



Psychological Capital on Environmental Innovation Performance: A Moderating Intermediary Effect

He Jiang¹ and Yonghui Cao^{2*}

¹ School of Management, Guangzhou College of Commerce, Guangzhou 510000, China

² Quality Development Research Center, Henan University of Economics and Law, Zhengzhou 450000, China

Keywords

Psychological Capital; Top Managers' Environmental Awareness; Reconstruction of Environmental Knowledge; Environmental Innovation Performance

Abstract

In the micro firms' subject, how to enhance the green innovation willingness of firms' employees, so as to improve the firms' environmental innovation performance, has important practical significance and theoretical value. Based on this, taking domestic firms as the research object, this paper empirically discusses the relationship between psychological capital, top managers' environmental awareness, environmental knowledge reconstruction and environmental innovation performance. We find that: (1) Psychological capital will positively affect the performance of environmental innovation, in which the reconstruction of environmental knowledge plays an intermediary role; (2) The relationship between psychological capital and environmental knowledge reconstruction will be moderating by top managers' environmental awareness, the stronger level of top managers' environmental awareness, the stronger the positive relationship between psychological capital and environmental knowledge reconstruction; (3) The stronger level of top managers' environmental awareness, the stronger the mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance.

1. Introduction

With the deepening of China's economic structure adjustment, the requirements for energy conservation and emission reduction of firms are more stringent, and it is urgent to pay attention to environmental problems. Under the requirements of environmental regulation, firms must improve employees' enthusiasm for environmental innovation performance, establish a matching environmental innovation mechanism, and improve firms' environmental innovation ability; At the same time, firms need to give play to their own initiative. Under the influence of leaders' awareness of environmental protection, firms reduce the production and operation risks caused by environmental pollution related to products and production processes by strengthening the self-restraint mechanism of environmental protection.

*corresponding author. Email: lurky2000@126.com

In the era of Internet and knowledge economy, under the pressure of environmental regulation, the competition among firms is more intense and the degree of uncertainty is greater. Stimulating the work enthusiasm of internal employees and improving employees' psychological capital have become an important measure for firms to carry out environmental innovation. Luthans et al. (2004) defined psychological capital as a personal trait that can be measured and changed, including confidence, hope, optimism and resilience. Amabile et al. (1996) pointed out that compared with conventional work tasks, innovation activities are more difficult and have the possibility of failure, which is bound to consume a lot of physical and psychological resources of employees. The positive psychological resources contained in psychological capital, such as optimism, self-confidence and resilience, will increase employees' belief and courage to deal with innovation risks, and then promote employees' innovative behavior. The higher the degree of psychological capital, employees can establish clear goals. Even if they encounter difficulties in the process of innovation, they can achieve innovation goals with tenacious perseverance through positive ways such as self-guidance. Employees can seize opportunities, actively learn, actively face difficulties and overcome various obstacles to achieve innovation (Purwanto et al., 2021; Asbari et al., 2021; Miao et al., 2021; Wang et al., 2021).

So, how does psychological capital affect the performance of environmental innovation? The acquisition and reconstruction of environmental knowledge and other related resources has become the key to solve the relationship between the two. Knowledge is the foundation of innovation. Only by deeply excavating the existing knowledge and continuously exploring new knowledge can we form a good knowledge accumulation and reconstruction for innovation. Green innovation is an innovation considering environmental benefits (Asgarian, 2012) and knowledge is more important to green innovation. In the process of realizing firms' environmental innovation, employee psychological capital affects environmental innovation behavior through knowledge reconstruction. This is embodied in whether employees can confidently face the challenging work encountered in knowledge transfer and reconstruction, whether they can persevere in the goal of technological innovation, choose and adjust appropriate ways and methods of knowledge reconstruction to achieve success, whether they can positively attribute their current and future achievements, and whether they can persevere, quickly recover from difficulties and achieve success (Carmona-Halty et al., 2021; Shrestha & Jena, 2021; Haq et al., 2021)

In addition, Child points out in strategic choice theory that executives play a key role in corporate strategic decision-making. Enterprises with the same political and economic background adopt different environmental strategies, which are influenced by characteristics such as executive attitudes and values. This article argues that the impact of psychological capital on environmental innovation performance is moderated by executive environmental awareness, as executives' interpretation of external pressure and their own abilities can affect a company's environmental strategy. The stronger the environmental awareness of executives, the more inclined they are to identify the potential benefits and market opportunities of green innovation. Therefore, when exploring the mechanism by which psychological capital affects environmental innovation performance, it is necessary to explore the moderating effect of executive environmental awareness.

2. Theoretical Basis and Research Hypothesis

2.1 Psychological capital and environmental innovation performance

Recent studies have divided psychological capital into self-efficacy, hope, resilience and optimism. Among them, self-efficacy refers to the confidence that individuals must have to successfully complete their work tasks; hope is the most sincere wish and expectation of an individual, and the hope for a certain goal or result; resilience refers to a personal trait that can calmly deal with all kinds of difficulties, and can persist, recover and grow in the face of pressure; optimism means that individuals think that bad situations are always temporary, and they are always full of positive energy (Zuberbühler et al., 2021). After the concept of psychological capital was put forward, some scholars explored the relationship between psychological capital and innovation. Judge and Bono (2001) find that employees' innovation performance is closely related to their psychological capital. Positive psychological capital such as hope and optimism can help employees germinate more innovative ideas and innovative behaviors, and significantly affect innovation performance through employees' internal strong achievement motivation. When reviewing relevant literature, it was found that there is some controversy over the relationship between optimism and corporate innovation. On the one hand, optimistic traits can stimulate an individual's creativity and innovative spirit. Optimists usually have positive expectations for the future, are willing to take risks, and have a strong desire to explore. These characteristics are beneficial for them to maintain a leading position in a fiercely competitive market. On the other hand, being overly optimistic may have a negative impact on corporate innovation. Overoptimistic companies may underestimate market risks, blindly pursue growth, and lead to unreasonable innovation strategies. Larson and Luthans (2004) believe that employees with hope are willing to make scientific and feasible work plans, so it is easier to achieve goals. Therefore, if employees have hope, they are easier to achieve innovation. Employee psychological capital plays a vital role in firm technological innovation. Previous studies have shown that employees with high self-efficacy can actively face risks and challenges at work, creatively find shortcuts to solve problems, and consistently complete organizational innovation tasks and achieve innovation performance even in complex environments (Walumbwa et al., 2010). Yang and Gao (2010) explored that psychological capital can affect employees' organizational commitment, organizational citizenship behavior and ultimately organizational independent innovation from the individual and organizational levels. Wu and You (2011) found that employees' positive, healthy and sunny mentality is beneficial to the realization of firm technological innovation performance. Zhang (2013) verified the impact of psychological capital on organizational innovation behavior and its corresponding performance. Dong and Gao (2016) confirmed that psychological capital positively affects employees' innovation initiative. Scholars have studied how green psychological capital and green human resource management can achieve long-term sustainability of organizations (Khan, Jamil, and Khan, 2022). In addition, some scholars have studied the relationship between green intellectual capital and environmental innovation performance (Shahbaz, Ahmad and Malik, 2024).

Based on the above analysis, the following assumptions are inferred:

Hypothesis 1: Psychological capital has a significant positive effect on environmental innovation performance.

2.2 The mediation role of environmental knowledge reconstruction between psychological capital and environmental innovation performance

Whether firms can realize the reconstruction of environmental knowledge is highly related to the belief level of knowledge recipients, positive will and motivation, positive attribution and effective coping with difficulties. The reconstruction of enterprise environmental knowledge refers to the reconstruction of environmental related knowledge that enterprises focus on. It mainly refers to the process of enhancing the environmental awareness of enterprises, reorganizing and integrating environmental related knowledge in the context of low-carbon circular economy, aiming to improve the environmental management ability of enterprises and achieve the strategic goals of sustainable development of enterprises. Psychological capital theory shows that the reconstruction of environmental knowledge is inseparable from the support of positive psychological resources such as psychological capital, because the realization of environmental knowledge reconstruction requires knowledge recipients to have positive beliefs to realize knowledge transfer and reconstruction, maintain positive will and motivation, make positive attribution and make unremitting efforts when encountering the dilemma of knowledge reconstruction, so as to improve the ability of environmental innovation (Du, 2021). Literature research shows that psychological capital, as a core psychological ability, is the fundamental driving force for innovation performance growth. Among them, the higher the individual's self-efficacy, the more likely they are to engage in knowledge re learning. Under the constraints of environmental protection and low-carbon economy, they will be more proactive in reconstructing environmental knowledge. Individuals with an optimistic explanatory style have a positive expectation of themselves, which makes them more likely to develop new ideas and exhibit more creativity; An unwavering internal drive can help employees cope with environmental challenges in the enterprise, meet the need for creative problem-solving, and ultimately improve the environmental innovation performance of the enterprise through knowledge reconstruction.

Knowledge base view shows that in order to realize environmental innovation, firms need to constantly explore new knowledge and deeply tap existing knowledge. Extensive knowledge search can provide new knowledge for firms, enrich firms' knowledge reservoir, promote the reorganization of firms' knowledge, generate new knowledge combination, promote firms' green innovation and improve employees' green innovation capability (Chen et al., 2015; Ardito et al., 2021; Liu et al., 2021; Liao et al., 2021). Firms' employees are the main body of the application and reconstruction of environmental knowledge. Under the influence of positive psychological state, employees with high psychological capital can set more clear goals, actively face challenging work, timely adjust the ways to achieve goals, make positive attribution even in the face of difficulties, and quickly recover from difficulties, which will have higher potency and higher expectations than employees with low psychological capital level, reflecting higher motivation (Arnold & Rigotti, 2020; Song et al., 2021; Dawkins et al., 2018; Seo, 2021). This higher incentive will make employees more willing and motivated to accept, absorb and reconstruct knowledge, knowledge diffusion easier to occur, and environmental innovation performance easier to improve (Abbas & Sağsan, 2019; Kong & Suntrayuth, 2021; Ali et al., 2020; Awan et al., 2020; Li & Lv, 2021). Furthermore, in order to achieve the goal of knowledge reconstruction, high self-efficacy knowledge recipients constantly stimulate their motivation and willingness to accept knowledge, and fully mobilize cognitive resources. Through hard learning, they can achieve the realization of goals and tasks. They will invest more energy and time to

learn, develop and give full play to their potential, and even constantly change their cognitive thinking and mental model through knowledge reconstruction, to achieve higher environmental innovation performance (Chen & Bai, 2017). Therefore, the following assumptions are put forward.

Hypothesis 2: Environmental knowledge reconstruction plays a mediation role between psychological capital and environmental innovation performance.

2.3 Moderating effect of top managers' environmental awareness

The impact of employees' Psychological Capital on environmental innovation performance is moderating by top managers' environmental awareness. Environmental protection awareness can be divided into environmental protection risk awareness and environmental protection benefit awareness. The former refers to executives' awareness of the negative environmental impact of corporate behavior, and the latter refers to executives' awareness of environmental protection measures to increase corporate income and reduce costs. The stronger the environmental awareness of executives, the more inclined to identify the potential benefits and market opportunities of environmental innovation (Arocena et al., 2020; Heydari et al., 2021). Executives with strong environmental awareness are more likely to pay attention to employees' work psychology and give resource support (Zameer et al., 2021). By stimulating employees' work enthusiasm, they can search and reconstruct environmental knowledge, so as to enhance firms' response to the pressure of government environmental regulation. Firms are no longer limited to meeting the minimum requirements of environmental regulation, but actively strive for the government's market incentive resources to offset the cost of green innovation. Burk et al. pointed out that the attitude and commitment of senior managers to the environment affect green innovation, which is conducive to the establishment of a good cooperation environment. In addition, Child points out in strategic choice theory that executives play a key role in corporate strategic decision-making. Enterprises with the same political and economic background adopt different environmental strategies, which are influenced by characteristics such as executive attitudes and values. This article argues that the impact of psychological capital on environmental innovation performance is moderated by executive environmental awareness, as executives' interpretation of external pressure and their own abilities can affect a company's environmental strategy. The stronger the environmental awareness of executives, the more inclined they are to identify the potential benefits and market opportunities of green innovation. Therefore, when exploring the mechanism by which psychological capital affects environmental innovation performance, it is necessary to explore the moderating effect of executive environmental awareness.

Accordingly, hypothesis 3 is proposed:

Hypothesis 3: Top managers' environmental awareness plays a moderation role between psychological capital and environmental knowledge reconstruction. The higher the level top managers' environmental awareness, the stronger the positive relationship between psychological capital and environmental knowledge reconstruction.

In the above discussion, we assume that: (1) Environmental knowledge reconstruction plays a mediator role between psychological capital and environmental innovation performance; (2) Top managers' environmental awareness will strengthen the positive impact of psychological

capital on environmental knowledge reconstruction, and will affect the positive relationship between environmental knowledge reconstruction and environmental innovation performance. The top managers have awareness of environmental protection, which can mobilize the resources of environmental innovation, give diversified support to employees for environmental innovation, enhance employees' enthusiasm for environmental innovation, promote employees' willingness to share and reconstruct environmental knowledge, enhance the initiative of firms to actively respond to environmental pressure, and help reduce a series of mandatory environmental costs such as environmental protection tax, sewage charges and environmental fines, which can ensure the implementation effect of environmental regulation, so as to improve the environmental innovation performance of firms. According to these assumptions, we can further infer that the higher level of top managers' environmental awareness, the stronger the positive effect (indirect effect) of psychological capital on environmental innovation performance through environmental knowledge reconstruction. That is, the higher the level of top managers' environmental awareness, the stronger the mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance.

Hypothesis 4: The higher level of top managers' environmental awareness, the stronger mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance

Based on the above literature studies, this paper summarises all the hypotheses and supporting literature as shown in Table 1.

Table 1 *Summary of Research Hypotheses*

Number	Assumption Description	Research Literature
H1	Hypothesis 1: Psychological capital has a significant positive effect on environmental innovation performance.	Judge & Bono, 2001; Larson & Luthans, 2004; Walumbwa et al., 2010; Dong & Gao, 2016; Zuberbühler et al., 2021;
H2	Hypothesis 2: Environmental knowledge reconstruction plays a mediation role between psychological capital and environmental innovation performance.	Chen et al., 2015; Dawkins et al., 2018; Abbas & Sağsan, 2019; Ali et al., 2020; Arnold & Rigotti, 2020; Ardito et al., 2021; Liu et al., 2021; Kong & Suntrayuth, 2021; Li & Lv, 2021
H3	Hypothesis 3: Top managers' environmental awareness plays a moderation role between psychological capital and environmental knowledge reconstruction. The higher the level top managers' environmental awareness, the stronger the positive relationship between psychological capital and environmental knowledge reconstruction.	Dawkins et al., 2018; Abbas & Sağsan, 2019; Arocena et al., 2020; Heydari et al., 2021; Zameer et al., 2021
H4	Hypothesis 4: The higher level of top managers' environmental awareness, the stronger mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance	Arocena et al., 2020; Zuberbühler et al., 2021; Heydari et al., 2021; Zameer et al., 2021;

Based on the above analysis, this paper takes the psychological capital theory as the starting point to deeply study the relationship between psychological capital, high-level environmental protection awareness, environmental knowledge reconstruction and environmental innovation performance, in order to clarify its internal mechanism and promote the theoretical development of entrepreneurship education. The specific research framework is shown in Fig. 1:

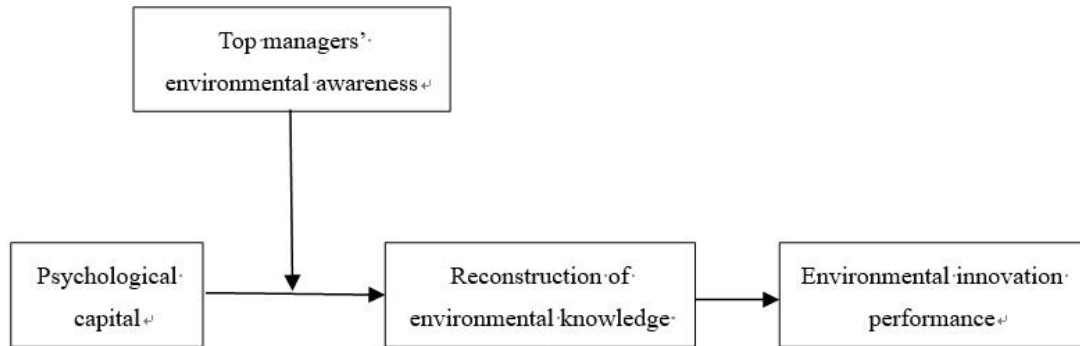


Fig. 1 *Research Framework of This Paper*

3. Research Methods

3.1 Questionnaire design

In order to ensure the scientific, reasonable and standardised design of the questionnaire, this paper mainly designs the questionnaire through the following steps.

Firstly, literature research and actual survey are combined with each other. According to the research design of this paper, literature combing is carried out on psychological capital, high-level environmental awareness, environmental knowledge reconstruction, environmental innovation performance and other related variables, focusing on the relevant measurement scales and questions in international authoritative journals, comparative analysis and screening, forming a preliminary scale, and comparing it with the relevant scales that have been empirically tested in China, to form the original first draft of the questionnaire. After that, we conducted enterprise research, conducted semi-structured interviews with the persons in charge of the relevant enterprises, and revised the questionnaire items according to the results of the interviews to form a more complete first draft.

Second, the questionnaire was revised through discussions with relevant experts. Through the regular academic meetings, we made an academic report on the design of the questionnaire, solicited the opinions of the team members, and revised the structure of the questions and the expression of the content in the first draft. In addition, we consulted with relevant scholars, and based on the suggestions, we improved the questions again to form the second draft.

Third, the questionnaire was pretested to form the final draft of the research questionnaire. The questionnaire was empirically tested on a small sample, and the reliability and validity of related variables were analyzed, and the questions with lower reliability were deleted to form the final official draft.

Likert 5-point scale was used for measurement. The scores were progressive from 1 to 5, where 1 indicates as not at all compliant, 2 as relatively not compliant, 3 as average, 4 as relatively compliant, and 5 as fully compliant.

3.2 Variable measurement

In order to ensure the validity and reliability of variables, this study scientifically designed the measurement items of related variables on the basis of classical literature. The explanatory variable is psychological capital. The result variable is environmental innovation performance. The mediating variable is environmental knowledge reconstruction. The moderating variable is high-level environmental awareness. The control variables are enterprise years, enterprise scale and enterprise nature. First, the dimension division and specific items of psychological capital refer to the research results of the following scholars and are adapted: Purwanto A, Asbari M, Hartuti H, et al., 2021; Asbari M, Prasetya A B, Santoso P B, et al., 2021; Miao R, Bozionelos N, Zhou W, et al., 2021; Second, the dimension division and specific items of environmental innovation performance refer to the research results of the following scholars and are adapted: Ardito L, Raby S, Albino V, et al., 2021; 2021; Kong Y, Suntrayuth S., 2021; Third, the dimension division and specific items of environmental knowledge reconstruction refer to the research results of the following scholars and are adapted: Asgarian N., 2012; Chen Y, Wang Y, Nevo S, et al., 2015; Chen H, Bai Y., 2017; Abbas J, Sağsan M., 2019; Fourth, the dimension division and specific items of high-level environmental awareness refer to the research results of the following scholars and are adapted: Arocena P, Orcos R, Zouaghi F., 2020; Heydari J, Govindan K, Basiri Z., 2021; Zameer H, Wang Y, Saeed M R., 2021; Fifth, control variables. This paper takes the years, scale and nature of enterprises as control variables. The definition of enterprise years refers to the length of time that an enterprise survives from its establishment to the end of the investigation. The measurement of enterprise scale is represented by the number of employees, which is divided into four key quantity points: 0, 200, 500 and 1,000. The nature of enterprises adopts 2 classification method, which is divided into manufacturing enterprises and service-oriented enterprises.

3.3 Data collection

(1) Prevention and inspection of common method deviation

This study adopts the methods of pre prevention and posttest to reduce or eliminate the deviation of common methods. The instructions are as follows: first, prevention in advance. It is mainly carried out from two aspects: collecting data by means of time separation and geographical separation; Optimize questionnaire settings. In the questionnaire design, we should reflect the confidentiality commitment to the respondents. Second, post inspection. The Harman single factor test was used to test, that is, all variables of the scale were put together for factor analysis. After no response deviation and common method deviation test, it is suitable for statistical analysis.

(2) Data collection process

This study has conducted two questionnaire surveys, with an interval of half a year. After the test of no response bias and common method bias, it is suitable for statistical analysis. (1) The object of the first survey is the firms' executives applying for the government quality

excellence award, because the firms applying for the government quality award generally need environmental quality system certification, which is the desirable object of this study. The contents of the survey include the background information of the firms, the psychological capital, the top managers' environmental awareness and the reconstruction of environmental knowledge; (2) The second survey is still conducted for the middle and senior managers of the firms surveyed for the first time. The contents of the survey include the psychological capital and environmental innovation performance of the firms where these executives are located. After each questionnaire is completed, the respondents can send it to the researchers through a variety of contact methods, such as e-mail, WeChat, QQ or sealed mail.

(3) Basic statistics

In the first survey, we sent out 500 questionnaires and recovered 382 valid questionnaires, with a recovery rate of 76.40%. In the second survey, 382 people who effectively filled in the first survey were re distributed with questionnaires, and a total of 286 valid questionnaires were recovered, with a recovery rate of 74.87%. In the collected questionnaire, the average age of firms is 10.49 years, and the standard deviation is 6.63. The firm scale is measured by the number of people. The specific situation is that 67 firms have more than 1000 people, accounting for 23.4%; 95 firms have between 501 and 1000 people, accounting for 33.2%; 107 firms have between 201 and 500 people, accounting for 37.4%; and 17 firms have less than 200 people, accounting for 5.9%, indicating that most firms are in a period of rapid growth. There are 166 manufacturing firms, accounting for 58.0%, and 120 service-oriented firms, accounting for 42.0%.

4. Data Analysis and Results

4.1 Tests of validity and reliability between variables

(1) KMO and Bartlett sphere test:

The results of the study showed that after the KMO test for all the observed variables, the value obtained was 0.871, in addition the significance of the Bartlett sphere test was 0.00, which is less than 0.05, and according to the KMO and Bartlett sphere test, it is suitable for factor analysis. (Table 2)

Table 2 *KMO and Bartlett's Test*

KMO and Bartlett's test		
Kaiser-Meyer-Olkin		.871
Bartlett's test of sphericity	approximate chi-square	2906.644
	df	136
	Sig.	.000

(2) Factor analysis

Principal component analysis method: factor extraction was carried out on the measured variables according to the maximum variation method, and the principle of extraction was that the eigenvalue was greater than 1, and a total of 4 factors were extracted. The results are shown in Table 3.

Table 3 *Total Variance Explained*

Component	Initial eigenvalue			Extract the sum of squares to load			Rotate the sum of squares to load		
	add up the total	% of variance	Cumulative %	add up the total	% of variance	Cumulative %	add up the total	% of variance	Cumulative %
1	6.647	39.100	39.100	6.647	39.100	39.100	4.986	29.327	29.327
2	2.295	13.503	52.602	2.295	13.503	52.602	2.545	14.969	44.297
3	1.700	10.000	62.603	1.700	10.000	62.603	2.426	14.272	58.568
4	1.435	8.439	71.041	1.435	8.439	71.041	2.120	12.473	71.041
5	.790	4.647	75.688						
6	.572	3.366	79.054						
7	.554	3.260	82.314						
8	.498	2.928	85.243						
9	.438	2.577	87.820						
10	.362	2.131	89.951						
11	.344	2.026	91.977						
12	.300	1.766	93.743						
13	.282	1.657	95.400						
14	.257	1.514	96.914						
15	.188	1.106	98.021						
16	.177	1.039	99.060						
17	.160	.940	100.000						
Extraction method: principal component analysis.									

The exploratory factor loading matrix results are shown in Table 4:

Table 4 *Exploratory Factor Loading Matrix Results*

Variable	Component			
	Psychological capital	Top managers' environmental awareness	Reconstruction of environmental knowledge	Environmental innovation performance
psychological capital 1	.226	.059	.836	.169
psychological capital 2	.259	-.038	.856	.134
psychological capital 3	.216	.094	.863	.118
top managers' environmental awareness 1	.029	.751	.009	.096
top managers' environmental awareness 2	.120	.748	.083	.018
top managers' environmental awareness 3	.089	.879	.037	.008
top managers' environmental awareness 4	.215	.712	-.012	.012
reconstruction of environmental knowledge 1	.724	-.027	.156	.170
reconstruction of environmental knowledge 2	.800	.129	.217	.125
reconstruction of environmental knowledge 3	.838	.096	.165	.155
reconstruction of environmental knowledge 4	.847	.171	.171	.027
reconstruction of environmental knowledge 5	.837	.161	.101	.172
reconstruction of environmental knowledge 6	.814	.155	.164	.194
reconstruction of environmental knowledge 7	.833	.102	.144	.150
environmental innovation performance 1	.134	.102	.071	.824
environmental innovation performance 2	.222	.018	.138	.769
environmental innovation performance 3	.209	.008	.181	.788

Extraction Method: Principal Component.

Rotation method: Orthogonal rotation method with Kaiser standardization.

Rotation converges after 5 iterations.

(3) Reliability test

Next, Cronbach's α coefficient was applied to test the internal consistency of the observed variables. The results are shown in Table 5, and all the variables have α coefficient values greater than 0.7, and therefore, have good reliability (Table 5).

Table 5 *Results of Confidence Analysis*

Structural variables	Number of indicators	Cronbach's α
Psychological capital	3	0.876
Top managers' environmental awareness	4	0.791
Reconstruction of environmental knowledge	7	0.935
Environmental innovation performance	3	0.772

4.2 Discriminant validity test

The discriminant validity of the four key variables of this paper: psychological capital, top managers' environmental awareness, environmental knowledge reconstruction and environmental innovation performance is tested. Amos20.0 is used in this study to conduct confirmatory factor analyses (CFA) on key variables and compare among multiple models. The results show that the four factor model is the same as the first mock exam model, which is significantly superior to the goodness of fit of the model.

4.3 Descriptive statistical analysis

First, do the correlation analysis between variables. From Table 6, we can see the correlation coefficient between psychological capital and environmental innovation performance is 0.359 ($p < 0.01$); the correlation coefficient between psychological capital and environmental knowledge reconstruction was 0.460 ($p < 0.01$); the correlation coefficient between environmental knowledge reconstruction and environmental innovation performance was 0.412 ($p < 0.01$). This is consistent with the hypothesis of this paper, and also provides evidence for further demonstration of relevant hypotheses.

Table 6 *Mean, Standard Deviation and Correlation Coefficient among Main Variables*

Variable	1	2	3	4h	5f	6e	7c
1. Industry	1						
2. Firm scale	.257**	1					
3. Firm age	.027	-.080	1				
4. Psychological capital	.056	.016	-.088	1			
5. Top managers' environmental awareness	-.023	.028	-.055	.123*	1		
6. Reconstruction of environmental knowledge	.003	.054	-.116	.460**	.283**	1	
7. Environmental innovation performance	-.112	.025	.107	.359**	.130*	.412**	1
Mean (M)	0.420	2.741	10.493	3.399	3.340	3.545	3.087
Standard deviation (SD)	0.494	0.884	6.633	0.783	0.623	0.651	0.708

Note: $n = 286$; ** $p < 0.01$, * $p < 0.05$

4.4 Hypothesis verification

(1) Main effect test

Hypothesis 1 proposes that psychological capital has a significant positive impact on environmental innovation performance. To test this hypothesis, we first set the environmental innovation performance as the dependent variable, then add the control variables (industry, firms age and firms scale), and finally put the independent variable (psychological capital) into the regression equation. The results of hierarchical regression are listed in Table 7. From Table 7, we can see that the impact of psychological capital on environmental innovation performance is significant (M_6 , $\beta = 0.380$, $p < 0.01$). Therefore, hypothesis 1 is supported by the data.

Table 7 Hypothesis Test Results

	Reconstruction of environmental knowledge				Environmental innovation performance			
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈
Control variables								
Industry	-0.006	-0.034	-0.025	-0.014	-0.133*	0.155**	-0.130*	0.144**
Firm scale	0.047	0.050	0.042	0.033	0.069	0.071	0.049	0.055
Firm age	-0.112	-0.071	-0.062	-0.063	-0.116*	0.151**	0.164**	0.173**
Independent variable								
Psychological capital(PC)		0.455**	0.428**	0.416**		0.380**		0.233**
Mediator								
Reconstruction of environmental knowledge;							0.429**	0.322**
Moderator								
Top managers' environmental awareness(TMEA)			0.225	0.201**				
Interactive item								
PC*TMEA				0.122*				
ΔR^2	0.015	0.205	0.050	0.014	0.029	0.143	0.181	0.081
ΔF	1.478	73.2811**	19.021**	5.431**	2.812*	48.416**	64.476**	30.381**

Note: ** $p < 0.01$, * $p < 0.05$

(2) Mediating effect test

Next, the hierarchical regression method will be used to verify the mediation role of environmental knowledge reconstruction between psychological capital and environmental innovation performance. The results of hierarchical regression are listed in Table 7. As we can see from Table 7, Psychological capital has a significant positive impact on environmental innovation performance (M_6 , $\beta = 0.380$, $p < 0.01$). At the same time, environmental knowledge reconstruction also has a significant positive impact on environmental innovation performance

(M_7 , $\beta = 0.429$, $p < 0.01$). After adding the mediator environmental knowledge reconstruction, the impacting coefficient of psychological capital on environmental innovation performance decreased significantly from 0.380 to 0.233, while environmental knowledge reconstruction still had a significant positive impact on environmental innovation performance. Therefore, we can conclude that environmental knowledge reconstruction plays a mediator role between psychological capital and environmental innovation performance, which supports hypothesis 2. Therefore, we can conclude that environmental knowledge reconstruction plays a mediator role between psychological capital and environmental innovation performance, which supports hypothesis 2.

After applying Baron and Kenny's (1986) mediation effect test criteria, in order to further test the significance of the mediation effect, this paper further uses the bootstrap method to test the significance of the mediation effect. The sample size is 5000 and tested under the 95% confidence interval. The test results show that the mediation effect is 0.1304, and the 95% confidence interval (LLCI = 0.0782, ULCI = 0.1860) does not contain 0, which shows that environmental knowledge reconstruction plays a mediation role between psychological capital and environmental innovation performance. Therefore, hypothesis 2 is further supported by the data.

(3) Moderating effect test

Hypothesis 3 proposes that top managers' environmental awareness will strengthen the positive relationship between psychological capital and environmental knowledge reconstruction. In order to test this hypothesis, we first set the reconstruction of environmental knowledge as the dependent variable, then introduce the control variable, independent variable (psychological capital) and moderator (top managers' environmental awareness), and finally add the product of independent variable and moderator. In order to eliminate collinearity, when constructing the product term of independent variable and moderator, we standardize the independent variable and moderator respectively. The results of hierarchical regression analysis are also listed in Table 7. From model 4 in Table 7, we can see that the interactive item has a significant positive impact on the reconstruction of environmental knowledge (M_4 , $\beta = 0.122$, $p < 0.05$). This shows that the higher level of top managers' environmental awareness, the stronger positive relationship between psychological capital and environmental knowledge reconstruction, which supports hypothesis 3. Fig. 2 shows the influence mode of this interaction. According to the procedure (Liu et al., 2021) recommended by Cohen et al., We take one standard deviation above the mean, mean, one standard deviation below the mean as the benchmark, and describe the different impact degree of psychological capital on environmental knowledge reconstruction different level top managers' environmental protection consciousness.

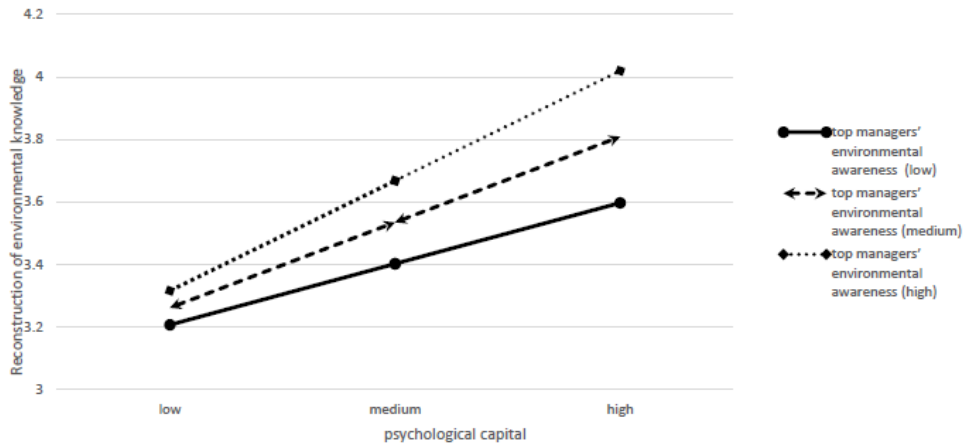


Fig. 2 *Different Effects of Psychological Capital on the Reconstruction Level of Environmental Knowledge under Different Levels of Top Managers' Environmental Awareness*

(4) Mediating effect with moderator

Hypothesis 4 proposes that top managers' environmental awareness will enhance the mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance. In order to test this hypothesis, according to the suggestions of Preach and Hayes, this paper uses the bootstrapping method to analyze and study the mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance under different levels of top managers' environmental awareness, that is, the moderating mediating effect test. The results show that the index is 0.0548, and it is found that the 95% confidence interval is located at (0.0031, 0.1209), and the interval does not contain 0, indicating that the effect is significant. In order to further explore the impact of different levels of top managers' environmental awareness on psychological capital, environmental knowledge reconstruction and environmental innovation performance, this paper conducts a bootstrap test for top managers' environmental awareness according to three levels: high, medium and low, that is, the mean of top managers' environmental awareness plus one standard deviation, the mean and the mean minus one standard deviation,

As shown in Table 8, the results show that when the top managers' environmental awareness is high, the coefficient is 0.1533, and the confidence interval (0.0870, 0.2278) does not include 0, which is significant; when the top managers' environmental awareness is medium, the coefficient is 0.1191, and the confidence interval (0.0687, 0.1720) does not include 0, which is also significant; when the top managers' environmental awareness is low, the coefficient is 0.0826, and the confidence interval (0.0325, 0.1449) does not contains 0, which is also significant. This shows that the higher level of top managers' environmental awareness, the greater mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance, which verifies Hypothesis 4.

Table 8 *Different Impact Degree among Psychological Capital, Environmental Knowledge Reconstruction and Environmental Innovation Performance under Different Levels of Top Managers' Environmental Awareness*

Moderator	Degree (value)	Repeated extraction times	Effect	BootLLCI	BootULCI
Top managers' environmental awareness	Low (2.7170)	5,000	0.0850	0.0325	0.1449
	Medium (3.3400)	5,000	0.1191	0.0687	0.1720
	High (3.9630)	5,000	0.1533	0.0870	0.2278

5. Conclusion and Discussion

5.1 Conclusion

This paper discusses the relationship between psychological capital, top managers' environmental awareness, environmental knowledge reconstruction and environmental innovation performance, we find that: (1) psychological capital will positively affect the performance of environmental innovation, in which the reconstruction of environmental knowledge plays an intermediary role; (2) The relationship between psychological capital and environmental knowledge reconstruction will be moderating by top managers' environmental awareness, the stronger level of top managers' environmental awareness, the stronger the positive relationship between psychological capital and environmental knowledge reconstruction; (3) the stronger level of top managers' environmental awareness, the stronger the mediating effect of environmental knowledge reconstruction between psychological capital and environmental innovation performance. In short, this paper explores the impact of psychological capital on environmental knowledge reconstruction and environmental innovation performance, analyzes the contingency effect of top managers' environmental awareness between psychological capital and environmental knowledge reconstruction, and comprehensively clarifies the mechanism of the impact between them.

5.2 Theoretical value

Compared with previous literature, this article conducts localized empirical research and provides a theoretical basis from psychological capital for corporate environmental innovation under environmental pressure. At the same time, it also analyzes the role of high-level environmental awareness in it. Compared with previous achievements, it is more scientific and convincing. In addition, previous literature research has mainly focused on the relationship between psychological capital and creative performance, with less analysis of the relationship between psychological capital and corporate environmental innovation performance. This article is also based on the macro strategic scenario of implementing a low-carbon economy in China, and has important theoretical value and practical significance. In research, to ensure the scientificity of the research, when collecting data, this paper adopts a multi-point longitudinal research design, and collects samples in variables at an interval of half a year, which helps to reduce the influence of common method bias and better reveal the causal relationships between variables. The use of bootstrapping method can describe the relationship between variables more deeply, which makes the research conclusion more robust. In short, this paper has positive

practical significance and theoretical guiding value for firms that will implement environmental innovation.

5.3 Managerial implications

This paper mainly studies the impact path of psychological capital on environmental innovation performance, and explores its regulatory mechanism and intermediary mechanism. This has important practical value for exploring the realistic path to improve the environmental innovation performance of enterprises, and provides reference for the sustainable and healthy growth of local enterprises. The positive effect of psychological capital on environmental innovation performance provides a practical direction for enterprises to implement appropriate green development strategy. In addition, the intermediary role of environmental knowledge reconstruction, when providing positive psychological capital for enterprise employees, consciously pay attention to the impact on environmental knowledge reconstruction, so that enterprises can improve environmental innovation performance and provide practical logic for enterprises to obtain sustainable competitiveness. Finally, the positive regulation of high-level environmental awareness provides external contingency factors for the practice of psychological capital affecting the reconstruction of environmental knowledge. For enterprises, we can use the influence of external factors to bring practical reference for enterprise employees from psychology to knowledge acquisition.

5.4 Research limitations and future research directions

Following the standardized management research paradigm, this paper systematically analyzes the relationship between psychological capital, environmental knowledge reconstruction and environmental innovation performance, deeply excavates the internal mechanism between them, and has achieved some results. However, due to the exploratory research, there are inevitably deficiencies. In the research, due to the limitations of various subjective and objective reasons, this paper only discusses the contingency impact of high-level environmental awareness on the interaction process between psychological capital and environmental knowledge reconstruction. However, in fact, there are many factors affecting the relationship between the two, including a variety of internal and external factors. Therefore, subsequent research can explore the impact of other contingency variables on the above-mentioned relationship, so as to obtain more and more valuable theoretical results.

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References

- Abbas, J., & Sağsan, M. (2019). Impact of knowledge management practices on green innovation and corporate sustainable development: A structural analysis. *Journal of Cleaner Production*, 229, 611-620.
- Ali, S., Dogan, E., Chen, F., & Khan, Z. (2020). International trade and environmental performance in top ten-emitters countries: The role of eco-innovation and renewable energy consumption. *Sustainable Development*, 29(2), 378-387. <https://doi.org/10.1002/sd.2153>

- Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, 39(5), 1154-1184. <https://doi.org/10.5465/256995>
- Ardito, L., Raby, S., Albino, V., & Bertoldi, B. (2021). The duality of digital and environmental orientations in the context of SMEs: Implications for innovation performance. *Journal of Business Research*, 123, 44-56. <https://doi.org/10.1016/j.jbusres.2020.09.022>
- Arnold, M., & Rigotti, T. (2020). Is it getting better or worse? Health-oriented leadership and psychological capital as resources for sustained health in newcomers. *Applied Psychology*, 70(2), 709-737. <https://doi.org/10.1111/apps.12248>
- Arocena, P., Orcos, R., & Zouaghi, F. (2020). The impact of ISO 14001 on firm environmental and economic performance: The moderating role of size and environmental awareness. *Business Strategy and the Environment*, 30(2), 955-967. <https://doi.org/10.1002/bse.2663>
- Asbari, M., Prasetya, A., & Purwanto, A. (2021). From creativity to innovation: The role of female employees' psychological capital. *International Journal of Social and Management Studies*, 2(2), 66-77. <https://api.semanticscholar.org/CorpusID:235585190>
- Asgarian, N. (2012). Knowledge management capacity and innovation performance. *Management Science Letters*, 2(8), 2739-2746. <https://doi.org/10.5267/j.msl.2012.10.015>
- Awan, U., Arnold, M. G., & Gölgeci, I. (2020). Enhancing green product and process innovation: Towards an integrative framework of knowledge acquisition and environmental investment. *Business Strategy and the Environment*, 30(2), 1283-1295. <https://doi.org/10.1002/bse.2684>
- Carmona-Halty, M., Salanova, M., Llorens, S., & Schaufeli, B. (2021). Linking positive emotions and academic performance: The mediated role of academic psychological capital and academic engagement. *Current Psychology*, 40(6), 2938-2947. <https://doi.org/10.1007/s12144-019-00227-8>
- Chen, H. G., & Bai, Y. H. (2017). Innovation and reconstruction of management mode in Internet era. *2017 International Conference on Education Science and Economic Management (ICESEM 2017)*, 151-155. <https://doi.org/10.2991/icesem-17.2017.35>
- Chen, Y., Wang, Y., Nevo, S., Benitez-Amado, J. & Kou, G. (2015). IT capabilities and product innovation performance: The roles of corporate entrepreneurship and competitive intensity. *Information & Management*, 51(6), 643-657. <https://doi.org/10.1016/j.im.2015.05.003>
- Dawkins, S., Martin, A., Scott, J., Sanderson, K., & Schüz, B. (2018). A cross-level model of team-level psychological capital (PsyCap) and individual-and team-level outcomes. *Journal of Management & Organization*, 27(2): 397-416. <https://doi.org/10.1017/jmo.2018.27>
- Dong, Y., & Gao J. (2016). The impact of psychological capital on employees' innovation initiative. *Academic Exchange*, (11), 122-125.
- Du, L. (2021). How knowledge affects incremental innovation in SMEs: Knowledge base and knowledge heterogeneity. *Journal of General Management*, 46(2), 91-102. <https://doi.org/10.1177/03063070209301>
- Haq, M. A. U., Ahmed, M. A., Khalid, S., & Usman, M. (2021). Effect of empowering leadership on knowledge sharing: mediating roles of psychological empowerment and psychological capital. *International Journal of Knowledge and Learning*, 14(3), 244-261. <https://doi.org/10.1504/IJKL.2021.116897>
- Heydari, J., Govindan, K., & Basiri, Z. (2021). Balancing price and green quality in presence of consumer environmental awareness: a green supply chain coordination approach. *International Journal of*

- Production Research*, 59(7), 1957-1975. <https://doi.org/10.1080/00207543.2020.1771457>
- Judge, T. A., & Bono, J. E. (2001). A rose by any other name: are self-esteem, generalized self-efficacy, neuroticism, and locus of control indicators of a common construct? *American Psychological Association*, 93-118. <https://doi.org/10.1037/10434-004>
- Khan, S., Jamil, S., Khan, U. R. (2022). How green psychological capital and green HRM can lead to long-term sustainability in organizations. *International journal of management research and emerging sciences*, 12(4).
- Kong, Y., & Suntrayuth, S. (2021). The causal model of absorptive capacity, strategic flexibility and innovation performance on sustainable competitive advantage: An internationalization perspective. *Thammasat Review*, 24(1): 214-246.
- Larson, M. D., & Luthans, F. (2004). Beyond human and social capital: The additive value of psychological capital on employee attitudes. *Nebraska: Working Paper, Gallup Leadership Institute, University of Nebraska-Lincoln*, 1-3.
- Li, D. D., & Lv H. J. (2021). Investment in environmental innovation with environmental regulation and consumers' environmental awareness: A dynamic analysis. *Sustainable Production and Consumption*, 28, 1366-1380. <https://doi.org/10.1016/j.spc.2021.08.012>
- Liao, Z. J., Liu, P., & Liu, S. C. (2021). A meta-analysis of environmental innovation and firm performance. *Journal of Environmental Planning and Management*, 64(1), 1-35. <https://doi.org/10.1080/09640568.2020.1855129>
- Liu, S., Xu, R. X., & Chen, X. Y. (2021). Does green credit affect the green innovation performance of high-polluting and energy-intensive enterprises? Evidence from a quasi-natural experiment. *Environmental Science and Pollution Research, Business Strategy and the Environment*, 28(46), 65265-65277. <https://doi.org/10.1007/s11356-021-15217-2>
- Luthans, F., Luthans, K. W., & Luthans, B. C. (2004). Positive psychological capital: Beyond human and social capital. *Business Horizons*, 47(1), 45-50. <https://doi.org/10.1016/j.bushor.2003.11.007>
- Miao, R., Bozionelos, N., Zhou, W., & Newman, A. (2021). High-performance work systems and key employee attitudes: the roles of psychological capital and an interactional justice climate. *The International Journal of Human Resource Management*, 32(2), 443-477. <https://doi.org/10.1080/09585192.2019.1710722>
- Purwanto, A., Asbari, M., Fahmi, K., & Hartuti, H. (2021). Effect of psychological capital and authentic leadership on innovation work behavior. *International Journal of Social and Management Studies*, 2(1), 1-13. <https://api.semanticscholar.org/CorpusID:236727751>
- Seo, R. S. (2021). Positive psychological capital, start-up intention, start-up behavior option network analysis. *Asia-Pacific Journal of Business Venturing and Entrepreneurship*, 16(1), 139-146.
- Shahbaz, M. H., Ahmad, S., Malik, S. A. (2024). Green intellectual capital heading towards green innovation and environmental performance: assessing the moderating effect of green creativity in SMEs of Pakistan. *International Journal of Innovation Science*. ahead-of-print. <https://doi.org/10.1108/IJIS-08-2023-0169>
- Shrestha, A. K., & Jena, L. K. (2021). Interactive effects of workplace spirituality and psychological capital on employee negativity. *Management and Labour Studies*, 46(1), 59-77. <https://doi.org/10.1177/0258042X20962994>

- Song, L. L., Wang, Y., & Zhao, Y. K. (2021). How employee authenticity shapes work attitudes and behaviors: The mediating role of psychological capital and the moderating role of leader authenticity. *Journal of Business and Psychology, 36*(6), 1125-1136. <https://doi.org/10.1007/s10869-020-09725-0>
- Walumbwa, F. O., Peterson, S. J., Avolio, B. J., & Hartnell, C. A. (2010). An investigation of the relationships among leader and follower psychological capital, service climate, and job performance. *Personnel Psychology, 63*(4): 937-963. <https://doi.org/10.1111/j.1744-6570.2010.01193.x>
- Wang, D., Kan, W., Qin, S., & Zhao, C. (2021). How authentic leadership impacts on job insecurity: The multiple mediating role of psychological empowerment and psychological capital. *Stress and Health, 37*(1), 60-71. <https://doi.org/10.1002/smi.2973>
- Wu, Q. S., & You, D. (2011). Cross level analysis of employee psychological capital, organizational innovation atmosphere and technological innovation performance. *Systems Engineering, 29*(1), 69-77.
- Yang, Y., & Gao, S. X. (2010). Research on the mechanism of psychological capital on Enterprise Independent Innovation -- An integration framework from the perspective of organizational learning. *Scientific and Technological Progress and Countermeasures, 27*(23), 79-84.
- Zameer, H., Wang, Y., & Saeed, M. R. (2021). Net-zero emission targets and the role of managerial environmental awareness, customer pressure, and regulatory control toward environmental performance. *Business Strategy and the Environment, 30*(8): 4223-4236. <https://doi.org/10.1002/bse.2866>
- Zhang, H. R. (2013). An empirical study on the impact of psychological capital on innovation performance. *Management World, (10)*, 170-171
- Zuberbühler, J. P., Calcagni, C. C., Martínez, I. M., & Salanova, M. (2021). Development and validation of the coaching-based leadership scale and its relationship with psychological capital, work engagement, and performance. *Current Psychology, 42*(10), 648-669. <https://doi.org/10.1007/s12144-021-01460-w>

He Jiang

School of Management, Guangzhou College of Commerce, Guangzhou 510000, China

E-mail address: jhe207@163.com

Major area(s): Environmental innovation; Green development of enterprises; Corporate psychology

Yonghui Cao

Quality Development Research Center, Henan University of Economics and Law, Zhengzhou 450000, China

E-mail address: lurky2000@126.com

Major area(s): Environmental innovation; Green development of enterprises; Corporate psychology

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