Inzinerine Ekonomika-Engineering Economics, **2023, 34(1), 75–88**

The Impact of Proactive Environmental Strategies on Ecological Sustainability of Chinese High-Tech Industry

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crossref http://dx.doi.org/10.5755/j01.ee.34.1.32834

China's concern toward ecological sustainability has increased to a great extent. This study aims to analyze the impact of proactive environmental strategies on ecological sustainability by understanding the mediating of eco-product, process, and organizational innovation. For this purpose, China's high-tech industries have been targeted and a survey-based quantitative technique has been applied. 350 questionnaires were distributed among the Chinese staff in the high-tech companies and 319 were received as complete questionnaires that were further analyzed using SPSS and AMOS to analyze the data with confirmatory factor analysis and structural equation modelling. The results indicated a significant impact of PES on ES. The mediation of EPR, EPRD, and EOI has also resulted to be significant between PES and ES. This study has practically contributed to the high-tech sectors of China. There is a great need for the management to apply proactive environmental initiatives that are crucial to gain ecological sustainability.

Keywords: *Proactive Environmental Strategies; Eco-Product Innovation; Eco-Process Innovation; Eco-Organizational Innovation; Ecological Sustainability.*

Introduction

In recent years, concern towards China's ecological sustainability has risen specifically in the high-tech sector. As its devotion to keeping the environment free of hazards, China has always shown responsible behavior regarding ecological stability through the identification of a problem before it arises (Frimawaty *et al.*, 2013; Kennedy *et al.*, 2020). This trait of creating proactive environmental strategies has led the country towards a great increment in the progression of ecological sustainability by encouraging environmentally responsible behavior. Policies regarding responsible behavior and conduct concerning the environment are prevailed and followed in China (Baneliene & Melnikas, 2020; Mariyono, 2019; Sell, 2020). Predicting or forecasting capabilities enables the regulatory bodies to formulate such proactive strategies that result in China's ecological sustainability. For this purpose, an implementation of a comprehensible approach and inculcation of environmental themes into different high-tech products and their production process could lead the increased awareness and importance of ecological sustainability. Eco-product innovation and eco-process innovation play a vital role in this regard (Anugrah & Dianawati, 2020; Cesarec *et al.*, 2020; Huda *et al.*, 2021). To cope with the increased innovation trends in any sector, China's devotion toward eco-innovation exists to a great extent. In the high-tech sector, eco-innovation thus results in prominent progress towards attaining the goal of sustainable development, by reducing the effect of its operational conduct on the environment (Braicic, 2021; Nuringsih & Nuryasman, 2021; Sung *et al.*, 2021). For meeting the needs of an ultimate goal of ecological sustainability, all the measures in China's sectors are taken concerning benefiting the environment (Lebens, 2021; Widodo *et al.*, 2021). When a country is aimed toward the encouragement of sustainable development, the steps taken for innovation revolved around the reduction of environmental impacts such as eco-product, eco-process, and eco-organizational innovation (Bruneckiene *et al.*, 2020; Wilujeng *et al.*, 2019; Yousaf *et al.*, 2021) (Saladich Nebot, 2019).

The shifting of China's high-tech sector from traditional resources to conventional sustainable resources in order to support the phenomenon of eco-innovational trends. With the rapid increase in knowledge creation about reducing the negative environmental impacts, the high-tech sectors are trying to go green including green supply chain, green purchasing, and green manufacturing of high-tech products. The green product design promoted in the Chinese tech industry has also proved to be a favorable factor in enhancing ecological sustainability (Ekantini & Wilujeng, 2018; Erturk & Ziblim, 2020). The overall resource usage has minimized and lessened to a great extent resulting from these novel implications of ensuring the provision of green products that are both financially and environmentally capable (Aldoghan, 2021; NEL & Masilela, 2020; Sagala *et al.*, 2019). Contrary to the traditional technology and advancement that have led to great about of environmental degradation and utilization of resources, green products have proved to be of great advantage in the reduction of resources utilized (in the form of gaseous release and non-reusable resources utility). Thus, have also contributed to lessening the negative environmental impacts and increased eco-sustainability in China (Ballestar *et al.*, 2021; Sugandi, 2022; Wahhab & Al-Shammari, 2021; Wolfe *et al.*, 2021). The scope of these factors thus in the high-tech sector has also been observed to cast a sharp spell. China's proactive

environmental strategies of high-tech sectors thus prove to help formulate a mindset of tech companies towards the importance of eco-sustainability and its practical application in the environment (Akpur, 2020; Fatimah *et al.*, 2020; Hussain & Jergeas, 2022).

Ecological sustainability is the sustainability of environment and its green protection that is necessary for better health to avoid the environmental issues. Eco-process innovation is to develop a new working process that is based on the sustainability and it is not harming to the environment in its nature. Eco-product innovation is innovative new products that are ecofriendly, and there is not expected harm of these products to the environment. Eco-organization innovation refers to taking new measurement for organization to make it sustainable and environment friendly.

There is a huge literature on ecological sustainability, but in the high tech sector, only a scarcity of research occurs to investigate the relationship between proactive environmental strategies and ecological sustainability in China particularly in the High-tech sector (Álvarez *et al.*, 2020; Lestari *et al.*, 2019). The tech industry, alone is responsible for 2 % of total gaseous emissions and global warming. If it continues to grow at the same pace, by year 2024, it will be responsible for 15 % of the gaseous release. (Ollivaud & Haxton, 2019). China's concern towards this factor is noteworthy as the less usage of resources and "greener" approach in tech sector can overall contribute to environmental sustainability (Yuliani & Hartanto, 2020). While taking it in the context of China's high-tech industry's gaseous emissions can cause deforestation, and utilizes massive energy and water, which results in an increased contribution to air pollution and waste problems (Agussani & Akrim, 2020; Duke & Osim, 2020). There is a need for the employees or the faculty members in China's tech sectors they should be provoked in lessening the use of those products which are non-recyclable such as oil, petroleum and nuclear energy (Chen & Hu, 2021; Ismail *et al.*, 2021; Voda *et al.*, 2021) (Saladich Nebot, 2019). In contrast, a scarcity of research has been noticed on the role of eco-product innovation, eco-process innovation, and eco-organizational innovation between PES and ES in China's high-tech sector (Darmawan & Dagamac, 2021). Eco-innovation in China is an emerging approach which is promoting sustainability through the prevalence of proactive environmental strategies regarding the whole life cycle of products manufactured and used in the country, by also increasing the global image and goodwill of China as an ecologically sustainable country (Darmawan & Dagamac, 2021; Olaleye *et al.*, 2022). Therefore, the current study has been conducted in China, the devoted region for the prevalence of ecological sustainability(Saladich Nebot, 2019). However, the literature has reported that the eco-friendly organization development and organizational working is still a big problem in China. This problem is not good for sustainability and environment for a long term.

The current study is thus aimed at empirically investigating the linear and indirect relationship and proposes the following research questions:

RQ1. What is the direct impact of proactive environmental strategies on ecological sustainability?

RQ2. What is the mediating role of eco-process innovation between the relationship of proactive environmental strategies and ecological sustainability among the employees of high-tech companies in China?

RQ3. What is the mediating role of eco-product innovation between the relationship of proactive environmental strategies and ecological sustainability among the employees of high-tech industry in China?

RQ4. What is the mediating role of eco-organizational innovation in the relationship between proactive environmental strategies and ecological sustainability among the employees of high-tech companies in China?

The relevance of this study lies in the help to educate people of high-tech industry regarding their duties towards protecting the environment and increasing eco-sustainability. The proactive environmental strategies thus form a basis of China's concern for enhancing ecological sustainability (Maxham & Miller, 2019). The need to create awareness among high-tech sector regarding their specific role in protecting the environment and adopting strategies and procedures that are not harmful for the environment are significant (Chi 2022). Training regarding the green environment has been provided in some of China's tech sector by the environmental enthusiast so that companies can learn, and their environmentally responsible behaviours can be created, but this practice is not so common yet. The proactive environmental strategies must be strengthened through efficient utilization of the resources, increased cost-effectiveness, lessening waste and disposal, and innovation capabilities such as eco-product, process, or organizational innovation. China is concerned about ecological sustainability and despite ranking 151 in the global index, there is still room for more devotion and attention towards the environmental sustainability factors and the creation of proactive environmental strategies. By incorporating all the emerging and crucial constructs into a single framework through reviewing past literature, this study tends to investigate the ecological sustainability in the high-tech sector of China (Maxham & Miller, 2019).

Literature Review

The Resource-Based Theory

The theoretical background in the strategic management field is widely based on the resource-based theory (Barney & Arikan, 2005). It is considered an underpinning theory in most strategic management studies (Liang *et al.*, 2010). Penrose first proposed this theory in 1959 to investigate how resources affect an organization's ability to grow. Following pioneering work by (Penrose & Penrose, 2009), (Wernerfelt, 2011), and others, (Barney & Arikan, 2005) defined RBV by identifying the crucial characteristics that define resources as strategic (Chi, 1994), i.e., functional, unusual, inimitable, and non-substitutable, and showcasing their significance in assisting firms in achieving sustained competitive advantage. To further clarify how businesses can identify and maintain sustainability development, modern RBT has been introduced (Barney *et al.*, 2011). Initial resource-based idea implicated both resource possession and resource utilization; during its formalization and successive growth

stage, philosophical advancements, and the investigation continued with a significant emphasis on resource possession whereas only implicitly acknowledging the significance of resource use; (c) during its maturity phase, the investigation was focused mainly on resource possession, but acknowledgement and constructive study of resource use started; and (d) finally, in its final stage, the main focus of theorizing and investigation became more diverted towards the use of resources (D'Oria *et al.*, 2021).

To illustrate the environmental strategy, elements, and issues, (Hart & Dowell, 2011) employed a resource-based perspective theory for the first time. According to (Hart & Dowell, 2011) the resource-based view theory phenomenon concentrates on internal factors that help businesses to achieve sustainability. The theory that best describes the connection between proactive environmental initiatives and achieving sustainability is the resource-based view theory, which is the most widely used theory in this area (Henriques & Sadorsky, 1999). In the past several researchers have used the resource-based view theory to discuss proactive environmental strategies and ecological sustainability development. (Hart, 1995) suggests that the RBV theory has several significant omissions. For instance, Barney does not consider how the organization's internal environment interacts with its external environment. This exclusion would have made sense in the past, but it is now apparent how important the natural environment is in defining sustainable advantage. Accordingly, the research has identified many assets and skills that boost sustainability by lowering pollution levels. As it is deduced from the theory that organizational resources and capabilities contribute towards attaining sustainability so here proactive environmental strategies and eco-innovations can serve as capabilities of the firm as they are specific to a specific institute, unique, and difficult to imitate (Hart, 1995; Hart & Dowell, 2011). So, our study applies proactive environmental strategies within organizational capabilities to examine ecological sustainability. That is why this study is based on this theoretical framework.

Proactive Environmental Strategies and Ecological Sustainability

The companies adopt proactive environmental strategies to maintain ecological sustainability and play their part in developing a sustainable environment. The research has been conducted in different sectors in the past. A study was done by (Carballo-Penela & Castromán-Diz, 2015), in which determinants of proactive environmental strategies for attaining ecological sustainability were examined in the service sector of Spanish environmental consulting firms. Multiple hierarchical regression analysis was employed, and it was observed that the companies who adopted proactive environmental strategies showed more role in developing ecological sustainability. However, this relationship must also be observed in other sectors to get more general results. In another study, two different dimensions of proactive environmental strategies were observed to examine their effect on attaining environmental sustainability by the firms. These two dimensions were green human resource management (GHRM) and environmental legitimacy (EL). This study was based on contingency theory. The study's hypotheses were examined in 11 different countries (Finland, Sweden, Germany, Taiwan, Israel, Mainland China, Spain, Brazil, Italy, South Korea, and Japan). The findings of the study showed a significant relationship between green human resource management and the firm's capability to develop a sustainable environment was significant but environmental legitimacy showed an insignificant result in this relationship. The companies that conducted green human resource management were more likely to be capable of producing a sustainable environment. Businesses that place a high priority on green human resource elements can amass essential tacit and ambiguous resources and knowledge, enabling them to recognize environmental challenges and effectively address them (Mazzanti, 2018). Two moderators were also observed to play a role in this relationship which were operational barriers and organizational barriers. (Zhang *et al.*, 2019) But here, this relationship can also study the mediating role of techno eco-innovation. The construction industry causes some serious environmental issues, so another study was conducted to study ecological sustainability in construction firms and which factors drive ecological sustainability (Saladich Nebot, 2019). This was done in Malaysia, and large construction companies were targeted. The mediating impact of the firm's capabilities was also observed, and structural equation modelling was used. The results of this study showed how proactive companies' environmental strategies might help construction companies in underdeveloped countries find innovative ways to conduct environmentally friendly building projects. This leads to developing a sustainable environment (Bamgbade *et al.*, 2019). But we can study this relationship in the context of other sectors and developed nations to get more valid results. It is still not an official organizational standard to expect businesses to support a sustainable natural environment (Haffar & Searcy, 2018). The (Ryszko, 2016) study shows that proactive environmental strategies and ecological sustainability development are not directly linked to each other, instead, they depend on a mediator.

It was examined in the US established firms that companies can adopt proactive environmental strategies for attaining ecological sustainability by getting inspiration from their fellow successful companies. This leads to better sustainability of the natural environment (De Mendonca & Zhou, 2020). However, the study should also be conducted in smaller firms as the large firms are always an easy target for concerned environmental authorities, and they used to display concern towards achieving sustainability. So, we should also examine the behaviour of smaller firms towards attaining natural environment sustainability (Saladich Nebot, 2019).

Based on the above studies, we can formulate our first hypothesis.

H1: Proactive environmental strategies have a positive significant impact on ecological sustainability.

The Mediating Role of Eco-Innovation Eco-innovation is necessary to speed up the shift to sustainable development on a worldwide scale (Dogaru, 2020). Eco-innovation aims to create goods, procedures, marketing plans, business deals, and corporate entities to minimize their adverse effects on the environment compared to conventional

methods (Ch'ng *et al.*, 2021). Similarly, a researcher like (Bossle *et al.*, 2016) noticed that eco-innovation creates new business models, goods, services, and knowledge-based innovations that enable a more comprehensive range of eco-practices. Following this, investigations (Bossle *et al.*, 2016; Brasil *et al.*, 2016) spread eco-innovation along three primary axes: eco-process innovation, eco-product innovation, and eco-organizational innovation. According to earlier research, proactive environmental strategies are linked to the development of ecological innovation (such as new products, enhanced manufacturing, and operational processes) and environmental sustainability performance (such as lower costs from reduced pollution and waste), which enables firms to realize its competitive advantages (Ong *et al.*, 2019).

Past studies have observed the relation of proactive environmental strategies to eco-innovation in companies, leading to ecological sustainability. This relationship was studied in the hotel industry, and the research was based on resource-based view theory and resource dependency theory. The aim was to assist companies in developing eco-innovations and competitive advantages. The findings revealed that proactive environmental strategies significantly impact eco-innovation (Kuo *et al.*, 2022). However, this research must be conducted in different countries to get comparative results as the cultural background does make a difference. Due to unprecedented industrialization, small businesses are under increasing pressure to survive in developing nations. Businesses must foster eco-innovation among SMEs engaged in manufacturing if they want to attain sustainability. This study aimed to show how eco-innovation and sustainable performance are related in Indian manufacturing SMEs. The findings show that eco-process innovation and eco-organizational innovation are significantly related to sustainable development. However, eco-product innovation has no bearing on sustainability development, including financial, ecological, and social achievement (Singh & Chakraborty, 2021). The study can also be extended to other countries and regions as different countries have different ecological needs and conditions, which could impact results. The role of proactive environmental strategies for maintaining ecological sustainability has also been observed in Taiwanese manufacturing companies, which leads to eco-innovation (Tsai & Liao, 2017).

Another study was conducted in Poland on 292 firms which explored the association between proactive environmental strategies, technological eco-innovations, and the ecologically sustainable development of the firm. Partial least squares structural equation modelling has been used to evaluate the proposed research model and assumptions (Somasundaram *et al.*, 2021). In this study, the proactive environmental strategies were not directly observed to impact firm sustainability development, but they influenced it with the help of technological eco-innovation. The findings, however, highlight the crucial mediating role that technical eco-innovation had in this relationship. This study demonstrated that technical eco-innovation concurrently supports the ecological and economic foundations of ecological sustainability since it lessens the ecological impact and enhances company performance (Ryszko, 2016).

Moreover, the three dimensions of eco-innovation must be studied in this context, and their mediation role is also studied. This study added to the literature regarding environmental management strategies by examining the impact of eco-innovation on environmental sustainability. The data was gathered for this purpose by compiling questionnaires from 219 Turkish manufacturing companies. They discovered using structural equation modelling that eco-innovation has a direct impact on preventing pollution, conserving resources, and recycling which leads to ecological sustainability; additionally, it has an indirect favorable impact on cost reduction and consequently on economic performance (Yurdakul & Kazan, 2020).

Eco-process approaches are often innovative updates to operating processes or equipment to prevent pollution, meet higher environmental law standards, and reduce carbon emissions. Consequently, maximizing material productivity, focusing on energy efficiency, creating value from waste, and substituting with renewable processes would not only lead to better environmental performance and also leads to the development of ecological sustainability (Liao, 2018) (Somasundaram *et al.*, 2021). Eco-product innovation contends that product development should be made simpler through technological advances like digitalization or digital accounting and should use parts and materials that are readily recyclable or biodegradable. Proactive environmental strategies lead to eco-product innovation, and these products can contribute to ecological sustainability (Ch'ng *et al.*, 2021). Eco-organizational innovation (EO) is a corporate culture and management system that proactively participates in ecological initiatives and regularly evaluates and manages its environmental impact throughout the entire organization. These kinds of eco-innovations are influenced by proactive environmental strategies, which can then play a role in maintaining ecological sustainability (Liao, 2018). Also, the research Model presented in Figure 1 is describing the impact of different variables on ecological sustainability. Hence based on the above studies, we can formulate the following hypotheses.

H2: Eco-process innovation has positive a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability.

H3: Eco-product innovation has positive a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability.

H4: Eco-organizational innovation has positive a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability.

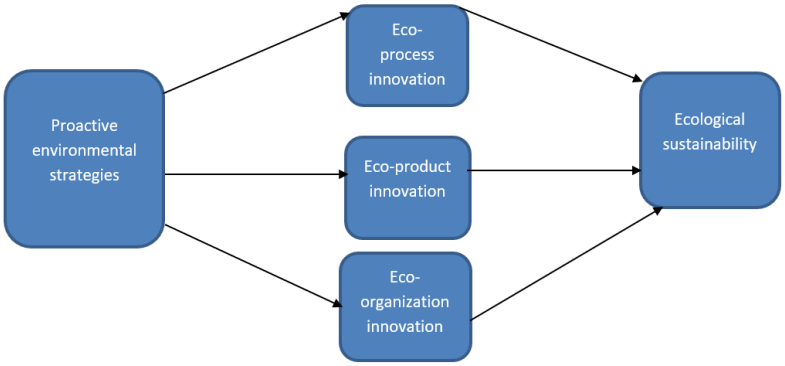

Figure 1. Research Model

Methodology

The methodology used for the current research is based on the quantitative technique of data collection. In the quantitative technique, the research conducts a survey based on the distribution of questionnaires among the target population (Kuswardinah *et al.*, 2022). The questionnaire of the research was based on a linear and mediating relationship between proactive environmental strategies and ecological sustainability along with eco-process innovation, eco-product innovation, and eco-organization innovation on the relationship between proactive environmental strategies and ecological sustainability. The target population for the research is the staff of the high-tech sector and the target country is China (Wynn *et al.*, 2020).

Data Analysis

A structural equation model has been used with the help of AMOS to interpret the data and draw the results for the research. AMOS helps in analyzing the theoretical framework which has been generated in the hypothesis on research variables. The research follows a two-way analysis of the data as per suggested by Leguina (2015). The first is the measurement model and the second is a structural model for each variable. The research provides measurement models of each variable with a defined number of items (Blahusiakova, 2022). It also provides a structural model which defines the relationship among each variable i.e., proactive environmental strategies, eco-process innovation, eco-product innovation, eco-organization innovation, and ecological sustainability. The research examines the linear impact of proactive environmental strategies on ecological sustainability along with the mediating impact of eco-process innovation, eco-product innovation, and eco-organization innovation on the relationship between proactive environmental strategies and ecological sustainability. The structural model below describes the hypothetical relationship among each variable of the research. AMOS tests the reliability and validity of the hypothesis of the research (Wynn *et al.*, 2020).

Measurement Items

Each variable has been analyzed with a different number of items. The number of items for proactive environmental strategies has been adopted from Singjai *et al.* (2018) which is comprised of four items for the variable. Moreover, there are four items for eco-process innovation which have been adopted from the measurement scale developed by Cheng *et al.* (2014). Similarly, the measurement scale for eco-product innovation has four numbers of items developed by Mady *et al.* (2021). The eco-organization innovation uses a measurement scale from Cheng *et al.* (2014) research with three numbers of items. Lastly, ecological sustainability has used the measurement scale of Shen with two items used in the development of the questionnaire. Along with the structural equation model the research also uses different measurement scales with a defined number of items for each variable to interpret the data and draw results. The measurement scales are developed for each variable including independent variables; proactive environmental strategies, dependent variables; ecological sustainability, and mediating variables; eco-process innovation, eco-product innovation, and eco-organization innovation. Each variable has its number of items based on which questionnaires are developed. The research constructs are investigated with the help of five points Likert scale representing number 1 ‘much lower’ to number 5 ‘much higher. The Likert scales define the levels of each variable.

Research Population and Sampling Method

A quantitative method has been applied to the research. The targeted population of the research is the staff of the high-tech sector of China that engages in ecological sustainability. The sector of research is the Chinese high-tech department. However, the research examines the linear impact of proactive environmental strategies on ecological sustainability along with the mediating impact of eco-process innovation, eco-product innovation, and eco-organization innovation on the relationship between proactive environmental strategies and ecological sustainability. The respondents have been asked to fill out questionnaires. The questionnaires were designed based on adopted measurement scales with a definite number of items which has helped in the interpretation of data. The research has developed 350 questionnaires which were distributed among the staff members of the Chinese tech department. The number of obtained questionnaires was 319 which

helped in the interpretation of the results. The study has left a margin of 50 questionnaires in case any of the questionnaires are left empty. The margin has helped to interpret accurate results. Thus, 319 questionnaires were usable for research and shows a 91.1 percent recovery rate.

Ethical Considerations

The basic ethical approach has been taken under consideration during research. Each author has been given considerable recognition for their contribution either in providing literature or developing measurement scales. The authors of measurement scales were asked for permission before adopting their scales for data analysis. Moreover, the privacy of the respondents has also been a major concern of the researcher. The response of each participant has been delivered without any bias. Along with this, the privacy of the respondents has also been respected while conducting the research. The respondents were asked for permission before the distribution of questionnaires. The rules and regulations of the high-tech sector developed and designed by the Chinese government were also respected and followed.

Findings

Respondent's Demographics

This research has targeted the employees of high-tech companies in China. This sample of data makes this study unique from the existing studies in the body of literature. A total of 350 questionnaires were distributed among the employees. Those included the staff and faculty members who were working in the different departments of high-tech companies including supply chain, product design, manufacture and production department, sales department, etc. The response obtained showed a minor fluctuation in terms of gender variation of participants. Among the 319 respondents, there were almost equal male and female respondents. There were 165 male employees and 155 female employees with a frequency of 44 % and 56 % respectively. The age distribution and work experience of respondents also varied, as among the 319 respondents 96 participants were freshly recruited as their age lies between 21–30, and 125 participants were senior staff of those high-tech institutes within the age group of 31–40. The participants' age of 41 years and above was 97. 38 participants were freshers (less than 1 year of work experience) as indicated in the survey, 59 respondents were working for 5 years in tech industry, 123 were old employees with over 10 years of experience, and 96 from others.

Descriptive Statistics

In research, the descriptive of studied variables are used to calculate, explain, and summarize the data collected efficiently. The important indicator of the descriptive of studied variables are skewness, standard deviation, and mean. The purpose of these values is to indicate the outliers and ensure normality in the data. Table 1 of the study highlights the descriptive summary.

Table 1

Descriptive Summary

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
EPR	319	1.00	5.00	3.1520	1.15589	-.034	.137
EPRD	319	1.00	5.00	3.2829	.98080	-.078	.137
EOI	319	1.00	5.00	3.2947	.94811	-.067	.137
ES	319	1.00	5.00	3.3401	1.15993	-.270	.137
PES	319	1.00	5.00	3.1066	1.11275	-.049	.137
Valid N (listwise)	319						

PES= Proactive environmental strategies, EPR= Eco-process innovation, EPRD=Eco-product innovation, EOI= Eco-organizational innovation, ES=Ecological sustainability

The cut-off values for skewness range between -1-and1. The standard mean statistics must be 3 and the value of standard deviation close to 1 which is indicated as a standard normal distribution (Sander & Teh, 2014). Table 2 indicates that the mean value falls in the required range along with the acceptable value for the standard deviation and skewness. It means that normality exists in the data as there is no outlier present in the data

Rotated Component Matrix

The rotated component matrix in a study ensures that the items in research are free from the issue of cross-loading. and it ensures the non-duplication among the items of the questionnaire.

Table 2

Rotated Component Matrix

	Component				
	1	2	3	4	5
PES1			.570		
PES2			.809		
PES3			.875		
PES4			.844		
EPR1		.923			

	Component				
	1	2	3	4	5
EPR2		.882			
EPR3		.843			
EPR4		.843			
EPRD1	.811				
EPRD2	.907				
EPRD3	.870				
EPRD4	.879				
EOI1					.782
EOI2					.880
EOI3					.909
ES1				.829	
ES2				.861	

PES= Proactive environmental strategies, EPR= Eco-process innovation, EPRD=Eco-product innovation, EOI= Eco-organizational innovation, ES=Ecological sustainability

Table 2 indicates the results of the rotated component matrix. As in this study, there was a total of 5 variables. It has been observed that all the items of these respected variables appear in their column. There is no issue of cross-loading and duplication. The minimum value observed for the variables was .7 and the maximum value was .9.

Table 3 explains the results regarding sample sufficiency in KMO & Bartlett test. The reported value indicates the sample sufficiency as .842.

Table 3

KMO & Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.842
Bartlett's Test of Sphericity	Approx. Chi-Square	5483.233
	df	136
	Sig.	.000

Validity Results

The first crucial step is to check the convergent validity of the variables involved in the study. Two important criteria must be fulfilled for this purpose, such as composite reliability and average variance extracted. The threshold values for CR and AVE should not be less than 0.7 and 0.5, respectively (Hair Jr, Howard, & Nitzl, 2020). The greater values are also acceptable and considered satisfactory. Table 4 illustrates the convergent validity results for the variables included in the study. No items in the results were dropped, and there was no problem with AVE in the data set. The output figures of the complete convergent validity test, as shown in Table 4, illustrates that the measurement model of our data set fulfils all the requirements necessary for convergent validity. Therefore, convergent validity was decisively formulated for this study, and we stimulated toward the subsequent step of tests.

Table 4

Discriminant and Convergent validity

	CR	**AVE**	**MSV**	**PES**	**EPR**	**EPRD**	**EOI**	**ES**
PES	0.834	0.676	0.352	**0.815**				
EPR	0.909	0.635	0.441	0.518	**0.792**			
EPRD	0.919	0.709	0.421	0.305	0.654	**0.854**		
EOI	0.976	0.717	0.394	0.482	0.592	0.768	**0.912**	
ES	0.934	0.855	0.498	0.499	0.567	0.712	0.609	**0.842**

PES= Proactive environmental strategies, EPR= Eco-process innovation, EPRD=Eco-product innovation, EOI= Eco-organizational innovation, ES=Ecological sustainability, CR= Composite reliability, AVE= Average variance extract

The discriminant validity is another important validity that must be reported. It indicates that the variables should not be correlated to each other theoretically. Table 4 explains that all the variables such as PES, EPR, EPRD, EOI, and ES have discriminant validity indicated in bold which depicts that for each construct the preceding value differs as that from the other values. The discriminant validity thus ensures that all the variables differ from the other variables theoretically and are not correlated.

Confirmatory Factor Analysis

The confirmatory factor analysis measures the fitness of the model formulated after reviewing the literature. In this analysis, the fitness of the model is estimated through some predefined indicators.

Table 5

Model Fit Indices

CFA Indicators	CMIN/DF	GFI	IFI	CFI	RMSEA
Threshold Value	≤ 3	≥ 0.80	≥ 0.90	≥ 0.90	≤ 0.08
Observed Value	2.671	0.851	0.925	0.986	0.073

It can be said that CFA is a method that is utilized to abandon or verify the theory of dimension and measurements. Most fit and suitable indices of the measured models which are commonly considered acceptable in the Table above nearly accomplished the threshold ranges. The standard acceptable value for χ^2 / *df* is lesser than 3. The threshold values for the indicators GFI, IFI, CFI, and RMSEA are ≥ 0.80, ≥ 0.90, ≥ 0.90, and ≤ 0.08, respectively. Table 5 indicates that the result of these values is 0.851, 0.925, 0.986, and 0.073, respectively. Figure 2 illustrates whether the model formulated through the hypothesis is fit or not, it means that despite their independent status such as dependent or independent, these can be related in the form of one model. The following figure 1 confirms the model fitness for this study.

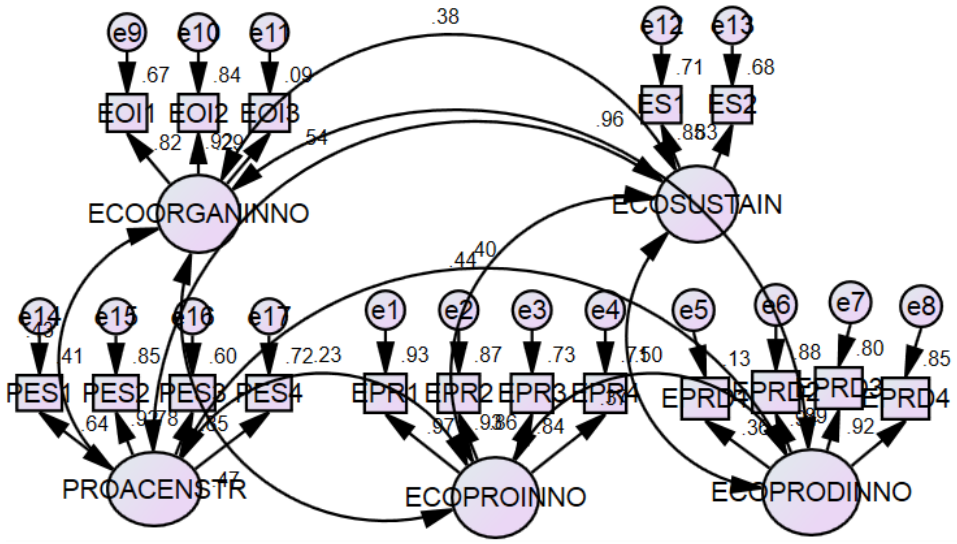

Figure 2. CFA

Structural Equation Modelling

Structural equation modelling is a two-way statistical process that is used to assess and identify the status of a relationship. It can be conducted in two series. The first one talks about the linear impact of the hypothesis, whereas the second step illustrates the indirect impact of variables. This is a set of statistical techniques that are used to measure and analyze the linkage of observed and latent variables. Table 6 exhibits the complete details of structural equation modelling.

Table 6

SEM

Effects	Hypothesized Path	B	S. E	P value	Conclusion
Linear Effects					
Hypothesis 1 (+)	PES → ES	.142	.195	.010	Accepted
Mediation Effects					
Hypothesis 2 (+)	PES → EPR→ ES	.256	.045	.002	Accepted
Hypothesis 3 (+)	PES → EPRD→ ES	.261	.049	.012	Accepted
Hypothesis 4 (+)	PES→ EOI→ ES	.252	.054	.001	Accepted

PES= Proactive environmental strategies, EPR= Eco-process innovation, EPRD=Eco-product innovation, EOI= Eco-organizational innovation, ES=Ecological sustainability

Table 6 illustrates the details regarding the acceptance and rejection of the hypothesis. The first linear effect is the direct impact between pro-environmental strategies and ecological sustainability which has been proven to be significant. The p-value for the hypothesis is .10, which exhibits that the hypothesis has been accepted (PES → ES,

β=.142 and P=.010). The second hypothesis states the indirect or mediation impact of three variables in our study such as eco-product, eco-process, and eco-organizational innovation. Hypothesis 2 has also been accepted as eco-process innovation observes to cast a significant impact between proactive environmental strategies and ecological sustainability (PES → EPR→ ES, β=.256 and P=.002), the hypothesis 3 has also been accepted as eco-product innovation significantly mediates the relationship between PES and ES. The p-value for the hypothesis is .012, (PES → EPRD→ ES, β=.261, and P=.012). The last mediation of EOI has also resulted to be significant between PES and ES. Therefore, the p-value for hypothesis 4 is .001, (PES → EOI→ ES, β=.252, and P=.001). The structural equation modeling results are shown in Figure 3.

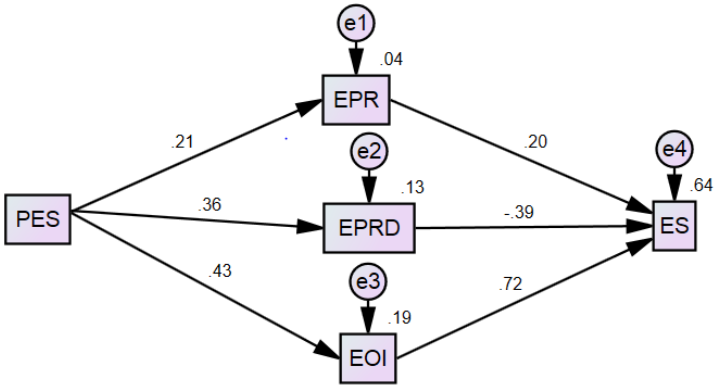

Figure 3. SEM

Discussion

Our research tried to answer the research questions in line with the research objectives. The study aimed to examine the relationship between proactive environmental strategies and ecological sustainability in the high-tech sector of China. The research was conducted on the employees of ecologically sustainable organizations. The research's first hypothesis, "Proactive environmental strategies have a significant impact on ecological sustainability," is accepted as its P value is less than 0.05. As per some past studies, proactive environmental strategies in the construction industries help companies to do more eco-friendly projects, leading to ecological sustainability success (Bamgbade *et al.*, 2019). But our study specifically focuses on the high-tech sector organizations. In another study, the firms observed the link between proactive environmental strategies and sustainable development in the context of environment data accounting. The results showed a significant relationship between these two variables (Metin, 2020). So, our result for this hypothesis is in line with past studies. Indeed, the sustainability of ecology is necessary for adopting the sustainable development goals (Sagala *et al.*, 2019). The organizations are required to work in the innovative way for better working environment development for ecological sustainability (Olaleye *et al.*, 2022).

The second hypothesis, "Eco-process innovation has a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability," is accepted as its P value is less than 0.05. There is a good amount of information on the ecological innovations studied in the past. Eco-innovation produces novel business frameworks, services, products, and organizational processes and maximizes material productivity, prioritizing energy efficiency, using waste to create value, and replacing it with renewable methods, leading to ecological sustainability (Demirel & Kesidou, 2019). The third hypothesis, "Eco-product innovation has a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability," is accepted as its P value is less than 0.05, and the last hypothesis, "Eco-organizational innovation has a mediating impact on the relation between Proactive environmental strategies and Ecological sustainability" is also accepted because its P value is less than 0.05. Eco-innovation has been studied, and its mediating role has also been observed. In Poland, manufacturing firms were studied, and the relationships between proactive environmental strategies, eco-innovation, and ecological sustainability development were observed. It was noticed that eco-innovations mediate the link between proactive environmental strategies and the ecological sustainability development of the firms. Our study is consistent with the past results however, the study lacked a detailed analysis of the three dimensions of eco-innovation. Businesses in emerging countries are under increasing pressure to survive because of tremendous industrialization. If businesses wish to achieve sustainability, they must encourage eco-innovation among organizations (Hu *et al.*, 2019). In a study conducted on Indian manufacturing SMEs, three dimensions of eco-innovation, product, process, and organizational eco-innovations, were analyzed. It was found out that eco process and eco organizational innovations significantly impacted achieving sustainability, including economic, ecological, and social sustainability. At the same time, the eco product innovation seemed to have no direct impact on either of these (Singh & Chakraborty, 2021). Hence our study tries to fulfil its research objectives by studying the relationships between proactive environmental strategies, ecological sustainability, eco process innovation, eco organizational innovation, and eco product innovation.

Furthermore, the sustainability of the organization is key to get the goals that are developed for appropriate actions that are taken for better environment (Darmawan & Dagamac, 2021). However, the organizations are required to adopt sustainability for better environment, because it would be helpful to get sustainability in the environment of the country (Ch'ng *et al.*, 2021).

Conclusion

Overall, this study indicates how proactive environmental strategies significantly enhance levels of ecological sustainability. Moreover, proactive environmental strategies influence eco-innovation, which then impacts ecological sustainability. Regarding meditators, all three dimensions of eco-innovation, e.g., design, production, sales and marketing, etc., play a significant mediation role between proactive environmental strategies and ecological sustainability. Thus, the government and the IT companies must pay attention to conducting these practices so that they can achieve ecological sustainability.

Implications

Theoretical Implications

A particular type of study findings that produce a fresh understanding of a valuable process for improving firms is required to make theoretical contributions. The present study provides such a novel insight following the empirical data on the research variables. Strategic management researchers still do not fully understand the elements of proactive environmental strategies, ecological sustainability, and eco-innovation. As a result, this study significantly contributes to these fields. To the utmost of the researcher's knowledge, minimal studies that combine proactive environmental strategies, ecological sustainability, and eco-innovation dimensions within the same framework are currently accessible. This work adds to the existing body of knowledge on figuring out how these factors relate to one another in line with RBV theory. This study also contributes to the support of RBV theory. The data on three dimensions of eco-innovations, such as process, product, and organizational innovations, is lacking in the literature. So, our study tries to enrich the literature on three dimensions of eco-innovation and their mediating role in the relationship between proactive environmental strategies and ecological sustainability.

Practical Implications

This study has practical contributions to organizations in the high-tech sector of China. The findings indicate the necessity for management to implement proactive environmental initiatives, which has significant managerial implications. Proactive environmental strategy implementation is crucial to achieving ecological sustainability and sustainable performance. Every organization should strive for ecological sustainability and sustained performance within the context of high-tech sector management. For instance, strategic planning procedures for organizations should include environmental challenges as a critical component. Every employee should be aware of the significance of environmental preservation, which demands attention across the entire firm. The study findings are helpful for management to improve their reputation in society by showing more concern towards ecological sustainability and by implementing proactive environmental strategies. The study helps the firms decide that all three dimensions of eco-innovation can be effective in achieving ecological sustainability, so they should focus on all these equally. The policymakers and the government should also pay attention to making policies that motivate the companies to adopt proactive environmental strategies, thus leading to ecological sustainability.

Limitations and Future Recommendations

This study established a framework for linking proactive environmental strategies, eco-innovation (product, process, and organization), and ecological sustainability. However, it also has some limitations. Firstly, the sample size was small due to the limited resources of the study, but in the future sample size can be increased to target more populations. This study is focused on the high-tech sector in China. The same study should be conducted for other emerging economies to get more valid results. As it is concentrated on a single country, comparing the factors affecting ecological sustainability in two countries can also be conducted, adding to the knowledge of culture's impact on proactive environmental strategies and ecological sustainability. It will help to evaluate the variations in the results. Future studies can examine if the same trends happen in other nations as well or not. The current study looks at ecological sustainability in terms of essential factors like proactive environmental strategies and eco-innovations. Future researchers may consider additional factors such as environmentally friendly human resource practices, environmental management control systems, green entrepreneurship, corporate social responsibility, or organizational innovativeness capabilities. It is a quantitative-based study. For future in-depth qualitative or mixed methods, approaches can also be used. Some other statistical methods can also be employed in the future. The limited period is another limitation of this study, so longitudinal studies can be conducted in the future to escape the limited period.

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The article has been reviewed.

Received in November 2022; accepted in December 2022.