International Journal of Contemporary Business and Economics 2024, Vol. 02 (02) 56-72 ©TARC-2024. ISSN-Print: 3005-5350, ISSN-Online: 3005-5369

Synergizing Green Innovation and HRM Practices: Exploring the Mediating Role of Green Process and Green Product Innovation on Organizational Performance

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ABSTRACT:

Sustainability in organizations is one of the most persistent issues for ecologists and business managers today. The emerging urgency of environmental sustainability has compelled organizations to adopt green innovation practices aimed at balancing ecological responsibility with performance outcomes. This study investigates the impact of green innovation adoption on the three critical dimensions of organizational performance—operational, ecological, and production and evaluates the serial mediation roles of green process and green product innovation. This study offers a unique perspective and contribution by examining the serial mediation effect of green process and product innovations in the relationship between green innovation and multi-dimensional organizational performance. Unlike most prior research that views green innovation as a monolithic construct, this study separates its components to reveal interdependent pathways of innovation impact. Grounded on the Ecological Modernization Theory, the study conceptualizes green innovation through two dimensions: green adoption and green capacity. Whereas organizational performance is analyzed through three dimensions, including the organization's production, ecological, and operational performance of organizations. The data was collected by administering a structured questionnaire to managerial employees of five leading companies in the construction industry in Pakistan and was examined using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. The findings demonstrate that green innovation significantly enhances ecological performance but has a weaker direct influence on operational and production outcomes. However, when green process innovation leads to green product innovation, a strong serial mediation effect emerges, highlighting their combined role in translating green innovation into comprehensive organizational performance gains. The study findings suggest that embracing green innovation is not only essential to advocate environmental sustainability in organizations, but it is also favorable towards business performance and productivity.

Keywords: Green Innovation; Organizational Performance; Serial Mediation; Organizational Green Practices; Sustainability;

Article History

Received: 08-10-2024
Accepted: 17-12-2024
Online: 23-12-2024

How to cite this paper: Shaikh, S., Shaikh, M., & Hussain, S. (2024). Synergizing green innovation and HRM practices: Exploring the mediating role of green process and green product innovation on organizational performance. *International Journal of Contemporary Business and Economics*, *2*(2), 56–72.

1. INTRODUCTION

The drastic upsurge in global environmental concerns has shifted the world business view from a customer-centric focus to an ecological discourse. Limited resources and critical environmental concerns have made sustainability and resource utilization the most critical global issues for economic development today (Singh et al., 2020). It is thus vital to all businesses that subsist as core contributors to the global economy to adopt sustainability measures and deploy efficient use of resources to save the planet from further harm and deterioration. With the rising ecological concerns, managers have become more curious to find ways to embrace creativity, innovation, and sustainability, not only for business development but for their longevity and survival. The competitive approach of businesses has now adopted a new realm apart from production quality and marketing proficiency to process innovativeness and resource efficacy (Susilawati et al., 2023). The business competitive environments have become fiercer, and addressing the new upheaval of issues concerning ecology to smart processing has overthrown the traditional business approaches and has become a new norm (Al-Madani et al., 2024). In such a competitive environment, businesses, in order to realize the need of time, have to counteract to equalize the balance between the limited resources, emerging consumption requirements, and environment-friendly business practices.

In the reflection of the resource-based view of organizational theory, the significance of the adoption of green practices by all the stakeholders involved in a business is apparent (Bıçakcıoğlu-Peynirci & Tanyeri, 2022). The changing world dynamics have radically altered the operational patterns of business, the consumption patterns of consumers, and the existing mechanisms of economic systems. In such instances, businesses today are more curious to find their competitive advantage aligned with the sustainability discourse (Allal-Chérif et al., 2023). Thus, managers are compelled to frame strategies to adopt green innovation as a core part of their business focus and concentration. The green innovation adoption concept in business originates from engineering and environmental studies, which assert the conservation, protection, and perseverance of the ecosystem and focus on implementing sustainable solutions. In business studies, the concept emerged from classical management philosophies in the 1800s and sprouted in the 1900s with massive promotion through research and practice in business, adding extensively to the literature on the subject. It implies to the business practices that involve new and novel ways that adopt modern advancements, transform manufacturing, production, business systems, and operations in a business, and support environmental sustainability (Xue, Boadu, & Xie, 2019). 'Green' comes from the concept of saving the environment, ecological and natural resources, and using environmental resources efficiently, saving them for future use and generations. The amalgamation of 'green' with 'innovation' evolved from an eco-innovation concept, which refers to the manufacture of products and services that are environmentally friendly and produced through processes that contribute to environmental sustainability (Khanra et al., 2022). Thus, the notion encircles organic production, pollution prevention, waste management, recycling, resource utilization, and process engineering through novel and technologically inventive ways.

The emerging global constructs, after the intensification of technological expansions and the latest disruptions caused by the pandemic and other economic turmoil, bring forth the obligation for businesses to adopt green practices and build their competitive advantage primal through eco-innovative approaches. To embrace sustainability and to hold endurance, global competition compels business organizations to infuse green innovation into their practices. Government authorities in developed and developing nations alike, under the realm of neo-institutional belief, are taking measures to strengthen the associative bonds between organizations and their green practices. Stringent laws, reforms, and revised policies are enacted to reinforce organizations' part in environmental perseverance (Upadhyay, 2020). The global environmental goals under SDGs (Sustainable Development Goals) accentuate the upgradation of

industries to render sustainability, adopt efficient use of resources with enhancement in technology deployment, and expansion in the use of cleaner production as well as waste management systems by 2030 (Global Goals, 2021). Environmental degradation, carbon emissions by industries, and environmental externalities impose a stark threat to the global ecosystem, hence, rigorous environmental regulations on businesses have carved a new competitive landscape for competing businesses today (Ouyang, Li, & Du, 2020; Rosati, & Faria, 2019).

Rendering to the stakeholder's theory on green innovation adoption, it is emphasized that organizations are built upon an interwoven connection between the firms' structures and their internal/external stakeholders. These stakeholders provide the juncture for businesses to create value for all constituent stakeholders, which are, in turn, responsible for business sustenance through an intertwined support system. In this stance, the attitude of customers, who are the most fundamental segment of stakeholders, has recently been observed to be significantly inclined towards green consumerism (Halder, Hansen, Kangas, & Laukkanen, 2020), and favoring green organizations (Gilg, Barr, & Ford, 2005). Tseng et al. (2013) emphasized on impact of environmental concerns on economic as well as organizational level development and stressed the importance of conserving resources for firms' long-term sustenance and growth. With the onset of green innovation adoption strategies, the firms also face a multitude of new external forces encompassing green competition to environmental management discourse (Soewarno, Tjahjadi, & Fithrianti, 2019; Landrum, & Ohsowski, 2018). Thus, to acquire a sustainable competitive advantage, firms need to delve into the core of eco-innovation. Firms that fail to adhere to eco-innovation are responsible for generating a mass degradation of environmental resources. According to the modern view of the stakeholders' perspective, the suppliers, consumers, and other stakeholder groups call for eco-friendly practices from firms, with minimal environmental damage or embedding any sizable ecological footprint. Efficient use of resources is another urging concern from patronizing participants (Mercado-Caruso et al., 2020), especially the green consumer advocacies (Agu et ., 2024), which demand organic produce, green packaging, and minimal wastage through the use of bio-degradable resources and ecological conservation; competing rivals, who incorporated green innovation; and regulatory authorities who compel firms to employ greening in their business practices (Buysse, & Verbeke, 2003).

The theoretical concept of the study is based on Ecological Modernization Theory (EMT), which posits that technological advancements, combined with environmental reforms, can drive both ecological sustainability and economic growth. EMT provides the theoretical foundation for examining how green process innovation and green product innovation interact to enhance organizational performance across operational, ecological, and financial dimensions. The root source of environmental instability today is the technology disruptions. The technological interface has shifted so rapidly in the past few decades that it has not only changed the entire business canvas but also has deeply impacted the social sensitivities and discernments of consumers (Kiss et al., 2024; Rao & Holt, 2005). In this regard, it is valid to state that the changes in the environment related to all three aspects of organizational performance—operational, ecological, and production— have not been studied in the previous literature under one study. However, the studies suggest that environmental factors are not static but fluctuate (Hoffmann et al., 2022). The contingency management approach, hence, also implies an unpredictable nature of the external environment and its instability that needs to be addressed to meet organizational objectives. Moreover, as green innovation and environmental concerns are pervasive issues today, their fusion with dynamic environmental variables is limited in the previous literature.

The competitive business scenario obligates organizations today to adopt green and eco-innovative practices to compete in the ever-evolving business environment (Cheng et al., 2023). However, despite the rising global emphasis on

sustainability and environmental responsibility, empirical research remains focused on examining the combined effects of critical dimensions of green innovation on organizational performance, which has been studied by disentangling all three dimensions in this study. This study diverges from traditional approaches by focusing on the mediating role of green products and process innovation practices. While prior research has established the association between green innovation and performance, few studies have explored how green process innovations specifically enhance product innovations, and how these, together, impact the three-dimensional organizational performance. This study also addresses a critical gap by proposing and testing a conceptual framework that positions green process and product innovation as serial mediators between green innovation and organizational performance. By examining this serial mediation relationship, this study contributes a novel kknowledge of how green practices can holistically improve organizational efficiency. Furthermore, this research covers the underexplored context of the construction industry in a developing economy, i.e., Pakistan, addressing a significant gap in the literature and advancing new insights into how green strategies function outside the existing Western-centric frameworks.

In the next segment of the paper, relevant literature related to the study variables has been presented, and hypotheses are formulated based on theoretical grounds and literature validation. In the subsequent sections, in the rest of the paper, the research methodology utilized to conduct the research, research results and outcomes, discussion of findings, and finally, the study conclusion are presented.

1.1 Research Questions

This study intends to investigate the following two broad objectives:

1. What is the impact of green innovation (green process innovation and green product innovation) on the operational, financial, and ecological performance of organizations?
2. How do green process innovation and green product innovation mediate the relationship between green innovation and organizational performance?

This paper constructs a model that organizations can use to obtain efficient performance by implementing green innovation through green products and green processes. The empirical results support that green innovation in organizations not only supports the overall performance of the organizations positively, but in some cases also has diverse impacts on multiple aspects of performance, such as production, ecological, and operational efficiencies. While previous literature has extensively explored the significance of green innovation on organizational performance, limited studies have examined the serial mediation between green processes and product innovations. Additionally, most research has treated green innovation as a monolithic concept, neglecting the interdependencies between different types of innovation (process vs. product) and their combined effect on multiple dimensions of performance. This study addresses this critical gap by analyzing the specific pathways through which green process innovation influences green product innovation, and how together they impact operational, ecological, and financial performance. By utilizing ecological modernization theory, this research offers a novel approach, linking green innovation adoption with multi-dimensional performance outcomes.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The global summit's commitment to adhere to the sustainable development goals in 1992, is a prolific example that emphasizes the importance of innovation and environmental concerns. Innovation at the heart of sustainability is compliance with environment friendly procedures in embracing the far-reaching changes in technology, infrastructure, and institutional practices. (Nuryakin & Maryati, 2020). Green innovation implies producing a new; or modifying an existing product through technology adoption and novel practices, that are aimed at reducing the impact on the environment. The 'innovativeness' in the green innovation concept is the novelty in production, product shape, its use, features, or characteristics. Innovation, as described

by Chang (2019) is the newness or creativity in organizations that bring forth new ideas molded them into reality through the proper utilization of technology and other resources. Similarly, the innovations are 'green' as they omit the likelihood of hazardousness to nature, resources, and the ecological environment at large. Production practices that involve environmental conservation, ecological sustenance, zero-waste strategies for production, and promotion of patterns for ecological consumerism are all part of green innovation.

The literature validates the significant and strong relationship between the study variables i.e., green innovation, organizational commitment to greening, organizational green image and identity, and performance (Ma et al., 2018). As the agents in the organizations tend to be more committed to green practices, the organizations realize 'greenability', and green practices are infused in their procedural systems. Chang (2019) emphasized the role of green innovation adoption by manufacturing organizations and asserted that greening helps enhance environmental and financial performance, and thus provides firms to achieve their competitive advantage to outperform other businesses in the industry. As business operations and value chain processes are interwoven, green practices help organizations achieve their operational efficacy. Similarly, the organization's operational efficiency and exergy efficiency were found to drive positive outcomes in the relationship between supply chain management and organizational performance in manufacturing firms (Zhao et al., 2018). Observing the trend, (Agustia et al., 2020) affirmed that green innovation practices not only lead to organizational efficiency, and sustainability but also improve a firm's performance. On the other hand, organizations concerned about their green identity and those that apply green creative practices through green strategies attain green innovation (Dangelico & Pujari, 2010). Organizational competencies and market shares could be enhanced through green innovation as the transforming consumer demands and awareness expect firms to be ecologically and environmentally responsive (Andersén, 2021; Chan et al., 2016). The recent studies on market consumerism and demand transformations in the digital era, literature emphasize that eco-friendly practices by firms such as lessening the negative by-stander impacts on societies, lower emissions of hazardous gases, increasing waste management processes, and employment of biodegradable resources, all refer to incumbent responses for organizations today, to remain in a competitive position. This eco-response encompasses green products and green process innovations.

While the literature establishes a general relationship between green innovation, organizational commitment to sustainability, and performance, many studies fail to consider the contextual factors that influence these outcomes. For instance, research by Xue et al. (2019) employed cross-sectional data, limiting the ability to establish causal links. Similarly, Chang (2019) highlighted the distinctively positive impact of green innovation on firm performance but overlooks industry-specific variables such as market competition and regulatory frameworks, which could moderate these effects. Contradictory findings also emerge; some studies suggest that green process innovation yields stronger performance outcomes emphasizing its impact on resource efficiency (De Jesus & Mendonça, 2018), while others prioritize green product innovation as it has an influential impact in shaping customers' perceptions (Anderson, 2023). Such inconsistencies require a more distinct approach to understanding the interplay between the two innovation types.

Furthermore, the literature emphasizes on benefits of green innovation without addressing its downsides such as high implementation costs, uncertain returns, and the risks associated with the integration of green processes into existing systems of the organization (Coad et al., 2022). All these concerns propose the potential drawbacks green innovation may cause to the organization. Hence, these inconsistencies call for a more nuanced analysis, such as the serial mediation explored in this study, which offers a clearer discernment of the dynamic interplay between green process and product innovations and their combined impact on organizational performance. Thus, the divergent

viewpoints explored in current literature underscore the importance of a balanced analysis, considering both the opportunities and challenges attributed to green innovation.

2.1 Organizational Performance

Organizational performance refers to an organization's capacity to make efficient utilization of its resources and produce an optimal outcome from the input resources. However, there is a need of a solid agreement on what explicitly signifies organizational performance. However, studies strongly suggest that an organization's performance is strongly represented by its growth (Chang, 2016). Literature also advocates various factors to measure organizational performance through multiple perspectives (Chang, 2016; Song et al., 2020), such as *i). Growth in total sales and revenue in a specific period of time ii). Market value of organizations' stocks, iii). Organizations' profitability iv). Change in production volume and capacity, v). Growth in market share,* and *vi). Number of employees.* Thus, it is inferred that there are several yardsticks through which the organization's performance can be measured. Sudaryati et al. (2020), in essence, to determine an organization's growth and performance, one has to keep the objective of research in mind. Nevertheless, the most common and well-established approach to measuring organizational performance in the literature is to assess the core production capacity and returns of the organizational functions. An organization's performance from the economists' point of view refers to the return on investments and the number of sales. Whereas the marketers see this through the lens of marketing perspective and expound it as the total market share seized by the organization. Similarly, the operational management perspective delineates it as the number of units/outputs produced by each number of inputs. This research in the proposition proffers to measure organizational performance concerning the pure managerial perspective and takes the relative production efficiency of the organization as a measuring standard.

In recent literature, many researchers have investigated the organizations' tendency to perform green in lieu of their contemporary performance so as to assess if green practices and innovations foster green outcomes and lead organizations to sustainable perseverance. When adopting green practices, organizations perform green i.e., they produce fewer bio-environmental hazards, follow green practices, adopt waste management systems, care for ecological wellbeing, and minimize resource wastage. Green performance according to Putri & Soewarno (2020), point to the measurement of the interface between a business and its environment.

2.2 Green Innovation and Organizational Performance

The majority of the competitive firms today, regardless of their size or nature, are involved in business practices complying with environmental regulations (Sudaryati et al., 2020). Although Woo et al. (2014), proclaim that larger-sized firms are required to invest more in green innovation than small firms, as they are more involved in producing anti-eco hazards and by-products. For organizations, the obligatory environmental regulations are not only a challenge but also provide them with an avenue to explore their competitive advantage related to the green innovation realm. (Zhang et al., 2020), where the response to the efficient use of natural resources and ecological receptiveness is an urgent call of the time. The increasing global population, higher demands, and technological breakthroughs have consistently put pressure on organizations to respond to energy crises, resource insufficiency, and sustainability goals. To address the ecological issues, organizations need to espouse energy conservation, utilize and re-utilize eco-friendly materials, and adopt pollution control strategies. According to recent surveys and research studies (Bhatia, 2021; Gao et al., 2018; Shahzad et al., 2020), managers consider an eco-innovative approach as a long-term strategic intent of organizations which in return can provide positive outcomes to organizational development. The environmental factors administering competitive pressures on firms and the opportunity to seize the benefits of impeccable market attractiveness, enforce organizations towards green innovativeness which is the recent tendency of emergent competitive

markets. Evidently, green innovation adoption paves an organization's way towards sustainability and development. Thus, in coherence with the above literature, we propose the first hypothesis:

H1a: Green Innovation significantly intensifies Green Process Innovation.

H1b: Green Innovation significantly intensifies Green Product Innovation.

H1e: Green Innovation has a significant positive impact on Organizational Production Performance.

H1c: Green Innovation has a significant positive impact on Organizational Ecological Performance.

H1d: Green Innovation has a significant positive impact on Organizational Operational Performance.

2.3 Green Process Innovation and Organizational Performance

The operations, mechanisms, and work systems in an organization refer to its processes. Green processes have gained much attention from businesses, researchers, environmentalists, and overall economies at large. The green process leads to sustainability concepts which have been widely regarded as a matter of concern in recent times. Green organizational process implies business actions that lead to reduced impact on the environment and ecosystem. The multitude of emphases on green process designs, enforce businesses today, to adopt green procedures that require less use of inputs, call for ecofriendly mechanisms, yield efficient use of resources, and also create recyclable by-products.

Recent literature, by and large, acknowledges that green innovation in organizations supports addressing environmental concerns. The external environment encompasses certain issues that directly and/or implicitly influence business operations and systems and affect their overall outcomes. Environmental concerns demand businesses to adopt practices that aid ecological sustenance. Organizations embrace green innovation to enhance the business environmental management process (Su et al., 2020). Innovation in business processes relates to technological, operational, managerial, or institution wide changes, however, the innovation turns into green innovation when the outcome of these changes results in the reduction of ecological impressions (De Jesus & Mendonça, 2018). Green processes, hence, create green organizations and generate organizational competitive advantage (Saengchai et al., 2019). Thus, with the above explanation we propose our next hypothesis:

H2a: Green Process Innovation has a significant positive impact on Organizational Ecological Performance.

H2b: Green Process Innovation has a significant positive impact on Organizational Operational Performance.

H2c: Green Process Innovation has a significant positive impact on Organizational Production Performance.

2.4 Green Product Innovation and Organizational Performance

Lately, vast literature and research studies have reported that managers from diverse industries are inclined to introduce green products. In recent years, research on green product innovation has also expanded, and further research interest in the subject has been developed (Huong et al., 2021). Latest reports on business insights on climate and ecological concerns transcribe that many organizations consider climate change and sustainability as the foremost issues and exhibit a dire need to produce or market innovative products that may meet varying demands. Although there is no consensus among the researchers to define green products nor a certain definition of the phenomenon has been propositioned so far, green products, as broadly coincided by researchers and as described by Nuryakin and Maryati (2020), is a products whose design, manufacturing, components and/or characteristics employs eco-friendly and/or biodegradable resources and which in its overall lifecycle instills positive ecological impact or reduces the negative ecological impact on the environment. Hence, the term 'green product' can be described as those products whose production, consumption, and disposition imply minimal impact on the environment. Besides, as the technological impetus is thriving, customer awareness about new products has increased and their demands for product innovativeness have stretched. Similarly, with

increased knowledge about the environment, sustainability, and greening, customers demand products, their packaging, and placements to be eco-and-environmentally responsive. In this essence, it is notable that the newer demands have intensified organizational interest in producing demand driven as well as technology driven innovative products. Even though the new world business standards compel organizations to adopt green practices, produce sustainable products, and create zero-waste. According to Ottoman et al (2006), green products protect or enhance the environmental ecology and impose no harm to nature. Hence, corroborating the above literature, the second hypothesis is proposed as:

H3a: Green Product Innovation has a significant positive impact on Organizational Ecological Performance.

H3b: Green Product Innovation has a significant positive impact on Organizational Operational Performance.

H3c: Green Product Innovation has a significant positive impact on Organizational Production Performance.

2.5 Green Process Innovation and Green Product Innovation

The root source of environmental instability today is the abruptions in technology. The technological interface has shifted so rapidly in the past few decades, that it has not only changed the entire business canvas but also has deeply impacted the social sensitivities discernments of consumers. The market demands players with more bargaining power and wide knowledge about available products and services through technology are themselves disconcerted. Whereas to meet the impulsive demand of buyers is a massive challenge for the suppliers. These fluctuating powers between the two market agents create a volatile and unpredictable market which is the core of environmental dynamism (Zhang et al., 2017).

Literature suggests that organizations that adopt green innovation strategies foster to maintain green processes in their manufacturing or service provisions. The green innovation concepts encompass the entire process concerning the application of novel and green ideas which encircles the concepts of resource efficiency and increased productivity. This implication is not only focused on producing efficient products but is prompted by the idea of green processes involving the sustainable development concept.

H4: Green process innovation and green product innovation create a serial mediation in the relationship between green innovation and organizational performance.

Figure 1. Conceptual Model [See Appendix 1]

3. MATERIALS AND METHOD

3.1 Questionnaire Development and Study Measurements

A self-administrative questionnaire was developed as a survey instrument to measure the study hypothesis. All items in the questionnaire were based on a five-point Likert scale rating (wherein 1 = strongly disagree and 5 = strongly agree) and were filled by the executives and managerial level employees of the firms, all measures of the study were adopted from previous literature. For *Green Product Innovation* a four-item scale was adopted from the studies of Amores-Salvadó et al. (2014) and Chiou et al. (2011). This scale included questions such as "Our organization uses less or non-polluting/toxic materials for manufacturing and packaging". For *Green Process Innovation* a four-item scale was adopted from the study by Frondel et al. (2007) and included questions like "Our organization uses recycled materials, recycling techniques, and environmental technologies in business processes". Whereas for green innovation another three-item scale was adopted from Chen et al. (2006). The construct *Organizational Production Performance* was measured through a three-item scale and was adopted from the study of Shaikh and Khoso (2019). Sample items include "Our organization's sales growth has increased over time" and "Our organization's profits have increased over time". The *Organizational Ecological Performance* construct was measured through a four-item scale, adopted from Xue, Boadu, and Xie (2019). The sample item of the scale was "Compared to key competitors, our organization's ability to reduce air

emission, waste, and solid waste is better". The *Organizational Operational Performance* was measured through a four-item scale, adopted from the studies of Ward and Duray (2000) and Chang et al. (2012). The scale included items such as "Our organization produces high-quality products that meet our customer needs". A pilot study with 30 respondents from the target population was conducted. This pilot study helped to refine the items, improve clarity, and reduce ambiguity. Construct validity was established through confirmatory factor analysis (CFA) during the pilot study, and reliability was evaluated by employing Cronbach's alpha and composite reliability (CR) tests, the findings of both tests was above the required threshold of 0.7, vaalidating the tool's robustness.

3.2 Data Collection and Study Sample

The sample of this study is chosen from a variety of sectors in the construction industry in Pakistan due to its significant environmental footprint and growing interest in green innovation. The sectors selected—cement, steel, electrical manufacturing, and wood installations—represent critical components of the industry, each with unique challenges in adopting sustainable practices. These sectors face increasing regulatory pressures to minimize carbon emissions and augment resource efficiency, making them ideal for studying the impact of green processes and product innovations. Furthermore, the literature reveals a gap in research on how green innovation affects organizational performance in emerging countries' construction industries, particularly in terms of operational and ecological performance. This study fills that gap by focusing on a high-impact industry with untapped potential for innovation-driven sustainability. A variety of sectors within an industry were included in the study to improve the generalizability of the study findings and to validate the proposed framework.

This study employed a purposive sampling technique, targeting executives and managers from five leading organizations within the construction industry. The sample size of 286 respondents was determined based on the recommended rule for SEM analysis, which proposes inclusion of atleast 10 respondents per indicator variable (Hair et al., 2021). This approach ensures the adequacy of the sample for structural equation modeling (SEM) and improves the robustness of the statistical findings. The questionnaire was distributed with the help of the human resources (HR) department of each organization by visiting each organization's HR department and explaining to them the study purpose and assuring data confidentiality.

3.3 Data Analysis Technique

For analysis, the acquired data was analyzed through Smart-PLS software and PLS-SEM was performed to deduce inferential results. This study employed PLS-SEM due to its appropriateness with exploratory research design and its capability to process intricate models with multiple mediation effects. Given the study's focus on green innovation's serial mediation effects on multiple dimensions of organizational performance, PLS-SEM offers greater flexibility in handling data that is not normal and smaller sample sizes (Hair et al., 2019). Statistical tools were applied to generate descriptive statistics results (See Table. 1). In SEM, measurement and structural analyses are conducted. The measurement model was analyzed to find convergent validity through average variance extracted (AVE), whereas the discriminant validity was measured by Fornell and Larcker's (1981) criterion. The model reliability was ascertained through composite reliability. Furthermore, the hypotheses testing and mediating effects were analyzed using the structural model.

3.4 Descriptive Analysis

The respondents of the study constituted of 72% male and 28% female. 18% of the respondents were 24-30 years old, 34% were 31- 37 years old, and 48% were 38-45 years old. 75% of the respondents had master's or equivalent post-graduate qualifications, whereas the remaining 25% were graduates and diploma holders. Lastly, a majority (59%) of the respondents had 5-10 years job experience. The results of descriptive statistics are presented in Table 1 below.

Insert Table 1 here. Descriptive Statistics [See Appendix 2]

4 RESULTS

This study employed the Structural Equation Modeling (SEM) method which offers researchers with a robust tool to examine the causal relationship between the studied variables in the model. Chin (1998) noted that SEM uses a flexible technique to draw inferences and involves both complex measurement and structural modeling. Hence, the PLS-SEM method has been administered in this study and SmartPLS software was used to analyze the data. To evaluate the research instrument, measurement model, validity, and reliability tests are conducted.

4.1 Measurement Model

The data collected for this study is primary in nature hence the validation of research instrument was imperative by establishing the reliability for the measurement scales used to measure all the study constructs. To determine the reliability of the scales, Composite Reliability (CR) and Cronbach's Alpha values are reported (See Table 2). The CR values of all constructs are greater than 0.70, whereas the Cronbach Alpha for all variables is above the required threshold. Thus, the reliability of scales is established.

4.2 Discriminant Validity

The discriminant validity of the measurement instrument was assessed by employing the Fornell Larcker Criterion (FLC) and Heterotrait-Monotrait Ratio (HTMT). Meanwhile, to measure the convergent validity of the model cross-loadings of the constructs are presented. The results of the FLC values of all the constructs of this study are reported to be above the required threshold i.e., 0.5 (Fornell & Larcker, 1981), and the HTMT results show that the values of all the variables are below the 0.90 cutoff, thus confirming the discriminant validity. To determine the strength of the measurement technique and instrument, construct validity is ascertained through cross-loadings. According to Hair Jr, Hult, Ringle, & Sarstedt (2021), a appropriate fit of a model comprises that all factors loadings are well loaded with their corresponding constructs, thus table 2. shows the loading results of all factors that are above the required value of 0.6, which demonstrates the construct validity.

4.5 Convergent Validity

The convergent validity of the model is assessed through the Average Variance Extracted (AVE). The table – reveals that all AVE values are under the 0.5 threshold, as suggested by Hair, Risher, Sarstedt, and Ringle (2019).

Table 2. Construct Reliability and Validity [See Appendix 3]

Table 3. Fornell Larker Criterion [See Appendix 4]

Table 4. Cross Loadings [See Appendix 5]

Table 5. Heterotrait Monotrait (HTMT) Ratio [See Appendix 6]

Table 6. Path Coefficients [See Appendix 7]

4.6 Hypothesis Testing

Table 6. Explains the results of the hypothesis which are based on the relationship between independent variables - green innovation; dependent variables - organizational production performance, organizational ecological performance, and organizational operational performance; and mediating variables – green process innovation and green product innovation integrated in this research. The relationship of the variables is justified through the path diagram (See Figure 1) that demonstrates the values that are required to evaluate the study. According to the study findings and hypotheses tests, the hypotheses H1a, H1c, H2c, H3a, H3b, and H3c are supported with significant p-values. Whereas the hypotheses H1b, H1d, H1e, H2a, and H2b are not supported.

The hypothesis results prove that there is a significant positive relationship between green innovation, green process innovation, and organizational ecological performance however, overall green innovation does not imply a significant relationship with organizational production or operational performance. The results show a positive but weak path coefficient for green innovation's impact on production (0.092, $p = 0.093$) and operational performance (0.047, $p = 0.279$). This disparity may be attributed to the fact that many organizations prioritize ecological initiatives driven by regulatory compliance and environmental pressures while neglecting the integration of green innovation into their production systems and operational processes. Such neglect could explain the weaker impact on non-ecological performance

measures. Moreover, the green product innovation significantly relates to all three dependent variables i.e., organizational production, ecological and operational performance, whereas the green process only supports the relationship with organizational production performance. Lastly, the objective of this study to assess the serial mediation analysis between green process innovation and green product innovation between the relationship of IV and DV is also proved (H4).

The PLS-SEM analysis showed that green product innovation had a path coefficient of 0.628 ($p < 0.001$) for improving operational performance and 0.307 ($p < 0.001$) for enhancing ecological performance. In contrast, green process innovation had a path coefficient of 0.195 ($p = 0.001$) for improving production performance. These results suggest that firms seeking to improve operational and ecological performance should focus on product-level innovations, whereas process-level innovations are more effective for production efficiency.

Furthermore, hypotheses, including H1b (Green Innovation → Green Product Innovation), H1d (Green Innovation → Organizational Operational Performance), and H2a (Green Process Innovation → Organizational Ecological Performance), were not supported. The reason for the insignificant relationships between these variables could be due to various contextual and industry-specific factors that could explain these outcomes (See discussion section).

Figure 2. Structural Model (Path Diagram) [See Appendix 8]

5. DISCUSSION AND CONCLUSION

Previous research literature suggests that green innovation plays an essential role in organizational performance. However, a thorough analysis to assess the impact of green innovation on multifaceted dimensions, including organizational production, ecological, and operational performance was widely ignored. According to Nuryakin & Maryati (2020), organizational performance and competitive capability of organizations to adopt green and innovative practices are influenced by green innovation adoption as it has a deep impact as per empirical results. Thus, this study attempted an extensive investigation to provide empirical evidence of the relationship between green innovation with organizational performance, and to ascertain the serial mediation or chain of relationship between green innovation and organizational performance. The study results demonstrate that green innovation generates a significant positive impact on organizational ecological performance but fails to provide positive production or operational output. The reason for this could be connected to the survey responses that indicate that many organizations in developing countries, such as those in the Pakistani construction sector, have focused their green innovation efforts on compliance with environmental regulations (Singh et al., 2020), rather than on fully integrating these innovations into their production lines or operations. Moreover, it has been observed that green innovation creates a sense of sustainability and ecological concern in organizations however due to the disengagement of corporate practices to operationalize green practices, infrastructural challenges– such as outdated manufacturing equipment or lack of access to green technologies– and the Human Resource skills gap– such as lack of technical knowledge– in the organization may lead to poor or inadequate production or operational returns. Survey data from this study supports corporate disengagement as one of the attributes of lack of operational and production outcomes, with 45% of respondents indicating that their firms had not developed comprehensive strategies to incorporate green processes into everyday production. Moreover, skill gaps among workers and managers were identified as key barriers, with 52% of respondents highlighting a lack of training in green technologies. This aligns with previous findings by Van den Berg et al. (2013), who found that skill deficiencies and organizational resistance to change often hinder the effective implementation of green practices.

As Van den Berg, Labuschagne, and Van den Berg (2013), revealed a positive relationship between the green innovation process and environmental performance, with statistical results he found out that we can lessen resource consumption and waste material along with the help of green innovation that

benefits the organizational environment. Similarly, green process innovations prove to generate green product innovation as the relationship between the two mediating variables is logically linked (Singh et al., 2020).

Organizations that tend to embed green innovation techniques into their processes manage to produce green products. The results also confirm that green product innovation mediates the relationship between green innovation and performance more effectively than green process innovation, with a stronger mediation effect observed in the ecological and operational dimensions. The mediation analysis showed that green process innovation significantly contributed to production performance ($\beta = 0.195$, $p < 0.001$), while green product innovation had a stronger impact on both ecological ($\beta = 0.307$, $p < 0.001$) and operational performance ($\beta = 0.628$, $p < 0.001$). These results suggest that while process innovations help streamline production, product innovations more directly influence ecological and operational outcomes. The study finding provides a unique insight into the subject and fill the literature gap through the provision of in-depth and extensive research attempts. The study findings also suggest insignificant relationships between various variables and some hypotheses, including the relationship between Green Innovation and Green Product Innovation; Green Innovation and Organizational Operational Performance; and Green Process Innovation and Organizational Ecological Performance were not supported. These results reveal that there could be contextual or industry-specific reasons that are responsible for yielding such outcomes. For instance, insignificance between green innovation and green product innovation implies the nature of the construction industry in Pakistan which tends to prioritize compliance with environmental regulations over proactive product innovation. Moreover, outdated production practices and limitations in acquiring skilled personnel may constrain the transformation of green innovation into tangible green product advancements. Similarly, the insignificant relationship of green innovation with green operational performance and green ecological performance could be related to constraints associated with the limitations of fully integrating green practices in organizations including financial and infrastructural barriers that may dilute the benefits of gaining green operational and ecological performance outcomes.

5.1 STUDY IMPLICATIONS

The theoretical implications of this study contribute to a deeper understanding of green innovation within organizational contexts, specifically enriching the literature on organizational development, behavior, and sustainability practices. This research advances ecological modernization theory by connecting it to practical organizational strategies, showing how green innovation in processes and products directly improves operational, ecological, and financial performance. Our findings suggest that green innovation significantly enhances an organization's capacity for ecological performance, allowing firms to adopt green practices as a strategic tool for boosting resource efficiency and overall output.

5.1.1 Managerial Implications:

Managers should develop strategic plans that prioritize ecological concerns and integrate green processes and products into their operations. Firms in developing countries, in particular, need to address existing barriers—such as insufficient infrastructure and lack of expertise—to effectively implement green innovations. Targeted interventions, such as training programs and technology upgrades, could help overcome these obstacles. While firms adopting green innovation are more likely to experience improvements in ecological performance, the firms also face certain barriers such as the requirement of significant upfront investments in new technologies and processes, infrastructure limitations, or slow returns of ecological benefits translated as operational gains. However, the firms that may overcome these challenges may achieve long-term gains, both in terms of cost savings through resource efficiency and gaining sustainable competitive advantage in a market.

5.2 Policy Recommendations:

The study highlights the importance of green innovation in addressing global environmental challenges. Policymakers should encourage and support organizations, particularly in developing

economies, to adopt greener practices by providing incentives, infrastructure support, and regulatory frameworks that promote sustainability.

5.3 Further Research Direction:

Future research can explore the specific industries and geographic regions that may require more nuanced approaches to green innovation. Additionally, longitudinal studies could measure the long-term impacts of green innovation on both financial and ecological performance.

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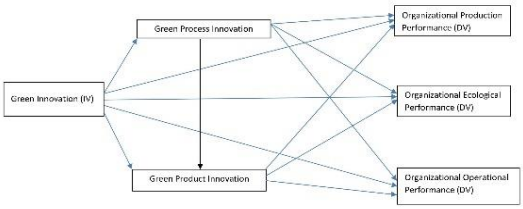
Appendix 1. Conceptual Model



Appendix 2

Table 1. Descriptive Statistics

Profile	Category	Percentage
Gender	Male	72
	Female	28
Age	24-30 years	18
	31-37 years	34
	38-45 years	48
Qualification	Graduate	75
	Postgraduate	25
Work Experience	0-3 years	-
	3-5 years	06
	5-10 years	59
	10-15 years	10
	15-20 years	17
	21 years or above	08

Appendix 3

Table 2. Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Green Innovation	0.988	0.991	0.991	0.965
Green Process Innovation	0.757	0.758	0.845	0.577
Green Product Innovation	0.962	0.965	0.972	0.898
Organizational Ecological Performance	0.849	0.877	0.896	0.683
Organizational Operational Performance	0.932	0.933	0.952	0.833
Organizational Production Performance	0.782	0.790	0.873	0.696

Appendix 4

Table 3. Fornell Larker Criterion

	Green Innovation	Green Process Innovation	Green Product Innovation	Organizational Ecological Performance	Organizational Operational Performance	Organizational Production Performance
Green Innovation	0.982					
Green Process Innovation	0.167	0.759				
Green Product Innovation	0.119	0.221	0.948			
Organizational Ecological Performance	0.214	0.166	0.343	0.827		
Organizational Operational Performance	0.126	0.171	0.639	0.288	0.913	
Organizational Production	0.154	0.265	0.300	0.432	0.260	0.834

Appendix 5

Table 4. Cross Loadings

	Green Innovation	Green Process Innovation	Green Product Innovation	Organizational Ecological Performance	Organizational Operational Performance	Organizational Production Performance
GI1	0.992					
GI2	0.986					
GI3	0.975					
GI4	0.977					
GPsI1		0.752				
GPsI2		0.761				
GPsI3		0.757				
GPsI4		0.767				
GPtI1			0.966			
GPtI2			0.963			
GPtI3			0.972			
GPtI4			0.887			
OEP1				0.832		
OEP2				0.874		
OEP3				0.841		
OEP4				0.755		
OOP1					0.919	
OOP2					0.933	
OOP3					0.946	
OOP4					0.849	
OPF1						0.819
OPF2						0.866
OPF3						0.816

Appendix 7

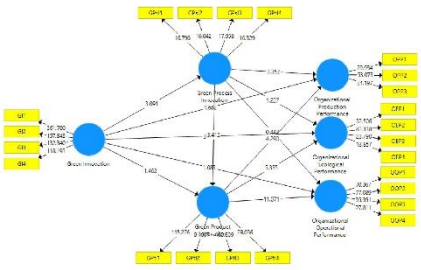
Structural Model

Table 6. Path Coefficients

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Hypotheses
Green Innovation -> Green Process Innovation	0.167	0.054	3.091	0.002	H1a Supported
Green Innovation -> Green Product Innovation	0.085	0.058	1.462	0.144	H1b. Not Supported
Green Innovation -> Organizational Ecological Performance	0.166	0.050	3.324	0.001	H1c Supported
Green Innovation -> Organizational Operational Performance	0.047	0.043	1.083	0.279	H1d Not Supported
Green Innovation -> Organizational Production Performance	0.092	0.055	1.682	0.093	H1e Not Supported
Green Process Innovation > Organizational Ecological Performance	0.070	0.057	1.227	0.220	H2a Not Supported
Green Process Innovation > Organizational Operational Performance	0.025	0.056	0.442	0.659	H2b Not Supported
Green Process Innovation	0.195	0.058	3.352	0.001	H2c

Appendix 8

Figure 1. Structural Model (Path Diagram)



Source: Data Analysis