Impact of Cross-Boundary Behavior on Team Innovation

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Absract. In contemporary organizational structures characterized by intricate hierarchies and diverse task allocations, the significance of team cross-boundary behavior has been accentuated. This research delves into the influence of team cross-boundary behavior on team innovation performance, with a particular focus on the mediating effect of knowledge sharing and the moderating effect of team cohesion. Drawing from an analysis of 108 valid team samples and 596 individual samples, it was discerned that team cross-boundary behavior markedly augments team innovation performance. Furthermore, knowledge sharing acts as a conduit mediating the relationship between team cross-boundary behavior and innovation performance. Notably, the presence of team cohesion amplifies this relationship. These insights offer valuable implications for organizations aiming to bolster team innovation performance by fostering boundary-crossing behaviors and knowledge dissemination, underscoring the pivotal role of team cohesion in this dynamic.

Keywords: Cross-boundary behavior; Innovation performance; Knowledge sharing; Team cohesion

1 Introduction

In today's highly competitive market environment, organizations and teams face increasing challenges. It is difficult to meet these challenges with internal knowledge and resources alone, especially in the context of the knowledge economy[1] . In order to adapt to this environment and remain competitive, teams and organizations are increasingly relying on cross-boundary behaviors to access external knowledge and resources[2] Small businesses, despite their success in technological innovation, have been able to Small businesses, despite showing strong momentum in technological innovation[3] They are often constrained by limited resources. This "inherent weakness" makes the competitive position of small firms in the marketplace more vulnerable (H. Li & Atuahene, 2007).[4] In contrast, large firms, although resource-constrained, are more vulnerable to competition in the market. On the contrary, large firms, despite their resource advantages (Koh & Venkatram, 2001), are more likely to be able to compete in the market.[5] resources, they face serious bottlenecks in innovation. These bottlenecks, such as bureaucratic culture[6, 7] and learning traps[8] that limit the ability of large firms to innovate. In this context, cross-boundary behavior becomes a key strategy that can help teams and organizations overcome these challenges. By connecting with external entities, teams can share knowledge more effectively and thus improve their innovation performance (Slowinski et al., 1996). In addition, internal characteristics of the team, such as team cohesion, may moderate

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this relationship, further influencing the team's innovative performance[9] .

The purpose of this study is to examine how cross-boundary behaviors affect teams' innovative performance and the mediating role of knowledge sharing in this process. Also, we will examine how team cohesion moderates this relationship. By examining these issues in depth, we hope to provide teams and organizations with practical advice on how to improve innovation performance.

2. Literature review

In the complex landscape of modern organizations, the impact of cross-boundary behavior on team innovation performance has garnered significant academic attention, particularly focusing on the mediating role of knowledge sharing and the moderating role of team cohesion. Han highlight the crucial role of human resource management in knowledge-intensive teams, suggesting that effective HRM can foster knowledge sharing and thereby enhance team innovation[10]. This is further elaborated by Wang, who explore the dynamics in cross-organizational settings like R&D alliances, emphasizing that an individual's position in the formal network is more impactful on job performance and team innovation than their role in the proposal network[11]. Wang also note that formal networks within a coalition can replace suggestion networks, affecting individual job performance and emphasizing the role of formal structures in knowledge sharing. Campbell add another layer by examining multi-team systems (MTSs), concluding that the alignment of specific behavioral patterns within teams can significantly influence the achievement of broader MTS goals [12].

In summary, the literature reveals a complex interplay between cross-boundary behaviors, knowledge sharing, and team cohesion, all of which collectively shape team innovation performance, albeit in a context-dependent manner that warrants further exploration.

3. Research methodology and hypotheses

Cross-Boundary Behavior and Team Innovation Performance

Cross-boundary behavior and its impact on the innovative performance of teams is a topic of increasing interest in organizational research. Teams are increasingly becoming the foundational unit of organizational performance, and their ability to innovate is critical to a firm's competitive advantage. However, the dynamics affecting team innovation are complex and influenced by a variety of factors, including cross-boundary behavior. The relationship between team identity and innovation is a complex but important topic.The paper by R. Litchfield et al. explores how team identity and team reflexivity affect team innovative behavior and cross-team innovative behavior. They found that strong team attachment may have complex effects on innovation. While team identity motivates individuals to act for the team, it does not necessarily encourage them to engage in innovative behavior. The paper further discusses team reflexivity as a legitimizing role that aligns team innovative behavior with identity and stimulates its expression[13] . Cultural diversity also plays a key role in team innovation.The paper by R. Bouncken et al. focuses on the impact of cultural diversity in teams during the innovation process. They argue that cross-cultural teams have high potential for creativity, but face

challenges related to different working and communication styles[14] The paper by Tai-Wei Chang and Cheng-Ze Hung discusses how green group identity at the team level affects the behavior and performance of organizational members. Although not directly related to cross-boundary behaviors, the paper provides insights into how team-level factors affect organizational performance[15] .

Cross-boundary behaviors and other related factors (e.g., team identity and cultural diversity) have complex effects on team innovation performance. Strong team identities may both help and hinder innovation, while team reflexivity may be a key moderator. Cultural diversity has also been identified as an important factor influencing the innovation potential of teams, but also poses a number of challenges that need to be actively managed from the outset. Based on the above literature, we derive the following hypotheses:

H1: Cross-boundary behavior positively affects team innovation performance

The mediating role of knowledge sharing

Team innovation performance is a key factor in organizational success, especially in an environment of increasing globalization and diversity. Cross-boundary behavior and knowledge sharing play an important role in team innovation performance. However, the relationship between these two and their impact on team innovation performance has not been fully investigated. Leadership has a significant impact on innovation performance in project-based organizations. Particularly in construction projects, transformational and transactional leadership have a positive impact on knowledge sharing and innovation performance. Knowledge sharing partially mediates the relationship between transformational and/or transactional leadership and innovation performance[16] . In the context of deepening globalization, individuals are increasingly embedded in culturally diverse environments. Employees' cultural intelligence has a positive impact on their sustainable innovation behavior. Knowledge sharing mediates between employees' cultural intelligence and sustainable innovation behavior[17] . In health professional education, knowledge sharing is recognized as a key mediator in achieving patient and community health. Health professionals are mediators between knowledge generators (researchers) and knowledge demanders (patients and communities)[18] . Empowered leadership directly impacts organizational innovation, and knowledge sharing mediates the impact of empowered leadership on individual creativity.

Cross-boundary behavior and knowledge sharing play an important role in team innovation performance. In particular, both show potential to positively influence team innovation performance in terms of leadership and cross-cultural management skills. Knowledge sharing mediates these relationships, but is also influenced by factors such as organizational culture and social capital. These findings provide organizations with theoretical guidance on how to improve team innovation performance by promoting cross-boundary behaviors and knowledge sharing. Based on the above literature, we derive the following hypotheses:

H2: Cross-boundary behavior positively influences knowledge sharing

H3: Knowledge sharing positively affects team creativity

H4: Knowledge Sharing Plays a Mediating Role in Cross-Boundary Behavior and Team Innovation Performance

The moderating role of team cohesion

Team innovation performance is one of the key factors for organizational success, and Cross-Boundary Behavior and Team Cohesion play an important role in this process. Cross-Boundary Behavior usually involves the interaction of team members with the external environment, such as collaboration with other teams or departments, while Team Cohesion focuses on the relationship and cooperation between members within the team. In Boardley and Jackson's study, they explored how team members' goal orientations (e.g., achievement goals and intra-team performance goals) predicted pro- and antisocial behaviors within teams. The study also found that the effects of these goal orientations may be moderated by team cohesion. This provides some theoretical basis for understanding how cross-boundary behaviors influence team innovation performance[19] . Team cohesion is recognized as a key factor influencing team performance. For example, Youngtaek Oh and Jung-In Yoo's study found that transformational leadership and social norms have a positive effect on team cohesion[20] . In addition, a study by Tiantian Yu et al. found that team cohesion mediated the relationship between openness to communication and reporting of hospital-acquired infections[21] The study also found that team cohesion

Summarizing the above literature, it can be hypothesized that cross-boundary behaviors may positively affect team innovation performance by enhancing team cohesion. Team cohesion may act as a moderating variable that affects the relationship between cross-boundary behavior and team innovation performance. Specifically, when team cohesion is strong, cross-boundary behaviors may be more likely to facilitate the sharing of information and resources, thereby enhancing team innovation performance. Based on the above literature, we derive the following hypotheses:

H5: Team cohesion has a positive moderating effect between cross-boundary behavior and knowledge sharing

H6: Team Cohesion Moderates the Mediating Role of Knowledge Sharing between Cross-Boundary Behavior and Team Innovation Performance

Based on the above research, the research model constructed in this paper is shown in Figure 1:

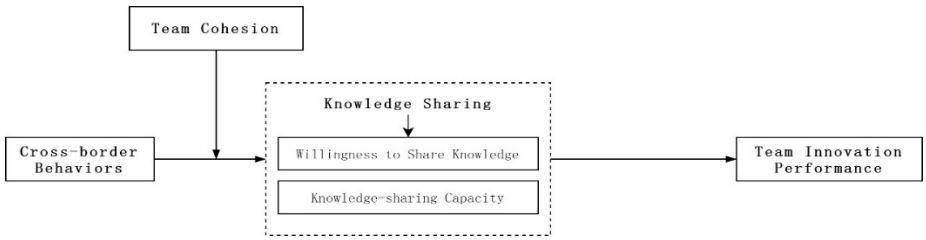

Figure 1. Research Model Diagram

3.1 Descriptive analysis

The total number of valid samples for the team in this study was 108, and Table 1 shows the results of descriptive statistics for the team sample.

Table 1 Leadership and Team Basic Characteristics

Variable	Attribute	Frequency	Percent
Team Size	10 and under	42	38.9
	11-20 persons	53	49.1
	21 and over	13	12.0
Length of time the team has been in existence	3 years and under	75	69.4
	4-10 years	25	23.1
	10 years and above	8	7.4
Gender of the leader	male	68	63.0
	women	40	37.0
Age of leadership	26-35 years	29	26.9
	36-45 years	38	35.2
	45 and over	41	38.0
Leadership qualifications	College and below	12	11.1
	undergraduate (adjective)	68	63.0
	Master's degree or above	28	25.9
Leadership experience	5 years and under	23	21.3
	5-10 years	51	47.2
	10 years and above	34	31.5

The maximum values of the skewness and the absolute value of the kurtosis of the measured items in this study are 1.216 and 0.965 respectively, which are both less than 3. Referring to Kline's criterion, when the skewness of the sample items is less than 3 and the kurtosis is less than 10, it is considered that the data in the sample are normally distributed; therefore, the data in this study satisfy the conditions of the subsequent analysis by meeting the normal distribution.

The total number of individual valid samples in this study was 596, and Table 2 shows the results of descriptive statistics of individual samples.

Table 2 Basic Characteristics of Employee Sample

Variable	Attribute	Frequency	Percent
Employee Gender	male	335	56.2
	women	261	43.8
Age of employees	Less than 25 years	66	11.1
	26-35 years	316	53.0
	36-45 years	169	28.4
	45 and over	45	7.6
Employee Education	College and below	162	27.2
	undergraduate (adjective)	374	62.8
	Master's degree or above	60	10.1
Employee Work Experience	2 years and less	59	9.9
	3-5 years	309	51.8
	6-8 years	158	26.5
	8 years and above	70	11.7

As shown in table 3,The maximum values of the skewness and the absolute value of the kurtosis of the measured items in this study are 0.450 and 0.917 respectively, which are both less than 3.

Referring to Kline's criterion, when the skewness of the sample items is less than 3 and the kurtosis is less than 10, it is considered that the data in the sample are normally distributed; therefore, the data in this study satisfy the conditions of the subsequent analysis by meeting the normal distribution.

3.2 Quality analysis of scale data

In this study, the common method bias test was conducted on all the data at the individual level and the percentage of variance explained by the unrotated first common factor after applying the principal component analysis was 29.892% much less than 50% (Podsakoff, 2003). It indicates that there is no serious common method bias in questionnaire measurement in this study.

Table 3 Common method bias test

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	9.267	29.892	29.892
2	3.506	11.311	41.203
3	2.636	8.505	49.708
4	1.966	6.341	56.049
5	1.63	5.256	61.305
6	1.555	5.017	66.323
7	1.307	4.215	70.537

3.2.1 Reliability and Validity Analysis of Team Variables

Reliability Analysis

To assess the internal consistency of the team variable scales, this study employed Cronbach's Alpha (α) coefficients. The results indicated that the Cronbach's Alpha coefficients for Boundary Expansion, Boundary Buffering (BB), and Boundary Consolidation (BC) were 0.858, 0.876, and 0.854, respectively. Additionally, Team Unity (TU) and Team Innovation Performance (TIP) had Cronbach's Alpha coefficients of 0.849 and 0.840, respectively. All variables and their dimensions had α coefficients greater than 0.7, suggesting good internal consistency of the scales.

Feasibility of Factor Analysis

Prior to conducting factor analysis, we evaluated its feasibility through the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value was 0.829, and the chi-square value for Bartlett's Test was 1232.210 with 210 degrees of freedom and a P-value less than 0.001. These results indicate that factor analysis is feasible and appropriate for principal component analysis.

Exploratory Factor Analysis

Further exploratory factor analysis was conducted to identify underlying structural dimensions. Through varimax rotation, five common factors were extracted, accounting for 70.498% of the

cumulative variance. These common factors were Team Innovation Performance (TIP), Boundary Buffering (BB), Boundary Expansion, Boundary Consolidation (BC), and Perceived Supervisor Trust (TU).

Confirmatory Factor Analysis

To further validate the structural validity of the scales, confirmatory factor analysis was conducted using Mplus 8.3 software. The model fit indices showed $\chi2$=253.372, df=179, $\chi2$/df=1.415, RMSEA=0.062, SRMR=0.063, CFI=0.934, TLI=0.923. All these indices met the generally accepted fit criteria, confirming good model fit.

The team variable scales demonstrated high reliability and validity in both aspects. All statistical indicators support the scales' ability to stably and consistently reflect the sample's team variables, providing a solid foundation for subsequent research.

3.2.2 Individual variable reliability and validity analysis

Reliability Analysis

Based on Cronbach's Alpha coefficients, the reliability for Knowledge Sharing Willingness (KSW) and Knowledge Sharing Ability (KSA) were 0.873 and 0.902, respectively, both exceeding the standard threshold of 0.7. This indicates high internal consistency for these two variables. The Corrected Item-Total Correlation (CITC) values were all greater than 0.4, and the Cronbach's Alpha if Item Deleted (CAID) values were lower than the corresponding Cronbach's Alpha coefficients, further confirming the reliability of the measurement tools.

Validity Analysis

Exploratory Factor Analysis (EFA)

Through KMO and Bartlett's Test, the feasibility of factor analysis was confirmed (KMO=0.910, Bartlett's Test chi-square=3379.008, P<0.001). The exploratory factor analysis revealed that the two main common factors (Knowledge Sharing Willingness and Knowledge Sharing Ability) accounted for 69.174% of the cumulative variance, exceeding the standard threshold of 60%. This suggests that these two factors adequately explain the primary variance in the data.

Confirmatory Factor Analysis (CFA)

The model fit indices indicated good data support for the model ($\chi2$/df=3.125, RMSEA=0.060, SRMR=0.024, CFI=0.979, TLI=0.972). All factor loadings were greater than 0.5, and the Average Variance Extracted also exceeded the standard threshold of 0.5, further confirming the model's convergent and discriminant validity.

The individual variables used to measure Knowledge Sharing Willingness and Knowledge Sharing Ability in this study demonstrated high reliability and validity. These results provide a solid foundation for further research.

3.3 Correlation analysis

The results of the correlation analysis show that in this study there is a significant positive correlation between cross-boundary behaviors and team innovation performance (P<0.01,r =0.516), a significant positive correlation between cross-boundary behaviors and knowledge

sharing (P<0.01, r=0.538), and a significant positive correlation between knowledge sharing and team innovation performance (P<0.01, r=0.653) ; the rest of the correlation analysis results are shown in the following table4.

Table 4 Correlation analysis

	Mean	Std. Deviation	1	2	3	4	5	6	7	8	9	10	11	12
1 Team Size	1.731	0.664	1											
2 Team i.e. years of existence	1.380	0.622	.430**	1										
3 Leadership gender	1.370	0.485	-0.124	-0.099	1									
4 Leader's age	3.111	0.801	0.057	0.121	0.085	1								
5 Leadership qualifications	2.148	0.593	-0.017	0.023	-0.095	-0.074	1							
6 Leadership experience	2.102	0.723	0.058	0.079	0.025	.610**	0.052	1						
7 Cross-border behavior	5.053	1.039	0.050	0.086	0.124	0.079	-0.099	0.000	1					
8 Team Cohesion	5.118	1.425	0.100	0.073	0.061	0.160	0.040	0.104	-0.073	1				
9 Willingness to share knowledge	4.928	0.886	0.016	0.077	0.072	0.023	-0.021	-0.102	.462**	0.102	1			
10 Knowledge-sharing capacity	4.814	0.927	-0.075	-0.018	-0.075	-0.001	-0.078	-0.045	.488**	0.038	.559**	1		
11 Knowledge Sharing	4.871	0.801	-0.034	0.032	-0.004	0.013	-0.057	-0.082	.538**	0.079	-	-	1	
12 Team Innovation Performance	5.300	1.299	0.073	0.045	0.036	0.108	0.002	0.037	.516**	0.119	.597**	.557**	.653**	1

Note: n=108,;* indicates P<0.05 and** indicates P<0.01;

3.4 Aggregation appropriateness test

As shown in table 5,Knowledge sharing, willingness to share knowledge, and ability to share knowledge were constructed as a null model without any independent variables in order to obtain estimates of the variance components of the above variables. This study refers to Bliese's (2020) criterion that individual member data can be aggregated to team level data when ICC (1) > 0.059, ICC (2) > 0.70 (*Glick W H,1985), and Rwg > 0.70 (Woehr D J et al., 2015)*.

Table 5 Aggregation test

Variable	ICC1	ICC2	RWG	
			Mean	Median
KSW	0.488	0.840	0.719	0.736
KSA	0.464	0.830	0.702	0.705
KS	0.492	0.845	0.770	0.778

Note: KSW = Knowledge Sharing Willingness, KSA = Knowledge Sharing Ability, KS = Knowledge Sharing.

The results of the aggregation appropriateness test in this study show that the ICC1 of knowledge sharing, knowledge sharing willingness, and knowledge sharing ability are all greater than 0.059, the ICC2 are all higher than 0.7, and the rwg mean and median are all higher than the 0.7 standard, which indicates that each variable meets the requirements for data aggregation, and all of them can be used to aggregate the data of individual members into team data.

3.5 Hypothesis testing

In this study, the moderating effects of team cohesion on knowledge sharing and the mediating roles of knowledge sharing willingness and knowledge sharing ability between cross-boundary behaviors and team innovation performance were examined by using the sequential test, the coefficient product method, and the mediating effect difference value test, and the results of the analysis are shown below:

3.5.1 The Effect of Cross-Boundary Behavior on Team Innovation Performance

The results of the study on the impact of cross-boundary behavior on team innovation performance are shown in Table 6:

Table 6 Results of the study

	Dependent Variable				
	Intermediary model 1		Intermediary model 2		
	KS	TIP	GKSW	GKSA	TIP
Intercepts	3.176*** (0.545)	-1.421 (1.045)	2.345*** (0.641)	2.855** (0.843)	0.206 (0.92)
Team Size	-0.089 (0.102)	0.188 (0.171)	-0.029 (0.128)	-0.149 (0.116)	0.18 (0.17)
Team Age	0.015 (0.121)	-0.091 (0.174)	0.072 (0.147)	-0.042 (0.127)	-0.099 (0.179)
Gender of the leader	-0.134 (0.117)	0.046 (0.179)	0.033 (0.152)	-0.301* (0.144)	0.022 (0.185)
Age of leadership	0.041 (0.078)	0.104 (0.108)	0.086 (0.102)	-0.005 (0.093)	0.097 (0.107)
Leadership qualifications	-0.005 (0.104)	0.137 (0.168)	0.056 (0.149)	-0.067 (0.122)	0.128 (0.165)
Years of leadership	-0.113 (0.091)	0.066 (0.115)	-0.19 (0.109)	-0.035 (0.116)	0.078 (0.115)

Cross-border acts	0.422*** (0.061)	0.277* (0.128)	0.388*** (0.076)	0.456*** (0.073)	0.281* (0.128)
Knowledge Sharing		0.883*** (0.142)			
Willingness to share knowledge					0.514** (0.148)
Knowledge-sharing capacity					0.371** (0.126)
τ00	0.44*** (0.064)	0.863*** (0.148)	0.598*** (0.104)	0.618*** (0.09)	0.86*** (0.149)

Note:* denotes P<0.05,** denotes P<0.01,*** denotes P<0.001; KS=Knowledge Sharing, KSW=Knowledge Sharing Willingness, KSA=Knowledge Sharing Ability, and TIP=Team Innovative Performance; standard errors are in parentheses.

H1: Cross-boundary behavior positively affects employee innovation performance

The analysis results of mediation model 1 show that: cross-boundary behavior has a significant positive effect on team innovation performance ((P<0.01, γ=0.277), the total effect of cross-boundary behavior on the team's innovation performance 95% confidence interval for [0.419,0.880],95% confidence interval does not contain 0, indicating that cross-boundary behavior has a significant effect on the team's innovation performance, and the total effect is 0.649. Therefore, it is considered that cross-boundary behavior has a positive effect on team innovation performance, so hypothesis H1 is valid.

3.5.2 The mediating role of knowledge sharing

As shown in table 7, The results of the mediation model 1 analysis show that there is a significant positive effect of cross-boundary behavior on knowledge sharing (P<0.001, γ=0.422), and hypothesis H2 is valid; there is a significant positive effect of knowledge sharing on team innovation performance (P<0.001, γ=0.883), and hypothesis H3 is valid;

Hypothesis H4: knowledge sharing mediates between cross-boundary behavior and team innovation performance: the analysis results of mediation model 1 show that there is a significant positive effect of cross-boundary behavior and knowledge sharing; there is a significant positive effect of knowledge sharing on team innovation performance, with reference to the sequential test method, which indicates that there is a mediating effect of knowledge sharing between cross-boundary behavior and team innovation performance, and the hypothesis H4 is valid; the coefficient of multiplication method is further used to test the mediating effect of knowledge sharing. method to test the mediating role of knowledge sharing, the Monte Carlo (MC) method to test the mediating effect, the analysis results show that: knowledge sharing in cross-boundary behavior and team innovation performance between the mediation of the 95% confidence interval for [0.218, 0.559], the confidence interval does not contain 0, indicating that knowledge sharing in cross-boundary behavior and team innovation performance between the mediation effect significantly, the mediation effect size is 0.373, and the mediation effect accounts for 58.1% of the total effect;

The results of the mediation model 2 analysis show that: there is a significant positive effect of cross-boundary behavior and knowledge sharing willingness (P<0.001, γ=0.388), and the hypothesis H2a is valid; there is a significant positive effect of cross-boundary behavior and

knowledge sharing ability (P<0.001, γ=0.456), and the hypothesis H2b is valid; there is a significant positive effect of knowledge sharing willingness and team innovation performance (P<0.01, γ=0.514), and the hypothesis H3a is valid; there is a significant positive effect of knowledge sharing willingness and team innovation performance effect (P<0.01, γ=0.514), hypothesis H3a holds; there is a significant positive effect of knowledge sharing ability and team innovation performance (P<0.01, γ=0.371), hypothesis H3b holds.

Hypothesis H4a: Knowledge sharing willingness mediates between cross-border behavior and team innovation performance. The analysis results of mediation model 2 show that: there is a significant positive effect between cross-border behavior and knowledge sharing willingness; there is a significant positive effect of knowledge sharing willingness on team innovation performance, with reference to the sequential test method, which indicates that there is a mediating role of knowledge sharing willingness in the mediation between cross-border behavior and team innovation performance, and the hypothesis H4a is valid; the mediating role of knowledge sharing is further examined by using coefficient multiplication method and the mediating effect is examined by the Monte Carlo method (MC) to test the mediation effect, the analysis results show that: knowledge sharing willingness in cross-boundary behavior and team innovation performance mediation of the 95% confidence interval for [0.084, 0.333], the confidence interval does not contain 0, indicating that knowledge sharing willingness in cross-boundary behavior and team innovation performance mediation effect is significant, the amount of mediation effect is 0.199, and the mediation effect accounted for the total effect of 30.7%, hypothesis H4a is valid;

Hypothesis H4b: Knowledge sharing ability mediates between cross-border behavior and team innovation performance. The analysis results of mediation model 2 show that: there is a significant positive effect of cross-border behavior and knowledge sharing ability; there is a significant positive effect of knowledge sharing ability on team innovation performance, referring to the sequential test method, which indicates that there is a mediating role of knowledge sharing ability between cross-border behavior and team innovation performance, and the hypothesis H4a is valid; the mediating role of knowledge sharing is further examined by using coefficient multiplication method, and the mediating effect of knowledge sharing is tested by the Monte Carlo method (MC) to test the mediation effect, the analysis results show that: the 95% confidence interval of the mediation of knowledge sharing ability between cross-boundary behavior and team innovation performance is [0.050, 0.319], and the confidence interval does not contain 0, which indicates that the mediation effect of knowledge sharing ability between cross-boundary behavior and team innovation performance is significant, and the amount of the mediation effect is 0.169 and the mediation effect accounts for 26.0% of the total effect, hypothesis H4a is valid. 26.0%, hypothesis H4b is established;

Table 7 Mediated effects test

		Estimate	S.E	95% LCI	95% UCI
	Total Effect	0.649	0.118	0.419	0.880
Intermediary model 1	Direct Effect	0.277	0.128	0.025	0.528
	Indirect Effect	0.373	0.087	0.218	0.559
Intermediary model 2	Total Effect	0.649	0.118	0.419	0.880

Direct Effect	0.281	0.128	0.030	0.532
Total Indirect Effect	0.368	0.087	0.197	0.540
BS-KSW-TIP	0.199	0.063	0.084	0.333
BS-KSA-TIP	0.169	0.068	0.050	0.319

3.5.3 The moderating role of team cohesion

The results of the analytical study on the moderating effect of team cohesion on cross-boundary behavior and knowledge sharing are presented in Table 8 below:

Table 8 Results of the study

	Dependent Variable				
	Moderated intermediation model 1		Moderated intermediation model 2		
	KS	TIP	KSW	KSA	TIP
Intercepts	5.385*** (0.331)	-0.022 (1.154)	4.928*** (0.529)	5.843*** (0.441)	0.036 (1.106)
Team Size	-0.082 (0.095)	0.188 (0.171)	-0.022 (0.115)	-0.143 (0.116)	0.18 (0.17)
Team Age	0.024 (0.113)	-0.091 (0.174)	0.082 (0.141)	-0.034 (0.118)	-0.099 (0.179)
Gender of the leader	-0.159 (0.1)	0.046 (0.179)	0.005 (0.136)	-0.324* (0.132)	0.022 (0.185)
Age of leadership	0.013 (0.07)	0.104 (0.108)	0.055 (0.093)	-0.03 (0.088)	0.097 (0.107)
Leadership qualifications	0.003 (0.073)	0.137 (0.168)	0.065 (0.116)	-0.06 (0.11)	0.128 (0.165)
Years of leadership	-0.099 (0.08)	0.066 (0.115)	-0.174 (0.105)	-0.023 (0.105)	0.078 (0.115)
Cross-border acts	0.418*** (0.056)	0.277* (0.128)	0.383*** (0.069)	0.452*** (0.072)	0.281* (0.128)
team cohesion	0.023 (0.073)		0.026 (0.065)	0.02 (0.093)	
Cross-border acts ×x Team Cohesion	0.221** (0.069)		0.244*** (0.063)	0.198* (0.088)	
Knowledge Sharing		0.883*** (0.142)			
Willingness to share knowledge					0.514** (0.148)
Knowledge-sharing capacity					0.371** (0.126)
τ00	0.331*** (0.069)	0.863*** (0.148)	0.464*** (0.077)	0.53*** (0.107)	0.86*** (0.149)

Note:* denotes P<0.05,** denotes P<0.01,*** denotes P<0.001; KS=Knowledge Sharing, KSW=Knowledge Sharing Willingness, KSA=Knowledge Sharing Ability, and TIP=Team Innovative Performance; standard errors are in parentheses.

Hypothesis H5: The moderating effect of team cohesion on cross-boundary behavior and knowledge sharing. The results of the analysis with moderated mediation model 1 showed that: for the main effect: there was a significant positive effect of boundary-crossing behavior on knowledge sharing ($P<0.001$, $\gamma=0.418$); for the main effect of the moderator variable: there was a non-significant effect of team cohesion on knowledge sharing ($P>0.05$, the difference was not statistically significant); for the moderating effect: there was a significant positive effect of the interaction term boundary-crossing Behavior × Team Cohesion has a significant positive effect on knowledge sharing between ($P<0.001$, $\gamma=0.221$). Therefore, H5 is valid;

In order to more intuitively reflect the moderating effect of team cohesion on cross-boundary behavior and knowledge sharing, a decomposition diagram of the moderating effect is drawn with reference to Aiken & West's (1991) suggestion, as shown in the following figure2: the positive effect of cross-boundary behavior on knowledge sharing is higher at high levels of team cohesion than the effect of cross-boundary behavior on knowledge sharing at low levels of team cohesion, i.e., the effect of cross-boundary behavior on knowledge sharing gradually increases with the increase of team cohesion. increases, the influence of cross-boundary behavior on knowledge sharing gradually increases.

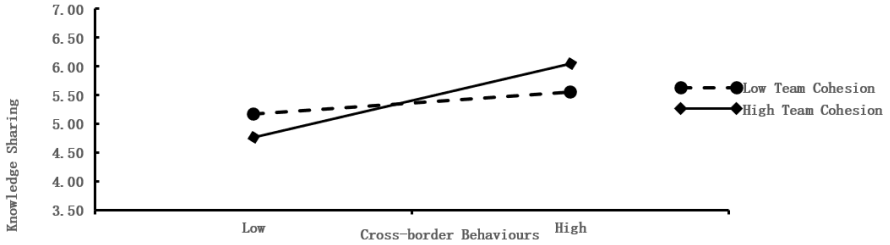

Fig. 2 Map of the moderating effect of team cohesion on cross-boundary behavior and knowledge sharing

Hypothesis H5a: The moderating effect of team cohesion on cross-boundary behavior and willingness to share knowledge. The results of the analysis with moderated mediation model 2 indicate that: for the main effect: there is a significant positive effect of boundary-crossing behavior on willingness to share knowledge ($P<0.001$, $\gamma=0.383$); for the main effect of the moderator variable: there is a non-significant effect of team cohesion on willingness to share knowledge ($P>0.05$, the difference is not statistically significant); for the moderating effect: there is a significant positive effect of the interaction term cross-boundary behavior × team cohesion has a significant positive effect on knowledge sharing willingness ($P<0.001$, $\gamma=0.244$). Therefore, H5a is valid;

Hypothesis H5b: The moderating effect of team cohesion on cross-boundary behavior and knowledge sharing ability. The results of the analysis with moderated mediation model 2 show that: for the main effect: there is a significant positive effect of boundary-crossing behavior on knowledge sharing ability ($P<0.001$, $\gamma=0.452$); for the main effect of the moderating variable: there is a non-significant effect of team cohesion on knowledge sharing ability ($P>0.05$, the difference is not statistically significant); and for the moderating effect: there is a significant positive effect of the interaction term cross-boundary behavior × team cohesion has a significant positive effect on knowledge sharing ability ($P<0.05$, $\gamma=0.198$). Therefore, H5b holds;

Hypothesis H6: Team cohesion moderates the role of knowledge sharing in mediating between cross-boundary behavior and team innovation performance. As shown in table 9, First, based on the sequential test (MULLER et al, 2005) there is a significant positive effect of cross-boundary behavior on knowledge sharing ($P<0.001$, $\gamma=0.418$); there is a significant positive effect of knowledge sharing on team innovation performance ($P<0.001$, $\gamma=0.883$); and there is a significant positive effect of team cohesion on cross-boundary behavior and knowledge sharing. moderating effect. Therefore, H6 is established. Second, based on the coefficient product method, referring to the suggestion of Yuan and Mackinnon (2009), the coefficient product method was used and tested by Monte Carlo simulation algorithm (Monte Carlo, MC) to have a moderated mediation index with a 95% confidence interval of [0.075, 0.328], which did not contain 0, indicating that H6 was established. Third, based on the mediated effect difference test (Edward and Lambert (2007)), the confidence interval of the mediated effect difference at the level of high and low moderated variables was estimated by the Monte Carlo simulation algorithm (Monte Carlo, MC), and the 95% confidence interval of the mediated effect difference at the level of high and low team cohesion (M±SD) was [0.166, 0.726], which did not contain 0 , also indicating that H6 holds.

Hypothesis H6a: Team cohesion moderates the role of knowledge sharing willingness in mediating between cross-boundary behavior and team innovation performance. First, based on the sequential test, there is a significant positive effect of cross-boundary behavior on knowledge sharing willingness ($P<0.001$, $\gamma=0.383$); there is a significant positive effect of knowledge sharing willingness on team innovation performance ($P<0.001$, $\gamma=0.514$); and there is a significant positive moderating effect of team cohesion on the relationship between cross-boundary behavior and knowledge sharing willingness, therefore, it is considered that hypothesis H6a is established. Second, based on the coefficient product method and tested by the Markov chain Monte Carlo simulation algorithm (MCMC) the mediation index with moderation has a 95% confidence interval of [0.037, 0.252], which does not contain 0, indicating that H6a is established. Third, based on the mediated effect difference test, the confidence interval of the mediated effect difference at the level of high and low moderated variables was estimated by Markov Chain Monte Carlo Simulation Algorithm (MCMC), and the 95% confidence interval of the mediated effect difference at the level of high and low team cohesion (M±SD) was [0.082, 0.559], which did not contain 0, and it also indicated that H6a was established.

Hypothesis H6b: Team cohesion moderates the role of knowledge sharing ability in mediating between cross-boundary behavior and team innovation performance. First, based on the sequential test, there is a significant positive effect of cross-boundary behavior on knowledge sharing ability ($P<0.001$, $\gamma=0.452$); there is a significant positive effect of knowledge sharing ability on team innovation performance ($P<0.01$, $\gamma=0.371$); and there is a significant positive moderating effect of team cohesion on the intermediary between cross-boundary behavior and knowledge sharing ability, therefore, H6b holds. Second, based on the coefficient product method, the 95% confidence interval of the mediation index with moderation tested by the Monte Carlo simulation algorithm (MC) was [0.008, 0.151], which did not contain 0, indicating that H6b was established. Third, based on the mediated effect difference test (Edward and Lambert (2007)), the confidence intervals for the mediated effect difference at the high and low levels of moderated variables were estimated by the Monte Carlo simulation algorithm (MC), and the 95% confidence interval for the mediated effect difference at the high and low

levels of team cohesion (M±SD) was [0.017, 0.334], which did not contain 0 , also indicating that H6b holds.

Table 9 Moderated mediation effect test

		Estimate	S.E.	95% LCI	95% UCI
BS-KS-TIP	Low (-SD)	0.092	0.115	-0.134	0.318
	Median (0)	0.369	0.083	0.207	0.531
	High (+SD)	0.646	0.127	0.397	0.895
	High-Low	0.554	0.178	0.166	0.726
	Index of moderated mediation	0.195	0.064	0.075	0.328
BS-KSW-TIP	Low (-SD)	0.019	0.066	-0.110	0.148
	Median (0)	0.197	0.064	0.072	0.322
	High (+SD)	0.375	0.128	0.123	0.626
	High-Low	0.356	0.159	0.082	0.559
	Index of moderated mediation	0.125	0.055	0.037	0.252
BS-KSA-TIP	Low (-SD)	0.063	0.068	-0.071	0.197
	Median (0)	0.168	0.066	0.039	0.296
	High (+SD)	0.272	0.091	0.093	0.450
	High-Low	0.208	0.094	0.017	0.334
	Index of moderated mediation	0.073	0.035	0.008	0.151

4. Results

In summary, the hypothesis testing results of this study are summarized in Table 10 and the path relationship results are shown in Figure 3.

Table 10 Summary of assumptions

Hypothesis:	**End**
H1: Cross-boundary behavior positively affects team innovation performance	be tenable
H2: Cross-boundary behavior positively influences knowledge sharing	be tenable
H2a: Cross-boundary behavior positively affects willingness to share knowledge	be tenable
H2b: Cross-boundary behavior positively affects knowledge-sharing capabilities	be tenable
H3: Knowledge sharing positively affects team creativity	be tenable
H3a:Willingness to Share Knowledge Positively Influences Team Creativity	be tenable
H3b:Knowledge sharing ability positively affects team creativity	be tenable
H4: Knowledge Sharing Plays a Mediating Role in Cross-Boundary Behavior and Team Innovation Performance	be tenable

H4a: Knowledge Sharing Willingness Plays a Mediating Role in Cross-Boundary Behavior and Team Innovation Performance	be tenable
H4b: Knowledge Sharing Ability Plays a Mediating Role in Cross-Boundary Behavior and Team Innovation Performance	be tenable
H5: Team cohesion has a positive moderating effect between cross-boundary behavior and knowledge sharing	be tenable
H5a: Team cohesion has a positive moderating effect between cross-boundary behavior and willingness to share knowledge	be tenable
H5a: Team cohesion has a positive moderating effect between cross-boundary behavior and knowledge sharing ability	be tenable
H6: Team Cohesion Moderates the Mediating Role of Knowledge Sharing between Cross-Boundary Behavior and Team Innovation Performance	be tenable
H6a: Team Cohesion Moderates the Mediating Role of Knowledge Sharing Willingness Between Cross-Boundary Behavior and Team Innovation Performance	be tenable
H6b: Team Cohesion Moderates the Mediating Role of Knowledge Sharing Ability Between Cross-Boundary Behavior and Team Innovation Performance	be tenable

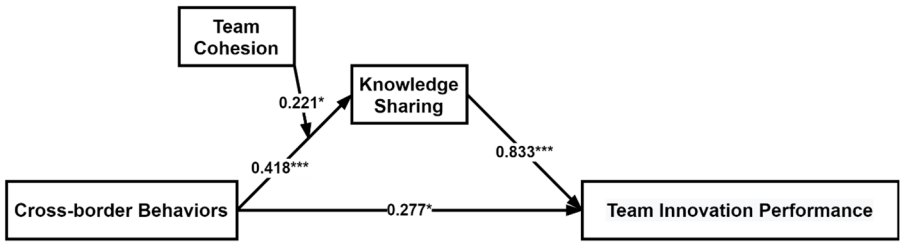

Fig. 3 Graph of path relationship results

5. Conclusion and Discussion

The following conclusions were drawn from the in-depth analysis of the data in this study. First, there is a significant positive relationship between cross-boundary behavior and team innovation performance. This means that when teams are more inclined to engage in cross-boundary behaviors, their innovation performance is correspondingly improved. Second, cross-boundary behavior can promote knowledge sharing, which is not only reflected in the overall level of knowledge sharing, but also in the willingness and ability of team members to share knowledge. More importantly, knowledge sharing has a positive impact on team creativity, which further demonstrates the centrality of knowledge sharing in the team innovation process. In addition, knowledge sharing plays a mediating role between cross-boundary behavior and team innovation performance.

The findings of this study emphasize the importance of cross-boundary behaviors in promoting team innovation performance. Cross-boundary behavior enhances team innovation by facilitating knowledge flow and sharing. And knowledge sharing, as a mediating variable,

further strengthens this relationship. In addition, team cohesion played a moderating role between cross-boundary behaviors and knowledge sharing, which implies that the positive effect of cross-boundary behaviors on knowledge sharing is also more significant when team cohesion is stronger.

For future research, we suggest further exploring other possible moderating variables, such as team culture and team leadership style, and how they affect the relationship between cross-boundary behavior, knowledge sharing, and team innovation performance. In addition, researchers may also consider how training and organizational interventions can enhance cross-boundary behaviors and knowledge sharing to further improve team innovation performance.

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