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RESEARCH PAPER

An Empirical Investigation of Internal Drivers and Sustainable Business Outcomes of Eco-Innovation adoption in Manufacturing Industry of Pakistan

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ABSTRACT

The study examines the dynamics of eco-innovation adoption in Pakistan's manufacturing industry, particularly focusing on the impact of internal drivers of EI such as technological capabilities, cost reduction, managerial environmental concern, and environmental strategy focus on sustainable business performance of the firms. The study also investigates the function of eco-innovation as a mediator in the relationship between these drivers and sustainable business performance. Data were gathered using an online questionnaire from lower, middle, and upper management of small, medium and large industrial enterprises in Pakistan. A complete empirical analysis reveals that all hypotheses are accepted, emphasizing the significant impact of internal determinants for eco-innovation adoption. Furthermore, the study underlines the crucial role of eco-innovation as a mediator, reinforcing the link between internal drivers of eco-innovation adoption and the attainment of sustainable business performance. This study adds vital insights into developing environmentally responsible manufacturing methods, with practical consequences for firms, legislators, and researchers.

KEYWORDS Cost Reduction, Eco-Innovation, Environmental Strategy Focus, Managerial Environmental Concern, Sustainable Business Performance, Technological Capabilities

Introduction

The manufacturing sector in Pakistan has been a significant contributor to economic growth, accounting for 12.01% of the country's GDP, employment generation, and export earnings (Pakistan Economic Survey, 2023). However, this growth has been accompanied by environmental challenges, including pollution, resource depletion, and carbon emissions, making Pakistan one of the most pollution-affected countries in South Asia (Raza et al., 2021). The industrial sector, responsible for over 49% of the country's total CO2 emissions, faces increasing pressure to adopt sustainable practices that balance economic, social, and environmental considerations (Dale, 2021).

To address these challenges, a paradigm shift towards sustainable and eco-friendly practices, known as Environmental Innovation (EI), is crucial. EI involves the introduction of new or significantly improved products, processes, organizational changes, or marketing solutions that reduce the use of natural resources and minimize harmful substance release throughout the life cycle (García-Quevedo, Kesidou & Martínez-Ros, 2020; Eco-Innovation Observatory, 2012). Various dimensions of EI, including technological, institutional, and organizational aspects, have been proposed by researchers (Ben Amara & Chen, 2022; Carrillo-Hermosilla, Del Río, & Könnölä, 2019).

Despite the growing importance of EI, limited literature has provided a comprehensive framework for understanding its determinants and impact on firm performance (Del Río et al., 2016). Although the prior research on EI drivers and outcomes consider both internal and external factors, including environmental management, technological capabilities, and stakeholder implications (Frigon et al., 2020). However, there is a particular gap in understanding the role of internal factors such as resources, competencies, and dynamic capacities in generating EI (Mazzanti and Zoboli, 2019).

Moreover, the existing research on EI has predominantly focused on developed countries, leaving a significant gap in understanding the motivations and challenges faced by developing countries like Pakistan (Aloise and Macke, 2017; Bossle et al., 2016; Cai and Zhou, 2014; Chen et al., 2017; Sanni, 2018). This knowledge gap hinders the development of contextually relevant policies and strategies for promoting EI in these regions.

The current study also highlights the evolving importance of sustainable business outcomes, encompassing economic, social, and environmental dimensions (Pichlak & Szromek, 2021). While prior research has explored various performance dimensions resulting from eco-innovation, including cost reduction, profitability, competitiveness, and firm image, sustainable business outcomes covering all three dimensions have received limited attention (Ch'ng et al., 2021).

In light of these gaps, the current study aims to investigate the impact of internal drivers, such as technological capabilities, managerial environmental concern, environment strategy focus, and efficiency-induced cost reduction, on eco-innovation. The mediating role of eco-innovation adoption in influencing sustainable business outcomes (economic, environmental, and social) is examined. This research contributes valuable insights into the mechanisms driving eco-innovation in the manufacturing sector in Pakistan and its implications for sustainable business practices. By addressing these gaps, the study aims to provide a foundation for the development of effective policies and strategies to promote eco-innovation in the context of developing countries, ultimately fostering a more sustainable and environmentally conscious manufacturing sector.

Theoretical Foundations, Literature Review & Hypotheses Development

Concept of Eco-Innovation

Eco-innovation, a multifaceted concept at the intersection of various disciplines including economics, environmental science, technology, and social studies, necessitates a nuanced theoretical framework to comprehensively understand its implications for organizational performance. Drawing on the resource based view (RBV), firms may use their unique resource bundles to gain a competitive edge and improve long-term business outcomes. To construct obstacles to replication in EI, this includes focusing on green skills, strategic collaborations, environmental knowledge, and aligning environmental plans with core strengths (Hazarika & Zhang, 2019b).

Similarly, the dynamic capability view (DCV) offers insights into how organizations build and deploy capabilities to respond to evolving sustainability problems, improving adaptability and long-term business success (Bag et al., 2022). Furthermore, applying the dynamic capability view (DCV) to the EI adoption phenomenon provides a lens for understanding how businesses build and deploy capabilities to effectively respond to the dynamic and evolving problems of sustainability (Arranz et al., 2020). The DCV framework is centered on a company's ability to modify, acquire knowledge, and innovate in response to changing surroundings, resulting in long-term business outcomes (Bag, Dhamija, Bryde, & Singh, 2022).

Impact of Technological Capabilities and Cost Reduction on Eco-Innovation

Technical turbulence can occur as a result of variations in industrial technology standards, which can lead to uncertainty induced by the quick speed of development. Companies who are unable to keep up with these changes may feel endangered (Ahmad et al., 2022). As a result, businesses are compelled to adopt new technology in order to improve internal efficiency (Cainelli et al, 2020). This increased efficiency can be achieved by cost-cutting measures as well as equipment upgrades. Cost savings are important motivators for businesses to reduce resource consumption, such as energy and inputs (Ahmad, 2021).

However, some businesses see environmental preservation as an expensive investment. According to Palmer et al. (1995), cost savings from EIs may be greater than the costs of environmental compliance. As a result, cost savings alone may not be sufficient to drive environmental innovation. Environmental laws, on the other hand, according to Porter and Vander Linde (1995), can motivate firms to engage in EI. They contend that more efficient and rational resource usage can offset any cost increase, resulting in increased competitive advantage and performance (Mahmood et al., 2022).

Several studies support the notion that EI offers opportunities for cost savings. For example, EI can enhance production effectiveness, reduce the consumption of raw materials and energy, and improve resource efficiency (Demirel et al., 2019). Additionally, implementing Environmental Management Systems (EMS) can contribute to environmental protection, such as green product design, recycling, source reduction, and pollution prevention (Cai et al., 2018).

Based on the above argument, following hypotheses are drawn:

H1: Technological Capabilities has a positive impact on EI adoption.

H2: Cost Reduction has a positive impact on EI adoption.

Impact of Managerial Environmental Concern and Environment Strategy Focus on Eco-Innovation

The significance of internal factors in effectively addressing environmental issues within companies has been increasingly emphasized in the literature. According to Peyravi et al. (2022), the success of EI programs relies on management abilities and capabilities. These authors highlight several critical roles of executives in EI, including:

- Managing EI alongside other company-related issues, such as time and quality, recognizing that environmental issues are essential challenges but not the sole focus.
- Integrating different departments and their actions, as sustainability, should permeate the entire organization and involve various departments.

- Developing cooperation with other companies to address common problems or leverage collective strengths, especially when a single company lacks the necessary competencies.
- Collaborating with public institutions to gain support and develop innovative environmental policies.

For EIs to succeed in the market and contribute to sustainable development, top management must achieve their environmental and social goals while delivering superior products and processes that hold recognized consumer value. Top management must be viewed as firm leaders who envision a systemic and long-term impact of environmental initiatives. These executives should be able to evaluate the advantages and disadvantages of adoption as well as address the company's environmental culture (Al-Shami & Rashid, 2022).

In alignment with the idea of upper echelons theory, managers play a crucial role in shaping a company's strategy, and their awareness of the importance of environmental issues can influence convincing others to adopt an environmental strategy. Environmental management concern has been highlighted as a significant determinant of environmental innovation strategy (Eiadat et al., 2008) and a critical component in developing a favorable image and reputation.

Besides, historically, companies viewed environmental strategy as conflicting with their goals of growth, competitiveness, and profitability (Salim, Ab Rahman, & Abd Wahab, 2019). The perception was that economic growth came at the expense of the environment, and innovation was closely tied to economic expansion. However, the increasing awareness of environmental issues among consumers and social and government pressures for companies to reduce their environmental impact has shifted the perspective. To achieve strategic and economic success, companies now recognize the importance of considering social and environmental factors when developing innovations (Ch'ng et al., 2021).

Environmental innovation strategy encompasses practices to mitigate a company's environmental impact, such as pollution reduction, prevention, and adopting environmental management systems (Eiadat et al., 2008). But why should companies integrate sustainability into their strategies? There are several critical reasons for this, including:

- Moral duty and responsibility: Companies are ethically obligated to contribute to a clean and sustainable environment (Nguyen et al., 2022).
- Economic and financial advantages: Embracing sustainability can lead to cost savings, increased efficiency, and improved resource management, benefiting a company's bottom line (Larbi-Siaw et al., 2022).
- Organizational culture: Sustainability becomes an integral part of a company's values, norms, and practices, shaping its overall organizational culture (Paraschivetal.,2012).

Upper Echelons Theory highlights the influence of top managers' attitudes, cognitive frames, and demographic traits on the adoption of Eco-Innovation (EI). When top executives possess strong environmental values, EI aligns with sustainability goals. Their environmental cognition enables them to recognize the competitive advantages and environmental benefits of EI, prioritizing it in strategic decisions. The theory emphasizes that top managers' characteristics mold values, perspectives, and decisions, influencing organizations to adopt EI and contribute to sustainable, environmentally responsible business practices. Hene the current study further hypothesizes as follows:

H3: Managerial Environmental Concern has a positive impact on EI.

H4: Environment Strategy Focus has a positive impact on EI.

Impact of Eco-Innovation on Sustainable Business Performance

To establish a direct link between Eco-Innovation (EI) and sustainable business outcomes, the concept of sustainable business outcomes must be defined. It encompasses two key considerations: the company's ability to generate profits and ensure long-term survival, and its capacity to deliver products or services without harming the environment or society's overall well-being (Almeida et al., 2023). A sustainability strategy aims to maximize internal and external resources for optimal financial returns, aligning with stakeholders' interests in supporting long-term business health and survival, as well as broader economic, social, and environmental systems (Ben et al., 2021).

The shift toward integrating social and environmental sustainability into strategic performance poses a challenge for many companies. Three crucial performance metrics in the context of sustainable business outcomes include financial sustainability, meeting present and future needs; social sustainability, meeting people's needs and fostering development; and environmental sustainability, focusing on protecting and renewing the biosphere (Pava, 2007). Scholars emphasize the equal importance of all three dimensions for a firm's sustainability (Larbi-Siaw et al., 2023).

The proposed link between EI and improved sustainable business outcomes is based on various factors. EI, as advocated by Porter et al. (1995), encourages efficient resource use, lowering production costs and increasing income. EI strategies optimize resources, enhancing competitiveness and distinguishing businesses from rivals. The resource-based view suggests that distinctive capabilities from internal and external resources offer a lasting competitive advantage (Xuhua, Larbi-Siaw, & Thompson, 2023). The European Commission underscores the importance of technology usage and innovation to improve the financial and environmental value of products and services (2010). Implementing EI enhances cash flow and overall business performance (Almeida et al., 2023). Environmental innovations in products stimulate demand by delivering environmental and social benefits to consumers (Xin, Miao, & Cui, 2023). Additionally, environmental innovation allows companies to improve resource productivity, balancing increased environmental costs (Yang & Jiang, 2023). Positive links between environmental performance and environmental innovation activities indicate the favorable impact of environmental innovation on business performance. Hence the current study further hypothesizes as follows:

H5: EI adoption has a positive impact on Sustainable Business Outcomes.

Mediation of Eco-Innovation in the relationship between firm internal drivers of eco-innovation adoption and sustainable business outcomes

Previous studies (Miao, Iqbal, & Ayub, 2023; Wang et al., 2020; Hazarika, & Zhang, 2019) highlight the mediating role of Eco-Innovation (EI) between environmental-related characteristics and economic outcomes. Research suggests that EI influences top managers' attitudes, dynamic capabilities, and response to stakeholder pressure, enhancing a firm's performance and competitive advantages. Management teams with strong environmental dynamic capabilities, informed about ecological risks and compliant with regulations, gain a competitive edge (Wang et al., 2020). Businesses adopting EI differentiate themselves from competitors and achieve cost advantages (Almeida et al., 2023). Dynamic skills alone are insufficient for competitive advantage without generating EIs. The Natural Resource-Based View (NRBV) asserts that senior managers' proactive stance on environmental issues is crucial for a firm's competitiveness. Cost savings and distinctiveness result from orientations and resources leading to EI activities like energy reduction and process simplification. Recognizing these mediating effects of EI enables firms to leverage eco-innovation for long-term sustainability and competitive advantages. Hence the current study finally hypothesizes as follows:

H6: EI mediates the relationship between technological capabilities and sustainable business performance.

H7: EI mediates the relationship between cost reduction and sustainable business outcomes.

H8: EI mediates the relationship between managerial environmental concern and sustainable business outcomes.

H9: EI mediates the relationship between environment strategy focus and sustainable business outcomes.

Theoretical Framework

Based on the literature reviewed, the current study establishes the following theoretical framework:

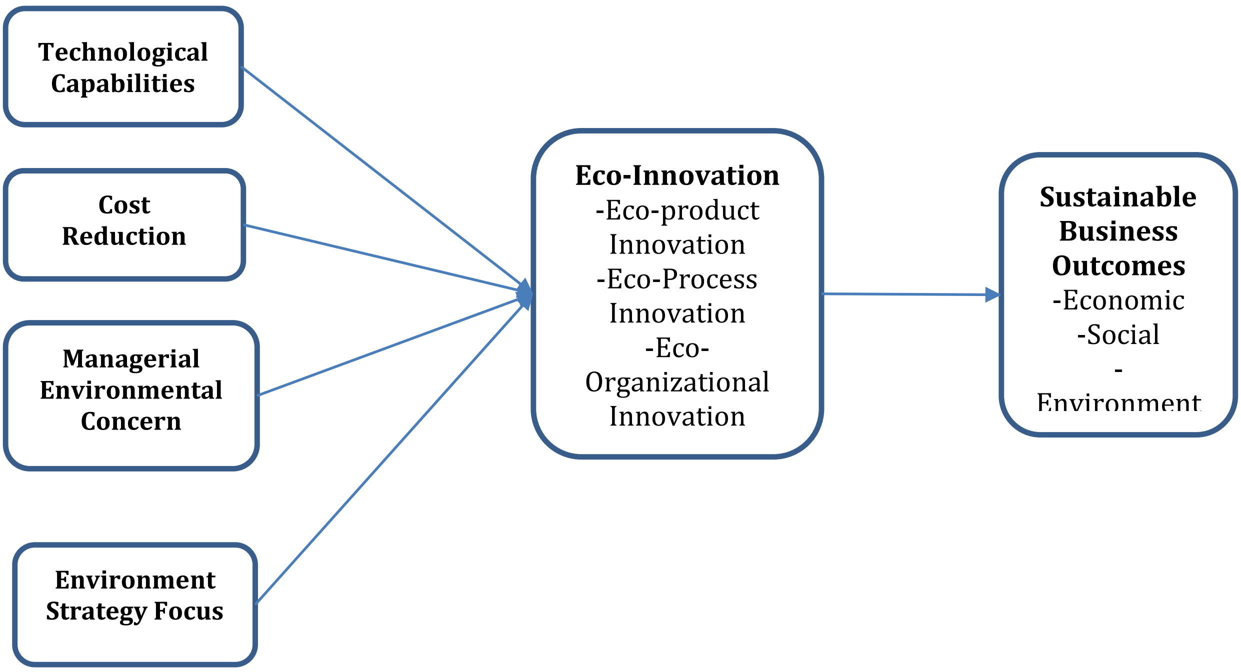

Figure 1: Theoretical Framework

Material and Methods

This quantitative study, guided by a post positivist stance, investigates the relationship between internal drivers of EI (technological capabilities, cost reduction, managerial environmental concern, and environment strategy focus), EI adoption (eco-product, eco-process, and eco-organizational innovation), and sustainable business outcomes (environmental, economic, and social). Employing a self-reported online survey targeting knowledgeable personnel in middle and top management across various departments within Pakistani manufacturing firms, the study gathered data using a non-probabilistic convenience sample. A robust response rate of 77.3% (232 valid responses out of 300 distributed surveys) was achieved.

Measurement of Variables

Study variables were measured using scales from previous research. Eco-Innovation (EI) was gauged with a sixteen-item scale adapted from Cheng et al. (2014), covering product, organizational, and process EI. Managerial environmental concern used a ten-item scale from Eiadat et al. (2008). Technological capabilities were assessed with a five-item scale from Wang (2009), while environment strategy focus employed an eight-item scale from Judge & Douglas (1998). Cost reduction used a four-item scale from Canepa and Stoneman (2003). Sustainable business outcomes were measured with a twelve-item scale from Fernando et al. (2021), encompassing economic, social, and environmental dimensions with four items each.

Data Analysis

Data analysis employed second-generation multivariate PLS-SEM (Ringle et al., 2015). PLS-SEM, suitable for forecasting, handles complex models, provides precision for larger sample sizes, and accommodates both reflective and formative measurement models effectively (Hair et al., 2016). In this study, all latent variables were reflective. The measurement model assessed construct reliability and validity, while the structural model tested study hypotheses.

Results and Discussion

Measurement Model Assessment

A reflective measurement model is evaluated for reliability and validity using indicators such as outer loading, Cronbach's alpha, composite reliability, average variance extracted (AVE), Fornell-Larcker criterion, and Heterotrait-Monotrait ratio (HTMT). Results in Table-1 indicate that most items have an outer loading exceeding 0.708, suggesting constructs explain over 50% of respective indicators' variance. Internal consistency reliability, measured by Cronbach's alpha and composite reliability, exceeds satisfactory benchmarks. Convergent and discriminant validity are also confirmed through AVE, Fornell-Larcker criterion, and HTMT.

Table 1
Assessment of Reflective Measurement Model

Construct	Items	Loading	Cronbach's alpha	Composite Reliability	AVE
CR	CR1	0.830	0.849	0.854	0.688
	CR2	0.831			
	CR3	0.836			
	CR4	0.820			
EI	EOI1	0.665	0.904	0.906	0.613
	EOI2	0.738			

	EOI3	0.678			
	EOI4	0.689			
	EOI5	0.732			
	EOI6	0.719			
	EPC1	0.644			
	EPC2	0.710			
	EPC3	0.648			
	EPC4	0.698			
	EPI4	0.639			
	EPI5	0.655			
	EPI6	0.652			
ESF	ESF2	0.819	0.813	0.815	0.64
	ESF3	0.778			
	ESF6	0.82			
	ESF8	0.782			
MEC	MEC1	0.785	0.846	0.853	0.617
	MEC2	0.755			
	MEC3	0.795			
	MEC5	0.776			
	MEC7	0.815			
SBP	SBP1	0.643	0.925	0.928	0.548
	SBP10	0.792			
	SBP11	0.754			
	SBP12	0.772			
	SBP2	0.727			
	SBP3	0.695			
	SBP4	0.731			
	SBP5	0.775			
	SBP6	0.731			
	SBP7	0.732			
	SBP8	0.712			
	SBP9	0.809			
TEC	TEC1	0.774	0.806	0.808	0.632
	TEC2	0.795			
	TEC4	0.800			
	TEC5	0.810			

Table 2
Fornell-Larcker Criterion

	CR	**EI**	**MEC**	**SBP**	**TEC**
CR	0.829				
EI	0.510	0.683			
ESF	0.486	0.664			
MEC	0.474	0.680	0.786		
SBP	0.596	0.561	0.582	0.741	
TEC	0.457	0.762	0.700	0.493	0.795

Table 3
Cross loading

	CR	EI	MEC	SBP	TEC
EIC1	**0.830**	0.461	0.427	0.441	0.463
EIC2	**0.831**	0.358	0.282	0.443	0.291
EIC3	**0.836**	0.444	0.455	0.560	0.394
EIC4	**0.820**	0.413	0.385	0.526	0.344

EOI1	0.406	**0.665**	0.394	0.327	0.566
EOI2	0.328	**0.738**	0.536	0.424	0.604
EOI3	0.394	**0.678**	0.444	0.443	0.437
EOI4	0.322	**0.689**	0.522	0.438	0.483
EOI5	0.383	**0.732**	0.448	0.406	0.620
EOI6	0.263	**0.719**	0.477	0.363	0.513
EPC1	0.324	**0.644**	0.438	0.297	0.499
EPC2	0.336	**0.710**	0.508	0.378	0.572
EPC3	0.335	**0.648**	0.400	0.350	0.440
EPC4	0.319	**0.698**	0.524	0.315	0.529
EPI4	0.343	**0.639**	0.441	0.407	0.488
EPI5	0.373	**0.655**	0.431	0.401	0.528
EPI6	0.343	**0.652**	0.461	0.415	0.455
ESF2	0.398	**0.539**	0.443	0.431	0.420
ESF6	0.354	**0.526**	0.514	0.384	0.487
ESF8	0.462	**0.576**	0.505	0.517	0.564
MEC1	0.399	0.631	**0.785**	0.470	0.652
MEC2	0.303	0.445	**0.755**	0.411	0.409
MEC3	0.392	0.480	**0.795**	0.471	0.512
MEC5	0.314	0.527	**0.776**	0.405	0.601
MEC7	0.437	0.553	**0.815**	0.521	0.532
SBP1	0.465	0.342	0.311	**0.643**	0.300
SBP10	0.439	0.402	0.327	**0.792**	0.342
SBP11	0.433	0.433	0.475	**0.754**	0.425
SBP12	0.463	0.418	0.442	**0.772**	0.412
SBP2	0.445	0.397	0.407	**0.727**	0.323
SBP3	0.555	0.423	0.476	**0.695**	0.338
SBP4	0.396	0.358	0.436	**0.731**	0.316
SBP5	0.487	0.445	0.473	**0.775**	0.440
SBP6	0.450	0.387	0.470	**0.731**	0.343
SBP7	0.457	0.405	0.448	**0.732**	0.292
SBP8	0.336	0.427	0.354	**0.712**	0.342
SBP9	0.388	0.510	0.522	**0.809**	0.465
TEC1	0.387	0.591	0.517	0.386	**0.774**
TEC2	0.342	0.615	0.602	0.387	**0.795**
TEC4	0.371	0.555	0.544	0.376	**0.800**
TEC5	0.356	0.654	0.560	0.415	**0.810**

Table 4
HTMT Criterion

	CR	**EI**	**MEC**	**SBP**	**TEC**
CR					
EI	0.576				
ESF	0.576	0.768			
MEC	0.546	0.766			
SBP	0.674	0.608	0.652		

TEC	0.545	0.886	0.833	0.565

Structural Model Assessment

Evaluation of the Structural Model include collinearity (VIF), significance and relevance of the structural model relationships (path coefficients), and explanatory power (coefficients of determination; R-squared). The variance inflation factor (VIF) was used as the standard criterion for assessing collinearity and the current study found no collinearity issues among the independent variables as VIF values are less than the benchmark of 5.

Direct Effects

Next, the Partial Least Squares (PLS) algorithm was employed to estimate the path coefficients for the hypothesized relationships. A bootstrap test with standard error calculation was used to assess the significance of these coefficients. As shown in Table-5, in terms of the direct paths, the current study found that among the internal factors, technological capabilities more significantly and positively impact eco-innovation (Beta value=0.248, T value=6.362, P value=0.000), followed by environmental strategy focus (Beta value=0.243, T value=4.444, P value=0.000), managerial environmental concerns (Beta value=0.179, T value=3.77, P value=0.000), and cost reduction (Beta value=0.104, T value=2.112, P value=0.035). Finally, as shown in Table-5, among the direct paths, the eco-innovation emerged as a construct having a most significant impact on sustainable business performance (Beta value=0.561, T value=9.341, P value=0.000).

Mediation Effects

To estimate the path coefficients for indirect effects, the current study has analyzed and interpreted the results as shown in Table-5 and found that eco-innovation mediates the relationship between technological capabilities and sustainable business performance more significantly and positively (Beta-Value=0.248; T-Value=6.362, P-Value=0,000), followed by between environment strategy focus and sustainable business outcomes (Beta-Value=0.136; T-Value=3.709; P-Value=0,000), between managerial environmental concern and sustainable business performance (Beta-Value=0.101; T-Value=3.359; P-Value=0.001), and between cost reduction and sustainable business performance (Beta-Value=0.058; T-Value=2.043; P-Value=0.041). Finally, as shown in Table-5, the current study find that all the mediating (indirect effects) are significant, since neither of the 95% confidence intervals includes zero. Hence, hypotheses H_6, H_7, H_8 and H_9 were supported.

Table 5
Direct and Mediating Effects

Hypothesis & Path		Std. Beta	Std. Dev	T -Values	P-Values	Confidence Interval Bias Corrected [2.5% 97.5%]		Decision
			Direct Effects					
H_1	TEC -> EI	0.443	0.056	7.839	0.000	0.324	0.546	Accept
H_2	CR -> EI	0.104	0.049	2.112	0.035	0.002	0.199	Accept
H_3	MEC -> EI	0.179	0.048	3.772	0.000	0.096	0.286	Accept
H_4	ESF ->EI	0.243	0.055	4.444	0.000	0.141	0.355	Accept
H_5	EI -> SBO	0.561	0.060	9.341	0.000	0.447	0.681	Accept
			Mediating Effects					
H_6	TEC->EI->SBO	0.248	0.039	6.362	0.000	0.174	0.328	Accept
H_7	CR->EI->SBO	0.058	0.029	2.043	0.041	0.001	0.116	Accept

H_8	MEC->EI->SBO	0.101	0.030	3.359	0.001	0.052	0.169	Accept
H_9	ESF->EI->SBO	0.136	0.037	3.709	0.000	0.073	0.215	Accept

Finally the results of structural equation modeling (PLS-SEM) have been depicted in Figure-2 (without bootstrapping and in Figure-3 (with bootstrapping), respectively.

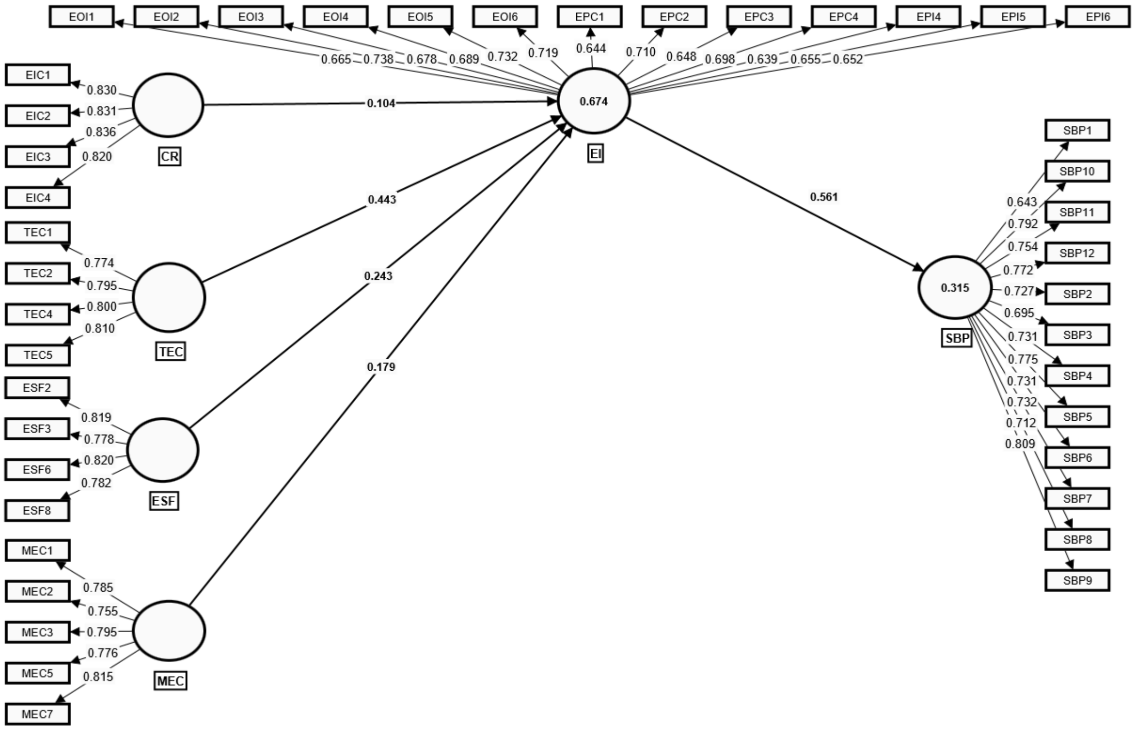

Figure 2: Structural Model without Bootstrapping

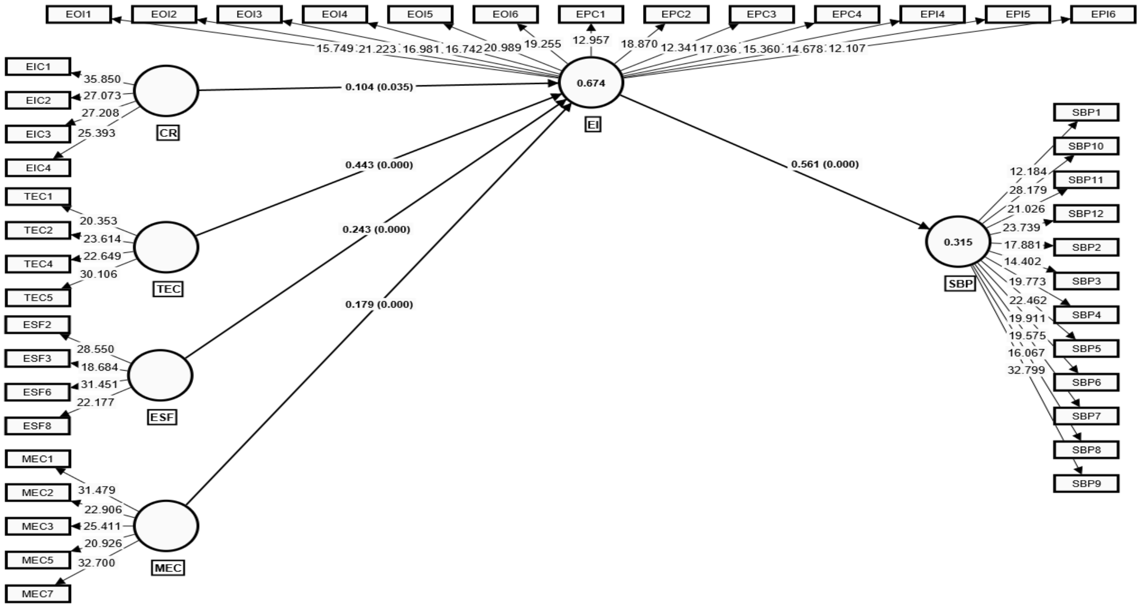

Figure 2: Structural Model with Bootstrapping

Assessment of the Model's Explanatory Power

Besides, the current study, through the coefficient of determination (R^2) value, as shown in Table-6 and Fig. 3 & 4, the values of R-square for eco-innovation is 0.674 (substantial) while R-square for SBP is 0.315 (moderate).

Finally, the f-square value depicts the change in the R^2 value when an antecedent variable is removed from the model. The suggested standard for f-square values greater than 0.02, 0.15, and 0.35 depict small, medium, and large f-square effect sizes (Cohen, 1988).

Table 6
Summary of Structural Model Assessment

	R^2	Assessment	f-square	Assessment
EI	0.674	Substantial		
SBP	0.315	Moderate		
EI->SBP			0.459	Large
TEC->EI			0.269	Medium
ESF->EI			0.10	Small
MEC->EI			0.045	Small
CR->EI			0.023	Small

Model Fitness

Besides, model fit indices examine how a proposed model supports the empirical data. Among the model fit measures, SRMR (root mean square residual covariance) assesses the difference between the manifest covariance and the model-implied correlations. The benchmark value of SRMR is below 0.12, which indicates a well-fitting model (Hair et al., 2022); in the current study, as shown in Table-7, SRMR value of 0.088 shows that the model fits the data well.

Table 7
Model Fit

	Saturated Model	Estimated Model
SRMR	0.066	0.088

Conclusion

The study aligns with Wu et al. (2020), affirming that strong technological capabilities act as a catalyst for Eco-Innovation (EI) in eco-product, eco-process, and eco-organization dimensions. These capabilities enable businesses to implement sustainable practices, streamline operations, and enhance long-term financial results. Additionally, managerial environmental concern and environment strategy focus were found to foster EI across these dimensions, as supported by Amara and Chen (2020). Managers prioritizing the environment are inclined to adopt and promote EIs, contributing to enhanced profitability, market share, and competitiveness. Cost reduction emerged as a significant driver of EI in eco-process, eco-product, and eco-organization dimensions (Cai et al., 2018), enabling businesses to cut waste and overconsumption expenses through sustainable practices. The study suggests that manufacturing firms can enhance competitiveness and sustainable business outcomes by integrating EI across all eco-process, eco-product, and eco-organization measures, alongside focusing on internal drivers such as efficiency-induced cost reduction, environmental strategy, managerial concerns, and technological capabilities.

Implications of the study

The rising demand for a circular economy necessitates firms to balance the costs of social responsibilities with the benefits of new environmentally and socially responsible business opportunities. This requires open governance to address stakeholders' concerns, including shareholders, employees, consumers, investors, civil society groups, and public authorities. Internal drivers of Eco-Innovation (EI) encompass strong technological capabilities, a clear environmental strategy focus, managerial environmental concerns, and efficiency-induced cost reduction. These drivers motivate investment in research and development, improvement of technical capabilities, setting clear environmental goals, integrating sustainability into decision-making, and optimizing resource efficiency. Policymakers can support manufacturing firms through research programs, environmental strategy promotion, awareness-raising, and incentives for adopting eco-friendly practices, facilitating sustainable business outcomes.

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