantly increasing firms' ecological and economic performance [44]. In particular, green process innovation and green product innovation influence each other. The green process innovation supports and ensures the development of eco-friendly products. This significant green configuration enables firms to successfully perform by massively reducing their ecological footprints [45].

GI practices ensure the development of green process innovation and green product innovation. Green process innovation and green product innovation have become integral factors driving firms' activities. Green process innovation fosters legitimacy within the business community, substantially benefiting worldwide societies through eco-friendly developments [46]. As such, the research indicates a positive effect of green process innovation on green product innovation [28]. In the manufacturing industry, green process innovation fosters eco-friendly production, thus making firms reduce the negative effect on the environment [47]. Green process innovation focuses on achieving sustainable goals through innovative product developments. Hence, the prior literature motivates us to develop the following hypothesis:

Hypotheses 4 (H4). *Green process innovation has a positive and significant impact on green product innovation.*

2.5. Mediating Role of Green Product Innovation

With the rapid growth in globalization, increased resource constraint and ecological degradation have formed bottlenecks to firms' sustainable development. This growing concern has made environmental deterioration the biggest problem for worldwide industries. The challenge of this current period is dealing with progressing climate change by embracing innovative eco-friendly strategies. In recent years, increased recognition of environmental innovations and green characteristics (e.g., green processes and products) have become the prime determinant of sustainability. In explaining this notion, one study states that green product innovation has become critical to achieving company sustainability [48]. Similarly, another study emphasizes green product innovation as a crucial factor in firms' sustainability, while minimizing the increasing environmental damages [49]. Hence, the prior research suggests incorporating green practices to achieve sustainable performance [50].

In past years, all the technologies and innovations have contributed to environmental enhancement. However, more recently, green product innovation has maximized ecological benefits, thus making product innovation accelerate firms' growth. In particular, the current need has encouraged enterprises to use GI tools to achieve sustainable performance. One study records a positive relationship between green product innovation and firms' enduring performance [51]. Today's firms are going greener, thus minimizing the negative effect of climate change. In addition, green product innovation, being an innovative concept, leads to products that are characterized by greenness, thus outperforming the other market's competitors. Therefore, one study illustrates that green product innovation is an approach by which stakeholders can make an organization sustainable in the competitive business world [52]. Therefore, based on the literature, we put forward the following hypothesis:

Hypotheses 5 (H5). *Green product innovation has a positive and significant impact on sustainable performance.*

The devastating effect of climate change has raised global concerns for manufacturers in recent years, emphasizing the need to diminish the negative influence of environmental damage. The growing demand for ecological management has developed a positive connection with innovation capabilities. Presently, to ensure their long-term survival, businesses are adjusting to the need for novel capabilities to enhance the firm's efficiency. The pioneer companies adopting green product innovation are strengthening their core competency, thus influencing sustainability development. The research on green initiatives shows that Pakistani manufacturing companies have strongly adopted eco-innovation activities, thereby accelerating business sustainability [53]. Indeed, the results suggest that novelty-centered businesses have adopted innovative capabilities to foster firm performance [49].

Innovation capability translates new ideas and knowledge into the firms' GI (i.e., eco-friendly processes and products). Green product innovation bolsters the firms' innovation capabilities, thereby enhancing the company's performance [40]. The firms' innovation capabilities are deeply rooted in their function, where the innovation perspective drives their sustainable performance. Given this, one study shows that firms' innovative capabilities redesign the firms' processes and products, significantly stretching them beyond the sustainability limits [54]. In particular, firms use product innovation strategies to distinguish themselves from their peers. However, the innovation process also enables firms to achieve a sustainable business advantage, whereas a lack of innovation causes the company to suffer in the long run. Therefore, firms' innovation capabilities are vital for maintaining their enduring performance.

Undoubtedly, a firm's innovation capabilities are essential for its survival in the business world. A firm's sustainability practices are highly dependent on the organization's resources. The green orientation strengthens the innovation capabilities, thus providing the firm with a significant market position. In particular, these novel capabilities are a source of competitive advantage, encouraging the development of green product innovation.

Eco-innovation capabilities drive the firms' practices, whereby organizational sustainability encourages the firms to employ the positive effect of GI practices, thus ensuring cleaner production [55]. Green product development facilitates firms' innovation capabilities to achieve sustainable performance. As such, one study indicates that firms experiencing competitive pressure adopt innovative green capabilities (i.e., green product innovation), thus influencing the company's performance [56]. Indeed, green product innovation plays a significant role in enhancing the firms' performance. It fosters the firms' innovation processes, thus leading to their sustainable performance [57]. Hence, based on the literature, this study proposes:

Hypotheses 5a (H5a). *Green product innovation mediates the relationship between innovation capabilities and sustainable performance.*

In the current period, a company's task is to develop products and process that support the firm's proper functioning. Considering today's climatic conditions, firms have been emphatically embracing business procedures that eradicate environmental negativity, thus boosting their innovative performance. Environmental issues are global problems, compelling firms to innovate. However, the aspects of firms' sustainability and innovation provide them with an opportunity to exhibit sustainable performance. Therefore, the research contends that green process innovation boosts a company's overall performance by encouraging green product innovation [45]. Green process innovation ensures the development of eco-friendly products, thus minimizing the firm's competition, subsequently leading to it exhibiting sustainable performance.

Green process innovation facilitates new production processes, thereby meeting the increasing ecological concerns. Green process innovation enables firms to innovate their offerings, substantially enhancing their profit and performance. The research suggests that eco-friendly processes significantly influence a firm's performance and sustainable development [58]. As a result, companies aiming to achieve sustainable goals are now strengthening the production process through eco-friendly innovations.

Creating green products requires firms' constant efforts and innovation. In particular, a firm's innovation process leads to business success. Therefore, to succeed, companies should enhance their performance through innovative practices. Green process innovation leads firms to achieve sustainable company performance [46]. Moreover, the research shows that the green configuration (i.e., green process innovation, green product innovation) fosters firms' sustainable performance [59]. Hence, developing novel products through modern environmental processes encourages firms to minimize pollution waste, thus increasing production efficiency. Altogether, based on the prior findings, the following hypothesis is proposed:

Hypotheses 5b (H5b). *Green product innovation mediates the relationship between green process innovation and sustainable performance.*

2.6. Moderating Role of Digital Leadership

Digitalization has become the prime determinant of innovation in recent years. However, today, digitization as a technological phenomenon has also taken over the world as the most significant ecological sin that has immensely destroyed the world's ecosystem. In particular, the current situation demands firms' ability to optimize their processes, thus bringing colossal benefits to the industry. Digitalization has emerged as the more fundamental solution to help firms accelerate their revenue. Increased digitalization has fostered consumption, leading to the rebound effect. This states that a firm's improved efficiency adversely influences the environment's well-being [60]. Accordingly, the literature suggests that the rebound effect occurs when energy consumption overpowers energy efficiency, thus diminishing the positive impact of environmental sustainability [61]. However, from this perspective, this study argues for the mitigation of the risk associated with the rebound effect, thus fostering firms' process through sustainable industrialization. The green ap-

proaches assist firms to drive growth through the production of recycled material, thereby maintaining their efficiency gains without harming the environment.

Due to the increasing market changes in this digital era, firms' innovation-based capabilities have significantly seized market opportunities, highlighting the significance of digital leadership. Digital leaders play a critical role in improving firms' performance. Leaders are the visionary actors who influence a company's operations while balancing the increasing pressure of the rebound effect by adapting to the green standards [62]. In particular, in the context of the manufacturing industry, the literature states that digital leaders enhance business sustainable performance [63].

However, the significant concept of innovation (i.e., product and process) is a core competence for firms, whereas technological innovation has sped up the firms' GI process, thus increasing eco-friendly product development. Hence, digital leadership benefits firms by influencing a company's innovation process [64]. Indeed, to manage the rapid growth in digital transformation, numerous firms' have appointed digital leaders as the fundamental element driving their operations. Such firms' digital background encourages leaders to spread digital transformation all across the firm, thus accelerating the firms' performance [65]. Indeed, to become a digitally sustainable organization, firms need to value the role of digital leadership in gaining business success.

In today's challenging industry, new emerging challenges have anticipated the need for effective leadership. The novel digital transformation has raised the demand for digital leadership to ensure the proper functioning of enterprises [64]. Digital leadership requires leaders to strengthen their competencies and actively participate in sustainability initiatives. Given this, research confirms that digital leaders improve a firm's performance [66], thus promoting its sustainability practices. Hence, based on prior studies, this study proposes that:

Hypotheses 6 (H6). *Digital leadership has a positive and significant impact on Sustainable performance.*

Digital leadership refers to the combination of firms' digital culture and competency. Being a market professional requires leaders to exhibit skilled capabilities, significantly influencing firms' sustainable performance. One study shows that digital leadership positively influences firms' innovation, thus leading to sustainable performance [66]. As such, the research indicates that digital leadership widely influences firm's innovative performance through digital means [67], thus ensuring the firm's enduring performance.

Over the years, digital start-ups have been prominent, but have often led to environmental degradation, thus elevating the role of digital leaders, influencing green product innovation and sustainable performance. Businesses cannot function in a climate where environmental deterioration has reached its peak. In such a situation, leaders' skills and abilities play a critical role in managing the business transformation process [68]. The increasing ecological issues have forwarded the need for digital leadership, thus promoting green development. The digital economy is experiencing rapid transformations, with digital technologies reshaping business development strategies. The ability to gain environmental sustainability demands innovative digital leadership. As a result, many organizations have adopted digital leadership skills and modern technologies to cope with climate change, thus influencing the firm's sustainable performance. This leads the current study to propose a final hypothesis:

Hypotheses 6a (H6a). *Digital leadership moderates the relationship between green product innovation and sustainable performance.*

Figure 1 shows the study's independent variables (innovation capabilities and green process innovation), mediating variable (green product innovation), moderating variable (digital leadership), and dependent variable (sustainable performance).

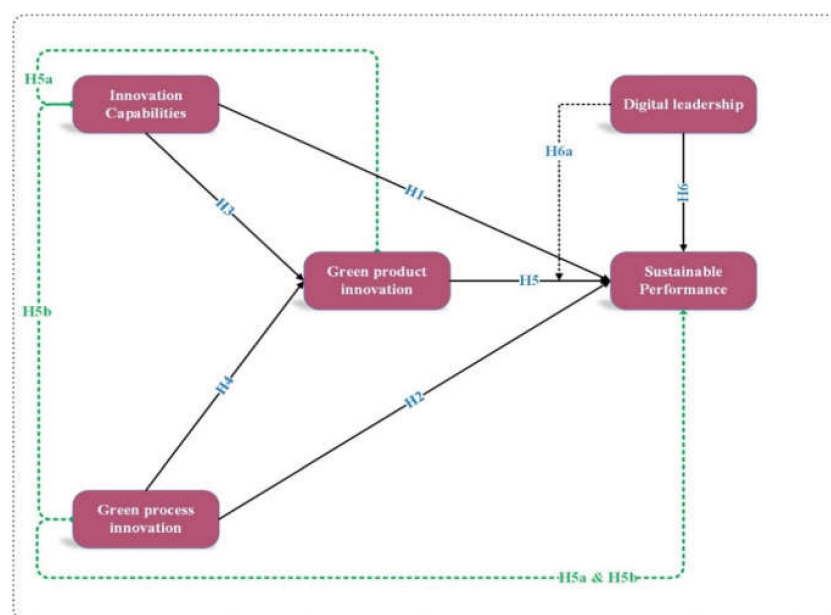


Figure 1. Conceptual framework.

3. Methodology

The study data was collected from the employees working in the manufacturing companies of Punjab province, Pakistan. General Manager, Senior Management, Middle-Level Manager, Quality Check Supervisor, Machine Operator, Product Designer, and Testing Officer were among the positions held by employees. Participation in the study was entirely voluntary. The surveys were collected with the support of HR managers, who helped us link respondents with their managers. The participants were informed that their replies would be kept private. Each questionnaire came with a return cover, and participants were asked to return the completed form to the researchers after sealing the envelope with dual-sided tape. A total of 400 questionnaires were distributed, and 299 valid questionnaires were received for data analysis. We maintained a two-month lag in time between the first (T1) and second (T2) waves of data collection to overcome common method bias. Table 1 presents study descriptive analysis results. These results reveal the frequencies in terms of gender, age group, education, and academic status of the participants of this study.

Table 1. Demographic characteristics.

Items	Frequency (N = 299)	(%)
Gender		
Male	163	54.5
Female	136	45.5
Age		
19–30	43	14.4
31–40	74	24.7
41–50	75	25.1
51–60	79	26.4
>60	28	9.4
Education		
Intermediate	43	14.4
Bachelor	101	33.8
Master	83	27.8

Table 1. *Cont.*

Items	Frequency (N = 299)		(%)
MPhil/Others	72		24.1
Marital Status			
Single	102		34.1
Married	197		65.9

3.1. Common Method Bias

This research also applied the common method bias using Harman's single-factor approach. The variance extracted by one single factor is 8.606%, which is less than 50%, indicating no common method bias in this study [69].

3.2. Measurement Scale

The study questionnaire was generally composed of three parts (e.g., study overview, variable-related questions, and demographic-characteristics-related questions). The current study adopted a previously developed and tested variables items scale. The innovation capabilities were measured on the five-item scale adapted from [70]. The scale sample items included "In our firm, we are constantly searching for new ways of doing things and reaching out to customers" and "Our firm is able to introduce new products or services due to the constant focus on innovative ideas and abilities".

Green process innovation was measured on the five-item scale adopted from [28]. The scale sample items included "Aiming to reduce the consumption of resources and energy and improve resource and energy efficiency" and "Using recycled materials, recycling techniques, and environmental technologies". Green product innovation was measured on the three-item scale adopted from [28]. The scale sample items included "Making changes to product designs in order to avoid polluting or toxic compounds within production processes" and "Improving and designing environmentally-friendly packaging for existing and new products". Digital leadership was measured on the six-item scale adopted from [70]. The scale sample items included "The leaders in our company recognizes the network character by identifying the competencies and contacts of individual employees", "In our firm, leaders provide necessary information to employees", and "Leaders have high confidence in the capabilities because of the fast-changing environment".

Sustainable performance was measured on the five-item scale adopted from Gelhard and Von Delft (2016). The scale sample items included "We are the first that offer environmental-friendly products/services at the marketplace", "We develop new products/services or improve existing products/services that are regarded as sustainable for society and environment", and "Our reputation in terms of sustainability is better than the sustainability reputation of our competitors".

3.3. Statistical Analysis

We applied partial least square structural equation modeling (PLS-SEM) using smart PLS to test the measurement model first, and then the proposed relationships of the study. It has several merits over other methods like conventional regression analysis or covariance-based SEM: (i) fewer restrictions of data assumptions, (ii) the ability to examine complex conceptual models, and (iii) more acceptability of constructs with few items [71,72]. We used Smart PLS software (Version 3.3.7, SmartPLS GmbH, Gewerbing, Germany) for data analysis. The structural equation modeling (SEM) technique was applied, and confirmatory factor analysis (CFA) was conducted to determine the model's internal validity and reliability. PLS-SEM was used to test the hypotheses developed between study variables.

4. Results

4.1. Assessment of Measurement Model

Before testing the study's proposed relationships, the measurement model was tested to verify the construct validity (convergent and discriminant) and reliability of the measures used in this study. As shown in Table 2, all the factor loading scores of the items on their respective constructs were well above 0.65, and the average variance extracted (AVE) score for all the constructs were above the cut-off value of 0.50, ensuring the convergent validity of all the measures used in this study [73]. Further, Cronbach's alpha and composite reliability (CR) of all the constructs were above the acceptable value of 0.70 [74], ensuring the reliability of the scales used in this study.

Table 2. Reliability and validity analysis.

Construct	Items	Loading	α	CR	AVE
Innovation Capabilities	IC_1	0.693	0.852	0.852	0.535
	IC_2	0.708			
	IC_3	0.769			
	IC_4	0.750			
	IC_5	0.736			
Green Process Innovation	GPCI_1	0.681	0.851	0.851	0.534
	GPCI_2	0.830			
	GPCI_3	0.697			
	GPCI_4	0.702			
	GPCI_5	0.736			
Green Product Innovation	GPDI_1	0.701	0.775	0.775	0.535
	GPDI_2	0.712			
	GPDI_3	0.780			
Digital Leadership	DL_1	0.620	0.888	0.886	0.567
	DL_2	0.802			
	DL_3	0.860			
	DL_4	0.730			
	DL_5	0.658			
	DL_6	0.818			
Sustainable Performance	SP_1	0.783	0.869	0.868	0.570
	SP_2	0.690			
	SP_3	0.799			
	SP_4	0.725			
	SP_5	0.772			

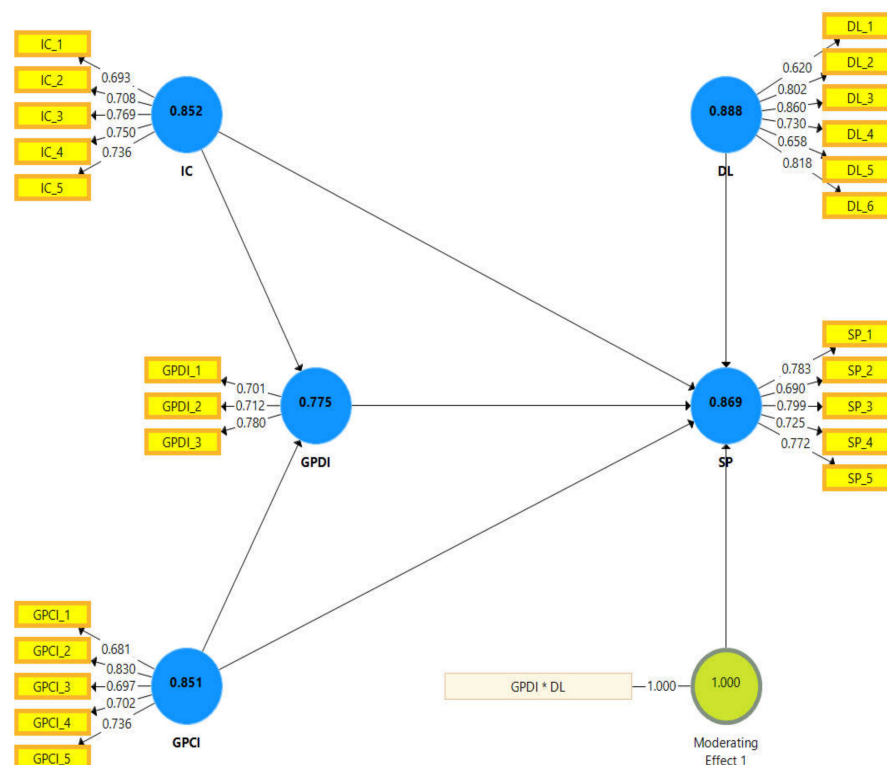
Furthermore, Table 3 presents the discriminant validity results of the constructs. According to the criterion prescribed by [75], each construct's square root of AVE should be greater than its correlation with all other variables. In the case of this study, all the square roots of AVE were well above the correlation values. Moreover, a more recent method known as the heterotrait–monotrait (HTMT) ratio is also used as a more robust approach to measuring the discriminant validity of the measures. According to this method, the HTMT ratio score should be less than 0.85, well achieved in the case of this study. All these results reported in Table 3 establish the discriminant validity of the constructs used in this study.

Table 3. Discriminant validity analysis (Fornel–Larcker and heterotrait–monotrait (HTMT)).

Constructs	1	2	3	4	5
1. Digital Leadership	<i>0.753</i>	0.238	0.422	0.205	0.384
2. Green Process Innovation	0.240	<i>0.731</i>	0.636	0.638	0.685
3. Green Product Innovation	0.423	0.636	<i>0.732</i>	0.684	0.719
4. Innovation Capabilities	0.203	0.641	0.685	<i>0.732</i>	0.718
5. Sustainable Performance	0.388	0.689	0.720	0.717	<i>0.755</i>

Note: Italicised values represent the square root of the average variance extracted, while the non-italicised values are correlations.

Figure 2 shows the graphical representation of assessment of the measurement model (independent, dependent, moderating and mediating variable). Table 4 shows variance influence factor values of digital leadership, green process innovation, green product innovation, innovation capabilities and sustainable performance.

**Figure 2.** Graphical representation of the assessment of the measurement model.**Table 4.** Variance influence factor.

Constructs	1	2	3	4	5
1. Digital Leadership					1.398
2. Green Process Innovation			1.698		1.940
3. Green Product Innovation					2.795
4. Innovation Capabilities			1.698		2.226
5. Sustainable Performance					

4.2. Structural Model

Table 5 reports the standardized path coefficient of all the direct proposed relationships among the variables of this research. The relationship between innovation capabilities and sustainable performance ($\beta = 0.311^{**}$, $t = 3.246$), green process innovation and sustainable performance ($\beta = 0.289^{***}$, $t = 3.672$), innovation capabilities and green product

innovation ($\beta = 0.471^{***}$, $t = 4.704$), green process innovation and green product innovation ($\beta = 0.334^{**}$, $t = 3.442$), and green product innovation and sustainable performance ($\beta = 0.362^{**}$, $t = 3.017$) were significant, empirically. These results empirically substantiated the first five direct hypotheses (H1–H5) of the study.

Table 5. Hypotheses testing direct effect.

Hypothesis	Direct Relationship	Std. Beta	Std. Error	T-Values	p-Values	F-Square
H1	IC \rightarrow SP	0.311	0.096	3.246	**	0.152
H2	GPCI \rightarrow SP	0.289	0.079	3.672	***	0.150
H3	IC \rightarrow GPDI	0.471	0.100	4.704	***	0.282
H4	GPCI \rightarrow GPDI	0.334	0.097	3.442	**	0.142
H5	GPDI \rightarrow SP	0.362	0.120	3.017	**	0.164

Indicates significant paths: ** $p < 0.01$, *** $p < 0.001$. IC = Innovation Capabilities, SP = Sustainable Performance, GPCI = Green Process Innovation, GPDI = Green Product innovation.

Next, Hypotheses 5(a) and 5(b) of this study asserted that green product innovation mediates the relationship of (i) innovation capabilities with sustainable performance, and (ii) green process innovation with sustainable performance, respectively. As shown in Table 6, green product innovation mediated ($\beta = 0.17^*$, $t = 2.23$) the relationship of innovative capabilities, thus empirically supporting the study's H5(a). Furthermore, the mediating role of green product innovation for the relationship between green process innovation and sustainable performance ($\beta = 0.121^*$, $t = 3.113$) was also statistically significant, therefore approving the study's H5(b). Figure 3 is a graphical representation of the structural model.

Table 6. Hypotheses testing mediation effect.

Hypothesis	Indirect Relationships	Std. Beta	Std. Error	T-Values	p-Values
H5a	IC \rightarrow GPDI \rightarrow SP	0.17	0.076	2.23	*
H5b	GPCI \rightarrow GPDI \rightarrow SP	0.121	0.057	2.113	*

Indicates significant paths: * $p < 0.05$.

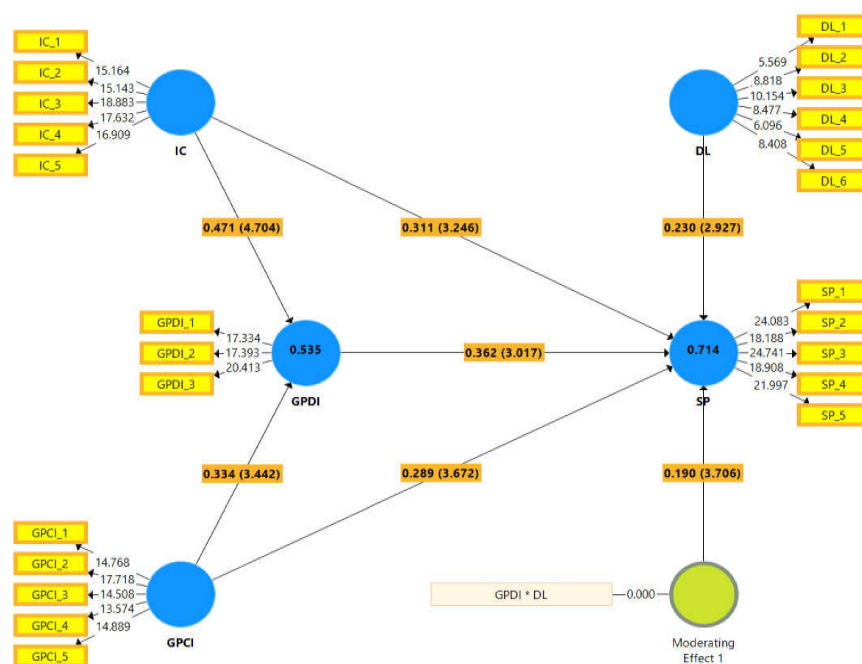


Figure 3. Graphical representation of the structural model.

Next, H6(a) of the study claimed that digital leadership moderates the relationship between green product innovation and sustainable performance. The results in Table 7 revealed that the interaction effects of digital leadership for the relationship mentioned above ($\beta = 0.23$ **, $t = 2.927$) were also statistically significant, thus supporting this study's H6(a). Figure 4 demonstrates the interaction effect between GPDI and DL.

Table 7. Hypotheses testing interaction effect.

Hypothesis	Interaction Effects	Std. Beta	Std. Error	T Values	p Values
H6a	Interaction GPDI \times DL \rightarrow SP	0.230	0.078	2.927	**
	Level of the Moderator	Effects	Boot SE	LLCI	ULCI
	+1 Std Dev	0.685 ***	0.076	0.536	0.834
H6a	Mean	0.580 ***	0.051	0.478	0.681
	−1 Std Dev	0.474 ***	0.055	0.365	0.582

Indicates significant paths: ** $p < 0.01$, *** $p < 0.001$. LLCI = Lower Limit Confidence Interval, ULCI = Upper Limit Confidence Interval, SE = Standard Error.

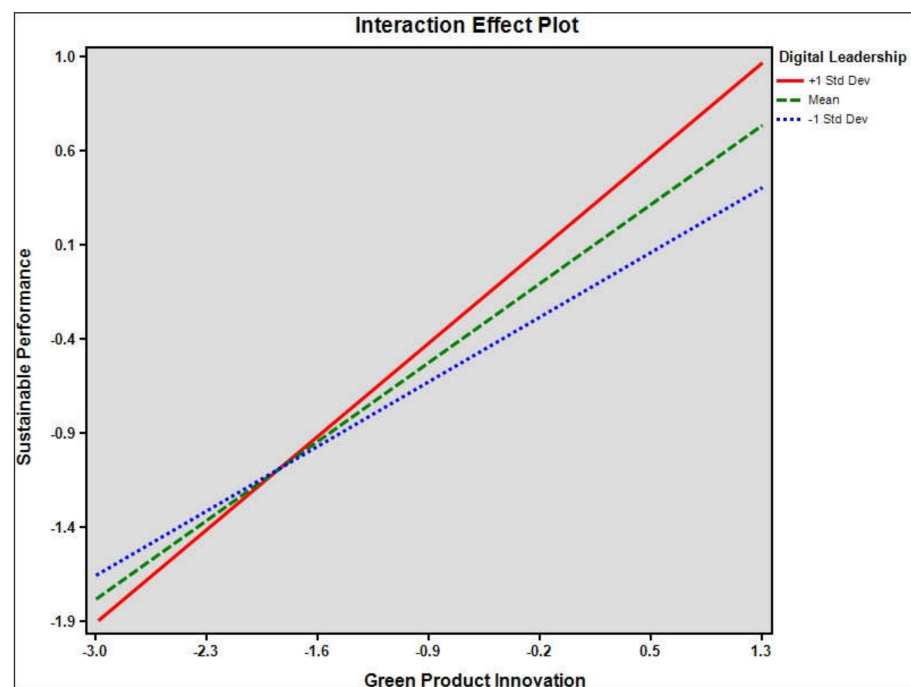


Figure 4. Demonstration of the interaction effect GPDI \times DL.

In addition to this analysis, the coefficient of determination (R^2) and the cross-validity redundancy (Q^2) of the outcome variables due to predictors were also measured and reported in Table 8. The adjusted R^2 values were 0.532 and 0.709 for green product innovation and sustainable performance, respectively. Furthermore, the Q^2 scores of green product innovation and sustainable performance were 0.256 and 0.357, respectively, which are greater than 0, indicating that all the independent variables have predictive relevance over the dependent variables (see Figure 5).

Table 8. Quality criteria.

Latent Variables	R^2	R^2_{Adj}	Q^2
GPDI	0.535	0.532	0.256
SP	0.714	0.709	0.357

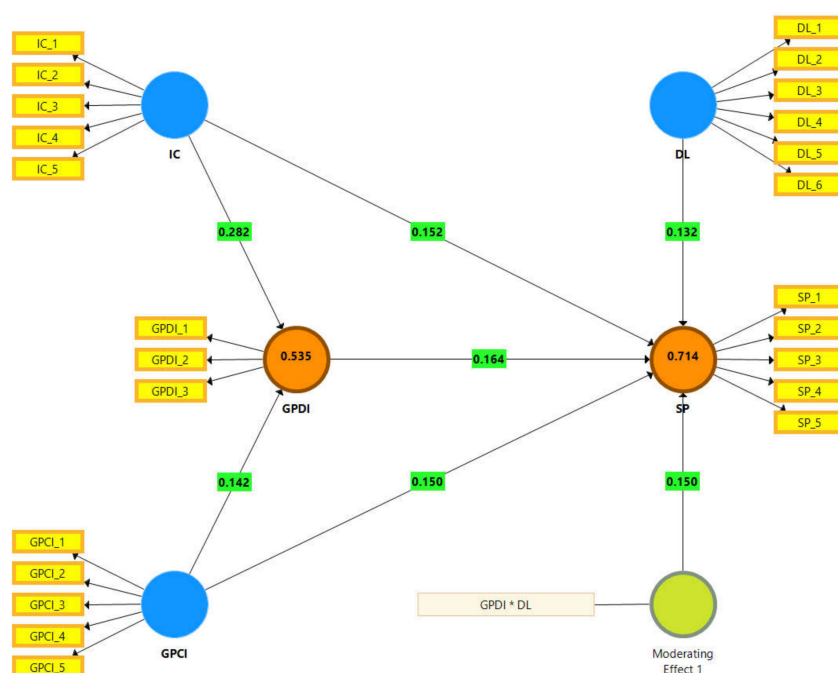


Figure 5. Graphical representation of R^2 and F^2 .

5. Discussion

Globally, organizations have adopted green management techniques and practices to enhance their overall performance and maintain their competitive position in the market. GI management is a concept that addresses organizations' environmental and social elements through various approaches such as sustainable value mapping [76] and life cycle evaluation [77]. In manufacturing, it aims to contribute directly to CSR or sustainable innovation management or practices while implicitly promoting sustainable competitive advantage. Hence, the ultimate goal of these concepts is to minimize costs through rendering waste management (reduction and recycling) efforts and effective use of resources [78]. This study has theoretical and practical implications for sustainable business performance. It brings new evidence on the relationship between the variables studied using simple and obvious assumptions, and evaluates the importance of GI and its various aspects. In short, the current study investigates (i) the association between innovation capability or green process innovation and sustainable performance; (ii) the mediating role of green production innovation between innovation capability or green process innovation and sustainable performance; and (iii) the moderating role of digital leadership between green production innovation and sustainable performance.

Mediation and moderation analysis were performed using (PLS-SEM); the statistical results revealed that innovation capability is positively and significantly associated with sustainable performance ($\beta = 0.311, p \leq 0.05$) and green process innovation is positively and significantly linked with sustainable performance ($\beta = 0.289, p \leq 0.01$). Henceforth, hypotheses H1 and H2 were accepted. Furthermore, the results in Table 5 also depict a positive and significant relationship between innovation capability and green process innovation, with green product innovation having ($\beta = 0.471, p \leq 0.05$) and ($\beta = 0.334, p \leq 0.05$), respectively. Likewise, a positive and significant relationship between green product innovation and sustainable performance ($\beta = 0.362, p \leq 0.05$) was found. Hence, hypotheses H3, H4, and H5 have been proved statistically. The statistical results revealed that green product innovation mediates the relationship between innovation capability and sustainable performance, and green process innovation and sustainable performance, proving H5(a) and H5(b). The study's findings also supported H6(a), i.e., digital leadership moderates the relationship between green product innovation and sustainable performance, such that the relationship strengthens when leadership is high.

These research results are pivotal because innovation capability and the GI process are essential in developing a firm's green product innovation. Knowledge exchange, encouragement, creative thinking skills, and an efficient system would contribute to developing an appropriate and coherent innovation process [57]. It is a process to create diverse opinions and then turn them into profitable products. As a result, innovation capability gives insight into a firm's potential avenues and assets that contribute to the understanding of the firm's strongest and weakest positions, as well as spots where the firm must grow, as it allows for the utilization of resources and the constant transformation of competencies and knowledge into products for the interest of the firm and gaining sustainable performance [79]. The current study also presents some limitations. First, the study results are based on a single industry (manufacturing). Innovation capabilities and green process innovation vary from company to company. Secondly, the study has only considered private sector manufacturing firms for data collection. Future studies could compare the private sector and the public sector manufacturing firms.

6. Conclusions

The study shows that increasing environmental concerns have made it necessary for manufacturing firms to adopt sustainable innovation practices. As such, the literature suggests that the high ecological demand has encouraged organizations to practice GI (e.g., process and product) to sustain their viability in the fast-growing business environment. GI works as a strategic path way to ensure firms' sustainable performance. Indeed, this green concept has considerably improved organizations' innovative competencies, thereby ensuring advancement in firms' performance. In the same vein, this study highlights that digital leadership also plays a significant moderating role in fostering firms' innovative capabilities, substantially gaining firms' enduring performance.

In contrast, the study demonstrates that the manufacturing industry has faced immense challenges, limiting the adaptation of green manufacturing practices. These barriers to implementing an eco-friendly system have meant the enterprises lack data, resources, and effective leadership (i.e., expertise experience). Indeed, these obstacles limit firms' ability to achieve sustainable performance. Since SMEs play a critical role in enhancing the organizations' performance, it is imperative to identify the drivers that hinder green developments. However, by investigating its solution, this study infers that leaders' expertise plays a crucial role in fostering the firms' innovation process. The study suggests that leaders' dynamic qualities and firms' GI capabilities (i.e., business processes and products) help firms overcome these barriers, thus achieving sustainable performance. Altogether, the study suggests that effective digital leadership and green product innovation are the prime motivators influencing company's performance.

However, the study results showed that the research findings were consistent with the hypothesis. All the variables significantly supported the firms' sustainable performance. The findings of the current study have provided a theoretical foundation for analyzing the association between innovation capability, green process, product innovation, and sustainable performance, and provide statistical evidence to prove the hypotheses that innovation capability and green process innovation have an integral role in promoting green product innovation and sustainable performance. The study reveals a positive relationship between firms' innovation capability and green process innovation and the firms' sustainable performance. The results suggest that green product innovation mediates the relationship between innovation capability, green process innovation, and sustainable performance. In addition, digital leadership moderates the relationship between green product innovation and sustainable performance.

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