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The Impact of Sustainable Innovation on Environment, Social and Governance (ESG) Framework: A Moderating Paradigm from Research and Development (R&D) Expenses

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Abstract

In recent years, businesses are giving more and more emphasis to create sustainable innovations that balance economic, environmental, and social objectives. The objective of this paper is to investigate the impacts of sustainable innovation on Environmental, social and governance (ESG) performance. This paper also examines the moderating effect of Research

and Development (R&D) expenses on sustainable innovation and ESG. The analysis makes use of information from 34 Bangladeshi listed firms from 2018 to 2022. A content analysis method was applied to collect the panel data from secondary sources. To test the study hypotheses, multiple regression analysis is employed. The result shows that sustainable innovation has a positive impact on ESG performance. In addition, the study also found that R&D has no significant effect on the relationship between sustainable innovation and ESG performance. The results could assist managers and policymakers in developing nations in establishing sustainable innovation strategies to attain ESG performance. This is the yardstick study towards SDGSs to examine the impacts of Sustainable innovation and ESG performance considering R&D expenses as a moderating variable in the context of Bangladesh, an emerging country.

Keywords: Sustainable Innovation, Environment, Social and Governance (ESG), Research and Development (R&D) Expenses

1. Introduction

Sustainable innovation is the invention of new products, processes, and technologies that support the growth and well-being of people's as well as organization’s desires while respecting the environment’s natural resources and its capacity for regeneration. Sustainable innovation as innovations in which the renewal or advancement of products, services, technological, or organizational processes not only fulfils an improved economic performance, but also enhances environmental and social performance, both in the short and long run (Akter & Toha, 2021; Hossain, Al-Amin, Toha, & Strategy, 2021; M. A. TOHA, 2021). Such innovations have the power to create favourable social and environmental impacts. sustainability considerations should be integrated into corporate structures from the creation of ideas through to research and development (R&D) and commercialization when analysing the difficulties that management faces associated with sustainable innovation. For businesses to be environmentally responsible and for societies to be prosperous, sustainable innovation is crucial. For many firms today, sustainability and innovation are crucial principles. It is now essential for corporate strategy to address environmental, social, and governance (ESG) challenges (M. A. Toha, Akter, & Uddin, 2022; M. A. Toha, Khan, Irfan, Salim, & Khan, 2024). Regulations governing reporting have a significant impact on why ESG data is reported.

Through sustainable innovation, businesses offer new technologies that allow their employees to manufacture high-quality, environmentally friendly goods and services, resulting in the sustainability of both the economy and the environment (M. Toha, Johl, & Khan, 2020; M. A. Toha & S. K. Johl, 2021). For SMEs in the water, beverage, detergent, and metal fabrication industries, innovations in product design and packaging, promotion, retail, and pricing give a durable competitive edge (Uddin, Toha, & Faruq, 2019). Green product innovation is positively influenced by green process innovation, and both of these innovations can boost a company's financial success. Green process innovation and a

company's financial performance are mediated through green product innovation (Tian, Siddik, Pertheban, Rahman, & Knowledge, 2023; Yin, Salmador, Li, Lloria, & Journal, 2022; Zhan, Wang, & Zhong, 2023).

Green process innovation and green product innovation have given businesses several chances to mobilize resources to protect the environment and promote prosperity. There is evidence that green process and green product may be used to address environmental issues (M. Toha et al., 2020; M. A. TOHA, 2021; M. A. Toha et al., 2024). The mainstream interest among asset managers in ESG investment has increased. In the largest markets in 2019, ESG-focused portfolio capitalisation topped US$30 trillion. ESG investment is important to investors for at least two reasons. First, ethical investment behaviors are actively encouraged by an emphasis on ESG investing (Kao & Economics, 2023; Nicolo, Zampone, Sannino, & Tiron-Tudor, 2023; Rau & Yu, 2024; M. A. Toha et al., 2024). Second, ESG investing is increasingly seen to improve managed portfolio performance by boosting returns and lowering portfolio risk. Businesses are under growing pressure to create sustainable innovations that balance social, environmental, and economic objectives. Businesses everywhere need to do more to show they care about and are responsive to society. Surprisingly, the countries which have lower GDP are not willing to pay for R&D which is the area for further study.

It is claimed by researchers such as (Khan, Johl, Johl, & Environment, 2021b; Oduro, Maccario, & De Nisco, 2020; Stankeviciene, Nikanorova, & Cera, 2020) that a company's green process benefits from greater buyer participation in its R&D and training programs. Similarly, they discover that businesses with higher environmental management investments are better able to take advantage of knowledge possibilities and support their green process. Therefore, it is crucial to educate company management on the value of environmental investment. In emerging nations, research on the link between ESG and financial success is less common (Abdi, Li, Càmara-Turull, & Sustainability, 2022; Ahmad, Mobarek, Raid, & Management, 2023; Alareeni & Hamdan, 2020), and the relationship between ESG and green innovation performance is still little known. Most of the recent sustainable innovation literature focuses on the relationship between sustainable innovation and firm performance but the impact of sustainable innovation on ESG is not yet clear. Therefore, it can be said that for this study the research question is “Is there any relationship between sustainable innovation and ESG performance and how R&D affects this relationship?

Therefore, , this paper aims to analyse how sustainable innovation may influence ESG performance. The study also investigates how R&D plays a positive moderating role between sustainable innovation and ESG performance. This paper presents a thorough theoretical framework that investigates the connection between sustainable innovation and ESG performance in order to close the aforementioned research gap and deepen our understanding of how sustainable innovation might enhance businesses' ESG performance. By exploring the mediating impact of R&D costs, this study broadens our existing knowledge of the ways in

which organizations might enhance ESG performance via sustainable innovation. The study will be beneficial for the governments and the firms to encourages them to implement sustainable innovation for enhancing ESG performance. The study also can assist the policy makers to design more powerful tools relating to sustainable innovation and ESG and R&D expenses.

The article proceed as follows. Initially introduction is presented. Literature review in section two, the next section discusses about the data, sample and methodology of the study, section four shows the results and discussions and the final section includes the recommendation and conclusion.

2. Literature Review and Hypothesis Development

2.1 Sustainable Innovation and ESG Performance

Sustainable innovation is a very common phenomena that gives businesses the chance to lessen their adverse effects on the environment (Khan, Johl, Johl, & Environment, 2021a; Khan & Johl, 2020). It makes it possible to create goods and production techniques that are less damaging to the environment(Khan et al., 2021a; Khan & Johl, 2020). This means that all business decisions about goods and services, as well as the fresh business models that must be implemented, should be made using a sustainable approach to innovation. Sustainable process innovation and sustainable product innovation are the two main methodologies that comprise sustainable technology innovation. According to earlier studies, a company's process innovation and product innovation are closely related. It is claimed by (Ch'ng, Cheah, & Amran, 2021; Corral-Marfil, Arimany-Serrat, Hitchen, & Viladecans-Riera, 2021; Li, Gao, & Hui, 2021) that sustainable product innovation comprises enhancing the longevity or recyclability of products, reducing the number of raw materials used, choosing raw materials that are better for the environment, and removing potentially harmful ingredients (Johl & Toha, 2021; M. A. Toha & S. K. Johl, 2021).

According to (Ch'ng et al., 2021), Sustainable product innovation strives to alter or adapt product designs by utilizing nontoxic substances or biodegradable materials during the manufacturing process to lessen the environmental effect of disposal and increase energy efficiency. Sustainable process innovation, in particular, entails lowering emissions into the air or water, consuming less water, increasing resource and energy efficiency, and converting from fossil fuels to bioenergy. This allows companies who are leading the way in green technology innovation initiatives to attain and maintain a variety of competitive advantages, including cost efficiency and profitability. In order to increase resource efficiency, sustainable process innovation necessitates systematically improving all operational and management processes (E-Vahdati & Binesh, 2022; Ghisetti & Pontoni, 2015; Lee & Min, 2015; Mishra, 2022).

Green process innovation positively influences green product innovation. Both green process and green product innovation may enhance an organization's financial performance. Green

product innovation and financial success are influenced by a company's green reputation. According to (Barros, Verga Matos, Miranda Sarmento, & Rino Vieira, 2022; Ben Fatma & Chouaibi, 2021) it is assumed that there is a growing amount of interest in how much business activity contributes to or detracts from social wellbeing. Environmental, Social, and Governance (ESG) or Corporate Social Responsibility (CSR) are common terms used to describe corporate activities in this area (Barros et al., 2022; Ben Fatma & Chouaibi, 2021) .

How are economic, social, and environmental elements balanced in innovation activities is one of three research issues that the study aims to address and when deciding to create new sustainable innovations, three pillars—economic, social, and environmental development play a big part. The three sustainability elements of economic, environmental, and social sustainability are impacted by each Customer Relationship Management (CRM) component (sales, marketing, and services). CRM is a vital instrument for business model innovation, propelling SME efforts toward sustainability on all fronts economic, social, and environmental (AlQershi, Mokhtar, & Abas, 2020; Uddin et al., 2019) .

Moreover, to achieve a sustainable competitive edge, creative marketing techniques including fresh and changed product designs and packaging, new retail and promotion methods, and new pricing models are essential (Loang, 2023; Shui, Zhang, Smart, & Ye, 2022; M. A. Toha & S. K. J. D. Johl, 2021; Zhu, Husnain, Ullah, Khan, & Ali, 2022). Social and environmental developments are two significant antecedents for product innovation performance and they lead to many paths for product innovation performance. Innovation and the use of renewable energy both have a detrimental effect on China's transportation-related CO2 emissions. By adopting hybrid and non-polluting vehicles, China's policymakers and government may innovate their nation's transportation system while also making improvements. To reduce CO2 emissions in the transportation sector, China should push its citizens to adopt new technologies like electric automobiles and railroad systems (Loang, 2023; Shui et al., 2022; Zhu et al., 2022).

The involvement of buyer pushes companies to develop resource acquisition capability to enhance sustainable product innovation. In order to address the environmental issues facing industrial companies, it is crucial to invest in environmental management. This viewpoint contends that innovation should ensure social and environmental benefits in addition to competitive advantages for businesses (Khan et al., 2021a; Khan & Johl, 2020). It is claimed that technological innovation is an important factor to mitigate carbon dioxide emanations in case of Pakistan.

Additionally, by investing in sustainable product innovation, businesses may open up new market prospects, succeed with new green products, and avoid environmental protests and legal liabilities. Innovation is the catalyst for increasing earnings and gaining a competitive edge (Massoudi & Ahmed, 2021; Mohammad & Wasiuzzaman, 2021; Yunus & Sijabat, 2021). Innovation strives to simultaneously achieve economic prosperity and environmental benefits. The businesses in emerging countries like Bangladesh must enhance their economic

and environmental performance through sustainable innovation as a result of mounting demand to employ environmentally friendly business practices, which leads to the following hypothesis:

***H_1**: Sustainable Innovation has a positive impact on ESG performance.*

***H_{1a}**: Sustainable Product Innovation has a positive impact on ESG performance.*

***H_{1b}**: Sustainable Process Innovation has a positive impact on ESG performance.*

***H_{1c}**: Sustainable Technology Innovation has a positive impact on ESG performance.*

2.2 The Moderating Role of Research and Development (R&D) Expenses

Businesses should look for new development patterns that are environmentally friendly rather than achieving sustainable development at the expense of harming the environment. The effectiveness of natural resources may be increased, and pollution emissions can be decreased, through R&D efforts. In order to promote corporate sustainable innovation, the Synergy vision of economic growth and environmental protection identifies two key factors: (1) consumer wants and requests for sustainable goods; and (2) advancements in sustainable technology and expansion of the environmental industry.

Consumer demand, however, may drive businesses to be more responsible for the effects of their business activities as customers grow more conscious of environmental concerns and the value of resource conservation and protection. As more people are ready to pay more for eco-friendly items, corporate dedication to sustainable innovation becomes beneficial (Akter & Toha, 2021; M. A. Toha et al., 2022; M. A. Toha & S. K. J. D. Johl, 2021). A second driver of sustainable innovation is improvements in environmental technology, which is brought about by growing consumer awareness and demand as well as corporate investment in environmental R&D and technical innovation (E-Vahdati & Binesh, 2022; Lee & Min, 2015).

R&D centric innovation is giving way to an integrated approach that involves multiple departments both inside and between businesses. Because of this, modern innovation is increasingly focused on a company's capacity to meet consumer wants, analyse in-depth the function of lead users, and look forward to potential changes. Traditional reporting methods that do not take into account non-financial information are still prevalent in many nations, despite the significant rise in reporting and reporting requirements related to ESG practices in the business sector (E-Vahdati & Binesh, 2022; Lee & Min, 2015).

In lower GDP nations, the community frequently places other priorities above R&D for creating sustainable technology (e.g., inadequate water supply, housing, and food sources) (E-Vahdati & Binesh, 2022; Lee & Min, 2015). In this regard R&D could be an important factor to bridge between Sustainable innovation and ESG performance. For this reason, the

paper is trying to analyse whether R&D plays as a moderating role between sustainable innovation and ESG performance. So, here the hypothesis is:

H_2: R&D moderates the relationship between sustainable innovation and ESG performance.

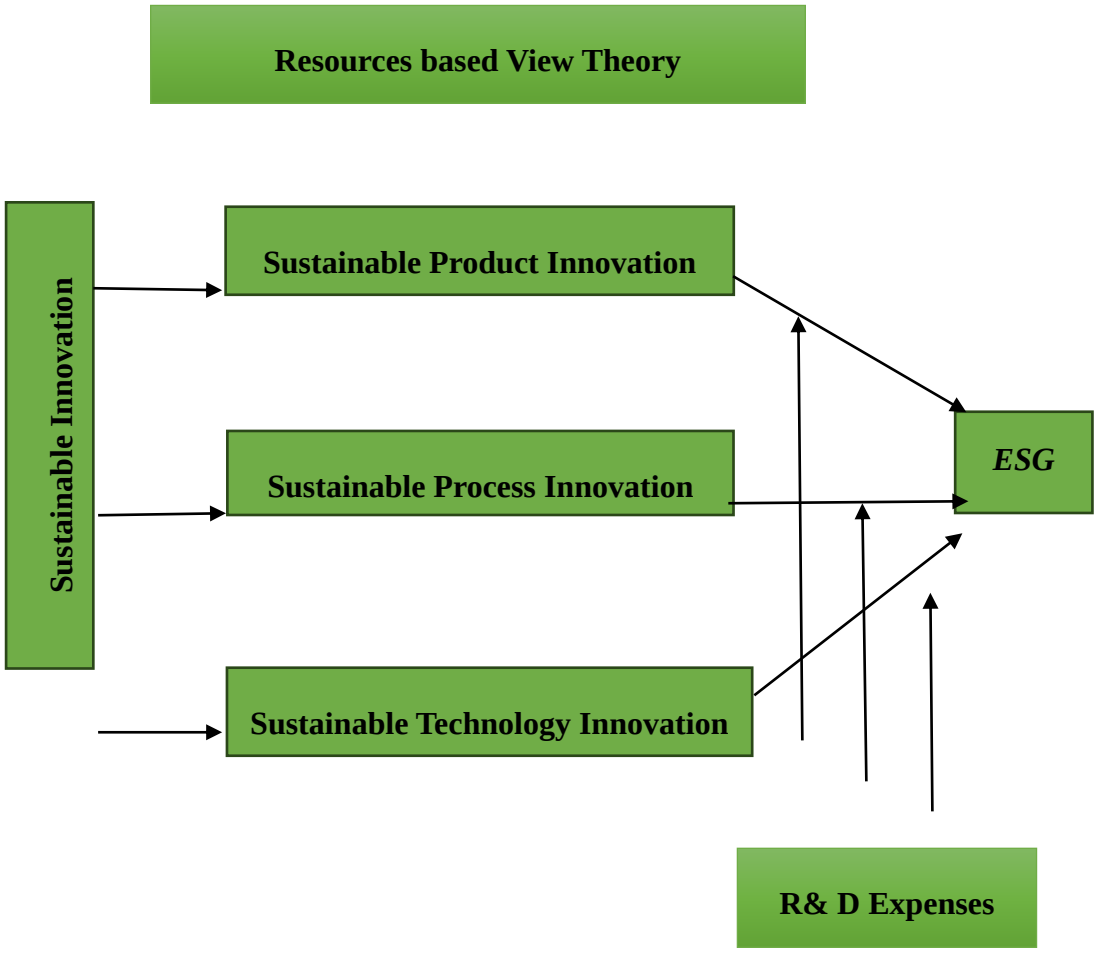

Figure 1. Research Model on Sustainable ESG Framework

Source: developed by authors

3. Data and Methodology

This study adopts a quantitative and deductive research approach to analyse the impact of sustainable innovation on Environmental, Social, and Governance (ESG) performance, with a specific focus on the moderating role of R&D expenses. The research focuses on the pharmaceutical sector in Bangladesh, utilizing a longitudinal or panel data approach spanning five years from 2018 to 2022. The population of interest is all pharmaceutical companies in Bangladesh. The study employs a purposive sampling technique, selecting companies listed on the Dhaka Stock Exchange LTD. (DSE) during the research period. The study utilizes secondary

data, specifically longitudinal or panel data obtained from company websites, annual reports, and sustainability reports. The independent variables for the study are derived from existing literature (García-Granero, Piedra-Muñoz, & Galdeano-Gómez, 2018) and (Arundel & Kemp, 2009). Moreover, dependent variables are derived from SynTao Green Finance indices. These include measures for sustainable innovation, ESG performance, and R&D expenses. The data collection spans five years, from 2018 to 2022, to capture trends and patterns over time.

The content analysis method is employed to extract relevant information from company websites, annual reports, and sustainability reports. ESG performance is gauged using ESG indexes provided by SynTao Green Finance, ensuring a comprehensive evaluation across environmental, social, and governance dimensions. Multiple regression analysis is utilized to test the hypotheses and analyse the relationships between sustainable innovation, ESG performance, and the moderating effect of R&D expenses. ESG performance is the dependent variable, measured using the ESG indexes. Sustainable product innovation, sustainable process innovation and sustainable technology innovation are the main independent variable. R&D expenses are introduced as the moderating variable to assess their impact on the relationship between sustainable innovation and ESG performance.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 showed the descriptive analysis. The ESG Performance, Environmental (ENV), Social (SOC), Governance (GOV), Sustainable Product Innovation (SPI), Sustainable Process Innovation (SPRI), Sustainable Technological Innovation (STI), Sustainable Innovation (SI), and ESG Performance mean values varied from 1.3539 to 1.5509. The study showed average Research and Development (R&D) Expenses (RD_EXP) was 6.6868, suggesting a moderate level of investment.

Table 1. Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
SPI	1.00	2.00	1.3539	.18042
SPRI	1.09	2.00	1.5509	.22469
STI	1.00	1.88	1.4833	.17403
SI	1.13	1.79	1.4601	.15777
ENV	1.00	2.00	1.4765	.22930
SOC	.83	2.00	1.4776	.19232
GOV	.80	1.80	1.3765	.25356
ESG	1.10	1.76	1.4434	.16000
RD_EXP	5.04	8.50	6.6868	.72265

Source: developed by authors

4.2 Correlation Results

The results of the Pearson correlation analysis (Table 2) confirm Hypothesis 1 (H1), which states that sustainable innovation has a positive influence on ESG performance. There is a substantial positive correlation ($r = 0.716$, $p < 0.01$) between SI and ESG performance. The correlation matrix (Table 3) highlights the interdependence of SI, SPI, SPRI, STI, ENV, SOC, GOV, and ESG by pointing to substantial correlations between these variables.

Table 2. Pearson correlation on SI and ESG

		SI	ESG
SI	Pearson Correlation	1	.716**
	Sig. (2-tailed)		.000
	N	170	170
ESG	Pearson Correlation	.716**	1
	Sig. (2-tailed)	.000	
	N	170	170

**. Correlation is significant at the 0.01 level (2-tailed).

Source: developed by authors

Table 3. Pearson Correlation

		SPI	SPRI	STI	SI	ENV	SOC	GOV	ESG	RD_EXP
SPI	Pearson Correlation	1								
	Sig. (2-tailed)									
SPRI	Pearson Correlation	.573**	1							
	Sig. (2-tailed)	.000								
STI	Pearson Correlation	.504**	.451**	1						
	Sig. (2-tailed)	.000	.000							
SI	Pearson Correlation	.835**	.853**	.768**	1					
	Sig. (2-tailed)	.000	.000	.000						

ENV	Pearson Correlation	.277**	.366**	.149	.330**	1			
	Sig. (2-tailed)	.000	.000	.053	.000				
SOC	Pearson Correlation	.310**	.408**	.174*	.375**	.170*	1		
	Sig. (2-tailed)	.000	.000	.023	.000	.026			
GOV	Pearson Correlation	.659**	.713**	.503**	.772**	.267**	.307**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		
ESG	Pearson Correlation	.606**	.716**	.405**	.716**	.689**	.644**	.779**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
RD_EXP	Pearson Correlation	.103	.048	.167*	.120	-.141	-.158*	.143	-.060
	Sig. (2-tailed)	.180	.534	.029	.119	.066	.040	.064	.439

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: developed by authors

4.3 Regression Results

According to the model summary (Table 4), there is a significant regression relationship ($\beta = 0.716$, $p < 0.001$) between Sustainable Innovation (SI) and ESG Performance, with SI accounting for 51.2% of the variation. H1 is supported by ANOVA findings (Table 5), which validate the significance of the model ($F = 176.467$, $p < 0.001$). Additional evidence for H1 is provided by the coefficient analysis (Table 6) which demonstrates that SI significantly and favorably affects ESG Performance ($\beta = 0.726$, $p < 0.001$).

Table 4. Model Summary (Regression table for H1)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.716[a]	.512	.509	.11207

a. Predictors: (Constant), SI

b. Dependent Variable: ESG

Source: developed by authors

Table 5. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.216	1	2.216	176.467	.000[b]
	Residual	2.110	168	.013		
	Total	4.327	169			

a. Dependent Variable: ESG

b. Predictors: (Constant), SI

Source: developed by authors

Table 6. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.384	.080		4.780	.000
	SI	.726	.055	.716	13.284	.000

a. Dependent Variable: ESG

Source: developed by authors

Significant contributions to ESG Performance are indicated by the model summary (Table 7) for Sustainable Product Innovation (SPI), Sustainable Process Innovation (SPRI), and Sustainable Technological Innovation (STI) (R^2 = 0.569, 0.561, and 0.535, respectively). H1a, H1b, and H1c are supported by the ANOVA findings (Table 8), which validate the models' significance ($p < 0.001$). Table 9's coefficient analyses demonstrate that SPI ($\beta = 0.253$), SPRI ($\beta = 0.388$), and STI ($\beta = 0.014$) have positive effects on ESG Performance, with SPI and SPRI having very significant effects ($p < 0.001$).

Table 7. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.754[a]	.569	.561	.10596	.569	73.125	3	166	.000	.585

a. Predictors: (Constant), STI, SPRI, SPI

b. Dependent Variable: ESG

Source: developed by authors

Table 8. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.463	3	.821	73.125	.000[b]
	Residual	1.864	166	.011		
	Total	4.327	169			

a. Dependent Variable: ESG

b. Predictors: (Constant), STI, SPRI, SPI

Source: developed by authors

Table 9. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.478	.078		6.133	.000
	SPI	.253	.059	.285	4.325	.000
	SPRI	.388	.045	.545	8.535	.000
	STI	.014	.056	.015	.253	.800

a. Dependent Variable: ESG

Source: developed by authors

4.4 Moderation Analysis

Regression Analysis (Tables 10, 11, 12): Model 1 (Table 10) shows that SPI, SPRI, and STI together explain 56.9% of the variance in ESG ($R^2 = 0.569$, $F = 73.125$, $p < 0.001$). Model 2 includes RD_EXP, which increases the variance explained to 58.4% ($R^2 = 0.584$, $F = 57.821$, $p < 0.001$), with RD_EXP negatively influencing ESG performance ($\beta = -0.027$, $p = 0.018$). Model 3 incorporates interaction terms (SPI_RD, SPRI_RD, STI_RD), but the overall model shows a slight increase to 59.2% ($R^2 = 0.592$, $F = 33.514$, $p < 0.001$) without significant moderation effects of RD_EXP or interaction terms on ESG performance.

Moderating Role of RD_EXP: While RD_EXP positively correlates with sustainable innovation efforts, suggesting firms with higher R&D investments also prioritize sustainable practices, the regression analysis did not find significant moderation effects of RD_EXP on the relationship between SPI, SPRI, STI, and ESG performance. This suggests that despite supporting sustainable innovation, RD_EXP does not amplify the impact of these innovations on ESG metrics in the studied context.

Table 10. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.754[a]	.569	.561	.10596	.569	73.125	3	166	.000	
2	.764[b]	.584	.574	.10449	.014	5.699	1	165	.018	
3	.769[c]	.592	.574	.10445	.008	1.043	3	162	.375	.588

a. Predictors: (Constant), STI, SPRI, SPI

b. Predictors: (Constant), STI, SPRI, SPI, RD_EXP

c. Predictors: (Constant), STI, SPRI, SPI, RD_EXP, SPRI_RD, STI_RD, SPI_RD

d. Dependent Variable: ESG

Source: developed by authors

Table 11. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.463	3	.821	73.125	.000[b]
	Residual	1.864	166	.011		
	Total	4.327	169			
2	Regression	2.525	4	.631	57.821	.000[c]
	Residual	1.801	165	.011		
	Total	4.327	169			
3	Regression	2.559	7	.366	33.514	.000[d]
	Residual	1.767	162	.011		
	Total	4.327	169			

a. Dependent Variable: ESG

b. Predictors: (Constant), STI, SPRI, SPI

c. Predictors: (Constant), STI, SPRI, SPI, RD_EXP

d. Predictors: (Constant), STI, SPRI, SPI, RD_EXP, SPRI_RD, STI_RD, SPI_RD

Source: developed by authors

Table 12. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.478	.078		6.133	.000
	SPI	.253	.059	.285	4.325	.000
	SPRI	.388	.045	.545	8.535	.000
	STI	.014	.056	.015	.253	.800
2	(Constant)	.630	.100		6.307	.000
	SPI	.259	.058	.292	4.479	.000
	SPRI	.383	.045	.538	8.536	.000
	STI	.033	.055	.036	.591	.556
	RD_EXP	-.027	.011	-.122	-2.387	.018
3	(Constant)	.282	.672		.419	.676
	SPI	.528	.760	.596	.695	.488
	SPRI	-.194	.482	-.273	-.403	.688
	STI	.589	.516	.641	1.142	.255
	RD_EXP	.028	.101	.129	.282	.778
	SPI_RD	-.040	.113	-.412	-.356	.722
	SPRI_RD	.087	.071	1.041	1.215	.226
	STI_RD	-.085	.078	-.928	-1.098	.274

a. Dependent Variable: ESG

Source: developed by authors

Table 13. List of Hypothesis Summary Result

Hypothesis	Decision
H_1. Sustainable Innovation has a positive impact on ESG performance.	Accepted
H_{1a}: Sustainable Product Innovation has a positive impact on ESG performance.	Accepted
H_{1b}: Sustainable Process Innovation has a positive impact on ESG performance.	Accepted
H_{1c}: Sustainable Technology Innovation has a positive impact on ESG performance.	Accepted
H_2: R&D moderates the relationship between sustainable innovation and ESG performance.	Rejected

Source: developed by authors

5. Conclusion

This study investigated at the connection between R&D spending, ESG performance, and sustainable innovation in Bangladeshi listed companies. The results illustrate the significant perspectives on the workings of corporate sustainability plans and how they affect ESG results.

Firstly, the outcomes made visible, how much sustainable innovations in technology, process, and product had improved ESG performance. These results emphasise how crucial it is to include sustainability into business plans in order to improve environmental, social, and governance indicators as a whole. Secondly, the study has found no evidence of R&D expenditures having a significant moderating effect on the relationship between ESG performance and sustainable innovation, despite the fact that higher R&D expenditures was positively associated with sustainable innovation efforts, suggesting a commitment to innovation in sustainable practices. This implies that the benefits of sustainable technologies on ESG outcomes are not always amplified by merely raising R&D expenditures. Also, the addition of interaction variables was an attempt to investigate potential moderating effects, but the findings were not statistically significant. This suggests that levels of R&D spending may not have a major impact on how well sustainable innovations drive ESG performance in the environment under study. The future research could be conducted on mixed method considering different geographical location.

In items of practical applicability, these results imply that companies may enhance their ESG performance by concentrating on specific sustainable innovation projects rather than merely

increasing their R&D expenditures. By using a nuanced approach, sustainability initiatives might possibly maximise their influence on ESG measures by ensuring that they are in line with particular business aims and industry settings. Nonetheless, it is essential to recognise the limits of the research, such as its cross-sectional design and concentration on listed enterprises in Bangladesh. To enhance our comprehension of the relationship among sustainable innovation, research and development expenditures, and ESG performance, further studies may investigate supplementary moderators, longitudinal data, and varied geographical settings. In summary, the integration of sustainability into business operations is still critical even if sustainable innovation is a critical factor in improving ESG performance. These findings may be used by managers and legislators to promote sustainable development strategies that advance business performance and general society welfare.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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