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Innovation climate for individual motivation and innovation performance: Is innovative behavior a missing link?

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ABSTRACT

This study empirically examines the impact of individual motivation on innovation performance, where innovative behavior serves as a mediating construct, and discusses whether the innovation climate has a moderating effect. This study combines the Cognitive Evaluation Theory and behavioral performance to develop a new theoretical method for explaining the relationships between individual motivation, innovative behavior, and innovation performance. Data collected via a field study of 250 subjects who participated in a science and technology competition were analyzed using a PLS-SEM model. Barron and Kenny's mediation test and the bootstrapping method were used to evaluate the model and confirm the mediation and moderation effects, respectively. Robustness checks were conducted to exclude nonlinearity and heterogeneity in the model. The results show that individual motivation positively promotes innovation performance, in which innovative behavior plays an intermediary role, and that innovation climate moderates the relationship between innovative behavior and innovation performance. According to the results of this field study, stimulators concerning motivation and climate should be primarily considered by managers to boost innovation performance.

Introduction

Innovation, as the foundation of organizations' competitive advantage and a driving force to promote human society's development, has become the center of attraction worldwide (Acar et al., 2019; Afsar et al., 2014; Zhu et al., 2022; Gürlek & Koseoglu, 2021). Previous studies have elaborated that motivation can stimulate employees to promote and lead change, thus fostering innovation and output innovation performance (IP) (Correia & Braga, 2023; West & Anderson, 1996; Segarra-Ciprés et al., 2019; Hofmeister et al., 2022). Moreover, it is necessary to analyze the ways to promote IP from the perspectives of innovative behavior (IB) and innovation climate (IC) to support innovation (Segarra-Ciprés et al., 2019; Afsar & Umrani, 2019). Due to all these requirements, managers and scholars have called for more attention on innovation performance and its influencing factors.

The positive relations between individual motivation (IM) and climate on IP have been mentioned and proposed in previous studies (Amabile & Pratt, 2016; Afsar & Umrani, 2019; Munir & Beh, 2019; Scott & Bruce, 1994). Based on the Cognitive Evaluation Theory and behavioral performance viewpoint, a positive relationship could also be found between IB and IP (Segarra-Ciprés et al., 2019; Schunk & DiBenedetto, 2022; Shalley & Perry-Smith, 2001). There is plenty of literature on these factors and persuasive arguments about their positive effects on IP (Barron & Harackiewicz, 2000; Patterson et al., 2004), and many scholars have also studied the mediation and moderation mechanisms of those factors, such as the moderating role of inclusive climate between participative leadership and team service performance (Ali et al., 2022), the mediators between leadership and green innovation/creativity (Arici & Uysal, 2022), perceived organizational support for the environment as a mediator between leadership and innovation (Karatepe et al., 2023), and the mediating role of organizational learning capability (Akgün et al., 2023). However, former scholars paid little attention to the moderating effect of IC on the relationship between IM, IB, and IP or the mediating role of IB during the process. Our research aims to fill in the gaps on the moderation and mediation roles of IC and IB, respectively, on IP. In

Abbreviations: IB, innovative behavior; IP, innovation performance; IC, innovation climate; IM, individual motivation

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alignment with this logic, this study will empirically explore the relationship among individual motivation, innovative behavior, innovation performance, and innovation climate.

With a clear objective in mind, three research questions have been formulated:

Q1 What is the relationship between IM and IP?

Q2 What role does innovative behavior play between IM and IP?

Q3 Can innovation climate moderate the relationships between IM, IB and IP?

Our empirical research aimed to answer these three research questions through a field study conducted in China with 250 participants who were asked to complete a technical competition through teamwork. The total number of participants was constrained to control the competition scale. Our study attempts to fill the gaps in the mediating role of innovative behavior and the moderating role of innovation climate and to combine the Cognitive Evaluation Theory and behavioral performance viewpoints of innovation performance.

This study had several theoretical and practical implications. First, it provides a clear understanding of how individual motivation plays an important role in fostering innovation. Second, the study fills the gaps in the mediation and moderation roles of IB and IC. Third, this study suggests a way to find appropriate stimuli to enhance innovation performance by considering the effects of IM, IB, and IC.

The structure of the study is as follows: Section 2 outlines the literature related to the hypotheses. Section 3 elaborates on the research methods used in this study. The results are described in Section 4, followed by a discussion and the implications of these findings in Section 5. Finally, conclusions and limitations are outlined in Section 6.

Literature review and hypothesized framework

The connotation of innovation

With fast-paced technological changes, innovation is crucial for national development (Hussein et al., 2016; Yang et al., 2018; Karatepe et al., 2023) and business growth (Acar et al., 2019; Shalley, 1995; Munir & Beh, 2019; Newman et al., 2020). Since Guilford, the president of the American Psychological Association in the 1950s, presented a speech, innovation research has revealed a large number of findings (West & Anderson, 1996). Innovation is attracting increasing attention from scholars and practitioners (Leavy, 2015; Castillo et al., 2023; Arici & Uysal, 2022). It is increasingly recognized as a key factor in achieving sustainable competitive advantages for organizations that must respond to unpredictable challenges (Martins & Terblanche, 2003; Janssen et al., 2004; Anderson et al., 2014; Afsar & Umrani, 2019). Innovation is critical for helping organizations improve their competitiveness (Carmeli et al., 2006) and lays the foundation for creating high performance and promoting long-term organizational success (Janssen et al., 2004).

The concept of innovation has attracted considerable attention from scholars in various disciplines (Ghosh, 2015; Gürlek & Koseoglu, 2021; Hollebeek et al., 2022). Thompson (1965) defined innovation as the "generation, acceptance, and implementation of new ideas, processes, products, or services." Based on the view of Amabile (1988), innovation could be defined as the successful implementation of creative ideas within an organization. Damanpour and Evan (1984) believed that innovation was the implementation of a new technical or administrative idea. Thus, innovation usually begins with the generation of new ideas that need to be proposed, tried out, and finally implemented.

Creativity, the ability to produce novel work, is often used as an interchangeable term for innovation in the field of management (Amabile & Pratt, 2016; Shalley & Perry-Smith, 2001; Arici & Uysal, 2022), and is considered by creative theorists to be the starting point and the root of innovation (Ghosh, 2015; Afsar & Umrani, 2019). Creativity is a complex and diffuse construct that has been described in various ways (Ghosh, 2015; Ekvall, 1996). Amabile (1983) outlines the creativity component framework and posits that creativity is the basis for innovation. Shalley (1995) studied creativity at the individual level and considered creativity to be the foundation of an organization's creative and innovative potential. Shanker et al. (2017) argue that innovation is a general construct of high abilities, including creativity. Generally, there is wide agreement on the difference between the two terms. Innovation is associated with the generation, adoption, and implementation of new ideas to generate products, services, and processes, whereas creativity is usually regarded as the ability to innovate (Ghosh, 2015; Arici & Uysal, 2022; Acar et al., 2019). If ideas formed through creativity are implemented, the process and results can be referred to as innovation.

Innovation can take various forms (Lee et al., 2013; Podrug et al., 2017). It is widely accepted that innovation can be classified into three types: product, process, and administrative innovation. Damanpour and Evan (1984) and Chuang (2005) identified administrative and technological innovation as its two distinct forms. Another two-type classification of innovation, namely process and product, was proposed by researchers such as Podrug et al. (2017) and Martins and Terblanche (2003). West and Anderson (1996) defined innovation to refer to innovative processes, products, and services. Sarros et al. (2011) extended this category by exploiting and implementing a new administrative idea. Comparing the various types of innovation, it is clear that technological innovation, in which product and process innovation remain the two main elements, is the most common form of innovation (Cooper, 1998; Lee et al., 2013; Castillo et al., 2023). Thus, in this study, innovation is regarded as the outcome of developing new products and processes.

Individual motivation

Various motivational mechanisms have been identified and discussed extensively over the past few years. Amabile (1983), who first cast out the creativity component theory, regarded motivation as an important factor acting on the form, direction, intensity, and duration of creativity and as a driving factor generated from personal interests for some specific goals. Individual motivation can be driven by individual needs. In other words, an individual has the desire to innovate because the target itself is challenging and interesting (Ghosh, 2015; Cai et al., 2022). It also comes from rewards, recognition from others, and other elements (Lichtenthaler & Fischbach, 2016; Afsar & Umrani, 2019; Munir & Beh, 2019). Team members actively seek different solutions and continuously communicate and cooperate to meet their internal needs, complete innovation tasks, and improve team or organizational creativity (Martins & Terblanche, 2003). The motivation for group members to innovate must start with themselves rather than being driven by their organized team (Kim et al., 2021). Thus, in this study, we focused on the individual level and defined individual motivation as a set of forces that motivate individuals to perform, such as the desire to challenge, seek interest, learning orientation, and satisfaction.

Relevant research provides evidence that motivation positively affects innovation performance (Amabile & Pratt, 2016; Afsar & Umrani, 2019; Munir & Beh, 2019). Individuals with high motivation can initiate ideas or suggestions, search for solutions, produce various possible responses, and finally achieve innovation performance (Munir & Beh, 2019; Lee et al., 2013). This initiative serves as the basis for individual motivation, which plays a positive role in deducing innovation (Lee et al., 2013; Correia & Braga, 2023). Specifically, with

lower motivation, an individual is more likely to engage in routine and procedural behavior rather than concentrate on collecting useful information and discovering or creatively solving problems (Yu et al., 2018; Cai et al., 2022).

Based on the discussions above, we developed the following hypothesis:

H1. *Individual motivation is significantly and positively associated with innovation performance.*

Innovative behavior

Innovative behavior (IB) refers to a set of activities pertaining to and occurring during the multistage process of an individual's development, promotion, and implementation of useful ideas (West & Farr, 1989; Janssen, 2005). It usually starts with idea generation, resulting in technical innovation and the application of new methods in the form of products, processes, and procedures (Afsar & Umrani, 2019). From the creativity framework perspective proposed by interactionists, an individual's innovative behavior can be regarded as the outcome of a complex interaction of individual performance that differs in terms of the level of innovativeness and situational factors (Woodman et al., 1993). From a behavioral perspective, innovative behavior is believed to be proactive and pioneering, which means trying to innovate and becoming a relevant enabler of innovation (Segarra-Ciprés et al., 2019). During this stage, innovators are devoted to individual-level creativity (Shalley & Perry-Smith, 2001). Innovative behavior, which is challenging, risky, complicated, and uncertain Afsar et al. (2014), Scott and Bruce (1994), can enhance an organization's performance (Yuan & Woodman, 2010; Jiang & Gu, 2016; Shin et al., 2017; Wang et al., 2015; Afsar & Umrani, 2019).

Cognitive evaluation theory (CET)

CET was proposed by Deci (1972) and advanced in 1985 (Deci & Ryan, 1985) by focusing on an individual's cognitive evaluation of an activity and the reasons for his engaging in the activity, suggesting that cognitive evaluation is the initial element accounting for motivation. The assumption of CET is that people undertake particular activities because they have basic psychological needs (i.e., demonstrating capabilities and autonomy). If they feel that these internal needs have been met, motivation is generated, which in turn transforms into greater engagement (Veres et al., 2019). Starting from motivation, this theory emphasizes the importance of people's sense of interest, ability, control, and initiative in individual behavior (Hsu, 2022). It is nowadays a very popular theory recognized and welcomed by scholars, because it well explains an important personal variable, "self-efficacy," and can well explain the transition from motivation to behavior (Hsu, 2022; Schunk & DiBenedetto, 2022). However, this theory does not provide direct proof of the conversion of IM to IP.

Individuals with strong motivations would not only actively put forward their own ideas and suggestions and explore response possibilities (Yuan & Woodman, 2010), but also tend to seek opportunities to excel in others and enhance their abilities through efforts to meet the demand for innovations, which can increase the enthusiasm of individuals to participate in innovation activities (Sönmez & Yıldırım, 2019; Janssen, 2005), thus inducing innovative behaviors (Yu et al., 2018; Shanker et al., 2017). Previous studies found a positive relationship between motivation and innovative behavior (Munir & Beh, 2016; Ren & Zhang, 2015). Thus, we hypothesized the following:

H2a. *There is a positive relationship between individual motivation and individual innovative behavior.*

Innovation performance

Generally, performance results from efforts to achieve an expected goal (Zhou et al., 2016). There are two perspectives on the implications of performance and innovation. From this perspective, performance can be defined as the results produced during specific periods and activities (Segarra-Ciprés et al., 2019; Yuan & Woodman, 2010). Therefore, innovation performance can be regarded as the total actual achievements and benefits of novel and useful outcomes during the process of implementing an individual's innovation activities, such as products and technology or significant improvements in existing ones (Martins & Terblanche, 2003). From a **behavioral performance viewpoint,** performance is a group of behaviors related to the goals of the organization in which a person works (Shalley & Perry-Smith, 2001; Song, 2015). From this perspective, IP can be regarded as the ultimate consequence of innovative behavior related to objectives. In other words, the IP can be regarded as the result of the IB (Shalley & Perry-Smith, 2001). Thus, we combined the elements IM, IB, and IP with CET.

IP is implemented and extended by individuals whose creative behaviors are the core elements of innovation in an organization (Afsar et al., 2014; Afsar & Umrani, 2019; Amabile & Pratt, 2016). Our research focuses on individual-level innovation performance. Individual innovative behavior is the foundation of innovation performance (Shalley & Perry-Smith, 2001; Munir & Beh, 2019). Furthermore, a positive relationship between proactive behavior and product and process innovation performance has been revealed (Segarra-Ciprés et al., 2019). Therefore, we make the following assumptions:

H2b. *There is a positive relationship between innovative behavior and individual innovation performance.*

Researchers have devoted increasing attention to the individual and organizational factors that can promote innovation performance (Shanker et al., 2017). One of the best ways to stimulate IP is to capitalize on individual skills, knowledge, and innovative abilities, which can ensure continuous and long-term effectiveness (De Jong & Den Hartog, 2010; Afsar & Umrani, 2019). We analyzed and summarized previous studies to identify different influencing factors, including organizational commitment, goal guidance, member participation, team harmony, leadership support, value perception, number of members, and working time (Afsar & Umrani, 2019; Shalley & Perry-Smith, 2001; Vessey et al., 2014; Arici & Uysal, 2022; Chen & Liu, 2022). Previous work demonstrated that influencing factors can stimulate IP when team members are effectively motivated (Janssen, 2000; Cai et al., 2022).

Although individual motivation and innovative behavior form the basis of innovation performance, few studies have attempted to put these three elements into a coherent and integrated framework that is managerially relevant. Few studies have explored the mediating role of IB in the relationship between IM and IP. However, because innovation performance is defined as the ultimate consequence of a group of behaviors related to goals within an organization, we consider that IP can be reflected by means of IB. Furthermore, we defined individual motivation as a set of forces that motivate individuals to perform and conduct innovative behaviors, so we could think that IM leads to IB. Conversely, Rigtering and Weitzel (2013) suggested that it is necessary to analyze employees' innovative behaviors to support innovation in firms by focusing on employees' behaviors and motivations in promoting innovation performances. Thus, it would be interesting to check if there is any intermediary effect between IM and IP. Accordingly, the following hypotheses are proposed:

H3. *Innovative behavior plays a mediation role between IM and IP.*

Innovation climate

Studies on organizational climate have drawn considerable attention from scholars. Organizational climate is commonly viewed as a set of shared experiences regarding members' perceptions and observed patterns of behavior that characterize an organization (Patterson et al., 2004; Newman et al., 2020). Detailed discussions on

innovation climate have been conducted by scholars who believe that it is an extension of climate research (Patterson et al., 2004). IC, which includes many dimensions, such as teamwork and incentive mechanisms (Yu et al., 2013; Han et al., 2020), is related to organizational policies, affairs, practices, and procedures perceived by individuals (Newman et al., 2020; Zhu et al., 2022), which in turn formulate and shape their priorities and extend to the development of innovation achievements, creativity, service processes, and methods to achieve creative skills (Patterson et al., 2004; Malibari & Bajaba, 2022). Other scholars believe that IC is an individual's cognitive representation and psychological interpretation of the organizational setting that affects the formation, development, and exertion of innovation ability (Zhu et al., 2022; Martins & Terblanche, 2003). Some studies claim that IC represents a signal received by individuals that expresses the expected information of the organization for innovation-related activities to be used for innovation activities and further behavior (Sarros et al., 2008; Scott & Bruce, 1994). Moreover, although without a uniformly stated definition, there is a common view that the essence of IC is the perception of innovation support in the organizational environment (Sönmez & Yıldırım, 2019), which includes certain characteristics such as team cohesion, supervisor support, and autonomy (Afsar & Umrani, 2019; Sönmez & Yıldırım, 2019). In this study, IC refers to an individual's subjective perception and description of whether an organizational climate has innovative characteristics.

One organizational factor that affects innovation performance is organizational climate (Afsar & Umrani, 2019; Scott & Bruce, 1994), which has been widely examined by scholars. Earlier empirical research considered IC as a type of organizational support (Munir & Beh, 2019), along with other factors such as support for innovation (Sarros et al., 2011) and psychological empowerment for innovation (Afsar et al., 2014), and found significant and positive relationships between innovation climate, employees' innovative behavior, and innovation performance (Ghosh, 2015; Afsar & Umrani, 2019; Munir & Beh, 2019). A positive innovation climate withholds criticism and welcomes wild ideas; conversely, an innovation climate that impedes individuals from generating new ideas and implementing innovative behaviors inhibits innovation performance (Martín-de Castro et al., 2013). It has been emphasized that to promote innovation performance, it is particularly important to create a climate that is psychologically non-threatening and risk-tolerant (Afsar & Umrani, 2019), encourages employees' innovative behavior and capacity, and supports personal growth and development (Scott & Bruce, 1994; Afsar & Umrani, 2019). Organizational units should become innovative by utilizing members' capabilities to innovate (De Jong & Den Hartog, 2010; Malibari & Bajaba, 2022).

Many studies have investigated the correlation between organizational innovation climate and individual innovative behavior. Current creativity and innovation research suggests that innovative behavior is triggered by a combination of individual qualities, the work environment, and other individual- or organizational-level factors that can either facilitate or inhibit initiative in organizational contexts (Yuan et al., 2018; Munir & Beh, 2019). Furthermore, how these factors are socialized within an organization is significantly linked to innovativeness (Munir & Beh, 2019; Newman et al., 2020; Han et al., 2020). Amabile et al. (2004) believe that innovative behavior is more likely to occur in organizations that support and reward innovation than in those that punish innovation willingness. Scott and Bruce (1994) found that the psychological climate of innovation, such as organizational innovation support and resource provision, is highly related to employees' innovation behaviors. An organization's innovative climate is widely believed to be a precursor and enhancing factor for employees' IWB (De Jong & Den Hartog, 2010). Shanker et al. (2017) found that an innovative climate plays an essential role in employees' innovative representation and can be divided into two separate entities: individual creativity and innovative behavior. Therefore, we believe that an innovation climate can positively affect innovation performance by affecting individual innovative behaviors.

Theories on innovation climate have attempted to identify a climate that facilitates innovation performance, mainly from an organizational perspective (Amabile et al., 2004; Ghosh, 2015; Malibari & Bajaba, 2022). Scholars have primarily discussed innovation climate as an independent variable, leaving moderating effects untouched. One purpose of this study is to explore the moderating role of innovation climate on motivation, individual behavior, and innovation performance at the individual level.

Accordingly, this study puts forward the following assumptions:

H4a. *Innovation climate plays a positive moderation role between individual innovation motivation and innovation performance.*

H4b. *Innovation climate plays a positive moderation role between individual innovative behavior and innovation performance.*

In summary, this study constructs a conceptual model (see Fig. 1) to investigate the mechanism by which individual motivation affects innovation performance and explores the intermediary role of individual innovative behavior in this process and the moderating role of IC between IM, IB, and IP.

Methodology

Study context

This research is based on a two-phase university-wide innovation competition conducted by Beihang University in which participants, as experimental subjects, were asked to complete a technical competition through teamwork. Considering the topic of innovation, this experiment selected Kaggle's prediction experiment as the competition content, as it competes with the innovative approach to the accuracy of future forecasts. The competition committee selected

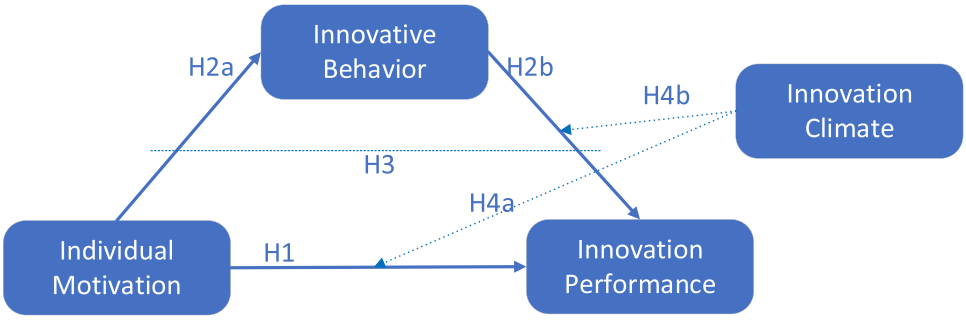

Fig. 1. Conceptual model.

Table 1
Demographic data and the results of comparison analysis.

Categories	Profile	No.	(%)
Nationality	Chinese	243	97.2
	Other nationalities	7	2.8
Professional background	Science	8	3.2
	Industrial engineering	43	17.2
	Econometrics	77	30.8
	Information systems management	122	48.8
Education background	Postgraduate	100	40
	Undergraduate	150	60
Gender	Male	172	68.8
	Female	78	31.2
Team size	Six-people team	12	24
	Five-people team	26	52
	Four-people team	12	24

participants who submitted their online resumes based on their science and technology knowledge and R&D experience. The sampled students came from various majors and different grades throughout the university. We intentionally chose students who were willing to engage in innovative work in the future. To control the competition scale and improve the overall performance, we set the participation scale at 250 students who were regarded as field study subjects and obtained 244 pieces of effective data. The difficulty in data collection lies in the voluntary desire of the subjects to provide their personal information. They were grouped into 50 teams by "freedom of choice." Seven experts were invited to observe the innovation progress and score each team's innovation achievement reports. During the two sessions, we controlled for the competition form, evaluation experts, and evaluation standards. None of the participants were informed that the innovation competition was a field study. The sampling framework, including nationality, professional background, educational background, gender, and team size, is presented in Table 1.

The experimental procedure was as follows: First, all subjects were asked to form R&D teams of 4–6 people. Second, the chairman of the competition explained the final competition task to all participants from the beginning: After one semester, each group must submit an innovation report and code documents with the same requirements before the deadline, and each member should undertake clear work tasks and cooperate with each other to complete the final innovation achievement reports. Third, the seven experts observed the contributions of the subjects during the entire process. Fourth, after the research reports and code files were submitted, a questionnaire was immediately distributed to all the participants to obtain feedback on their cognition and performance during the field research, including personal motivation, innovation climate, and individual behavior. Finally, the seven experts assigned specific innovation scores to the R&D members in combination with observations of the members' investment and the actual results of the science and technology competition, which served as a measurement of individual innovation performance.

Measurement and data collection

We designed a questionnaire that contained the elements of concern. For motivation, we designed a six-item scale based on Cognitive Evaluation Theory and the framework proposed by Deci (1972). We summarized the innovative behaviors mentioned in previous literature into three stages: generating ideas, looking for opportunities and support, and application (Scott & Bruce, 1994; Yuan & Woodman, 2010), and compiled an IB scale with four items: two for self-behavior and two for interaction within the groups. Anderson and West (1998), who proposed a four-dimensional model of IC—vision, participative safety, task orientation, and support for innovation—drafted the team climate of innovation (TCI) scale, which has become a popular measurement of IC. Subjects were invited to fill in the questionnaire according to the actual situation of their own thoughts, and a 5-point Likert scoring method (1 = very inconsistent and 5 = very consistent) was adopted. As mentioned in Section "The Connotation of Innovation" we regarded innovation as the outcome of developing new products and processes. Therefore, when we evaluate the achievement of technological innovation in our test, we measure it from both outcome and process aspects. To evaluate IP, seven experts used predefined criteria, which were designed to lay particular emphasis on the product and the process of behaviors, to evaluate the innovation performance of each team. Mutual evaluations among team members were also conducted to assign each individual's contribution weight to team innovation performance. We then obtained the final score for individual IP from the product of team performance and personal weight.

Data analysis

In this study, we used a partial least squares structural equation model (PLS-SEM) for data analysis. If a model contains many constructs and many items while the sample size is small, PLS-SEM can be used to maximize the explained variance of the endogenous constructs (Fornell & Bookstein, 1982; Hair et al., 2019; Fornell & Larcker, 1981). After data collection, we first verified the effectiveness of the experimental design. We used SPSS 24 to analyze the reliability and validity of the various scales used in the experiment and SmartPLS 3 to analyze the reliability and validity of the model we constructed. Subsequently, we built PLS-SEM in SmartPLS 3 to explore the relationships among the variables and determine whether there were mediating or moderating effects through bootstrapping procedures. Finally, to check the robustness of our test, we used SPSS 24 to perform the Ramsey regression equation specification error test (RESET) to exclude nonlinearity and SmartPLS 3 to check for heterogeneity.

Measurement model

Reliability and validity test of the scale

After the experiment, all questionnaires were collected to guarantee the recovery rate and authenticity. A total of 244 valid data points from 250 subjects were collected, and the collection efficiency was 97.6 %, which was within an acceptable range. Reliability and validity tests were conducted on the collected questionnaire data. The Cronbach's α values on the scale of IM, IB, and IC are 0.903, 0.865, and 0.895, respectively, so we can conclude that the questionnaire has high reliability. The KMO values were 0.873, 0.770, and 0.841, respectively, and all the significance levels of the Bartlett sphere test were 0.000; thus, we were convinced that the scales in our research have high validity. As the measurement of innovation performance was calculated directly, there was no need to test its reliability and validity.

Reliability and validity test of the model

It is necessary to conduct an indicator reliability and a convergent and discriminant validity examination of the PLS-SEM model to assess the measurement model and avoid collinearity before conducting further analysis.

Construct and convergent validity. Factor loadings, average variance extracted (AVE), and composite reliability (CR) indicate the convergent validity of the reflective measurement model (Chin, 1998; Hair et al., 2014). The construct and convergent validity results are presented in Table 2. The factor loadings of all items were above or nearly 0.8 and statistically significant (**means $p < 0.01$), while the CR was above 0.9 and the AVE of all latent variables was higher than 0.6. Researchers should also consider the variance inflation factor (VIF) to

Table 2
The results of construct, convergent, and discriminant validity.

Constructs	Indicators	Factor loadings	Sample mean (IM)	Standard deviation (STDEV)	*t*-statistic (|O/STDEV|)	VIF	CR	AVE
IM	im1	0.83	0.83	0.03	28.66**	2.54	0.93	0.68
	im2	0.84	0.84	0.03	33.80**	2.34		
	im3	0.83	0.83	0.03	32.68**	2.44		
	im4	0.80	0.80	0.04	20.80**	2.17		
	im5	0.80	0.80	0.04	21.14**	2.48		
	im6	0.83	0.83	0.03	27.11**	2.56		
IB	ib1	0.78	0.78	0.04	20.08**	1.74	0.91	0.71
	ib2	0.84	0.84	0.02	37.45**	2.08		
	ib3	0.88	0.88	0.02	57.90**	3.08		
	ib4	0.88	0.88	0.02	55.50**	2.90		
IC	ic1	0.81	0.76	0.20	4.02**	2.25	0.92	0.75
	ic2	0.93	0.79	0.24	3.86**	2.41		
	ic3	0.87	0.78	0.19	4.62**	2.56		
	ic4	0.86	0.80	0.20	4.35**	3.00		
	IM		IB		IC		IP	
IM	0.82							
IB	0.57		0.85					
IC	0.50		0.54		0.87			
IP	0.02		0.08		0.07		1.00	

Notes: $^{**}p < 0.01$; IM = individual motivation; IB = innovative behavior; IC = innovation climate; IP = innovation performance.

verify collinearity. The VIF scores for the constructs in our research were all less than or approximately equal to 3.

Discriminant validity. The discriminant validity of the model is shown in Table 2. All values on the diagonals were greater than the others in the corresponding row, which verified that the measures were discriminant (Fornell & Larcker, 1981).

Thus, we were convinced that it was suitable to conduct factor analysis.

Structural model

Partial least squares structural equation modeling was used to verify the hypotheses regarding the relationships among IM, IB, IC, and IP. The results of this analysis are presented in Table 3 and Fig. 2.

Main effect

H1 suggests that individual motivation positively affects personal innovation performance. To test this hypothesis, we conducted a relevance analysis, the results of which are presented in Table 3. As Table 3 shows, individual motivation positively affects innovation performance ($\beta = 0.15$, $p = 0.02 < 0.05$; the lower and upper limits of the confidence interval are all positive values). Therefore, H1 is supported.

Hypotheses H2a and H2b suggest that individual innovative behavior has a positive relationship with individual motivation and innovation performance. Table 3 shows that motivation has a great positive impact on innovative behavior, and innovative behavior has a significantly positive effect on innovation performance ($\beta_1 = 0.57$, $p = 0.000 < 0.01$; $\beta_2 = 0.16$, $p = 0.008 < 0.01$).

Mediating effect

In previous studies based on PLS-SEM, mediation has become increasingly prominent (Matthews et al., 2016; Hair et al., 2019; Akgün et al., 2023). It examines a statistical model in which the mediation construct is an intermediate between the other two constructs (Baron & Kenny, 1986), which means that changes in the exogenous structure could lead to changes in the mediation structure, which in turn leads to changes in the endogenous structure (Zhao et al., 2010). Partial least squares structural equation modeling is believed to be superior to regression analysis when assessing mediation (Hair et al., 2019). Based on these theories, Zhao et al. (2010) identified a typology investigating the coefficients of a*, b, and c to divide mediations into five situations: complementary mediation, competitive mediation, indirect-only mediation, direct-only non-mediation, and no-effect non-mediation.

In our research, as illustrated in Table 3, the mediated effect (a*b) and direct effect (c) both exist and point in the same direction, leading to the conclusion of complementary mediation (Zhao et al., 2010). Besides, we also conducted the Sobel test (Sobel, 1982), with a result of $p = 0.017 < 0.05$, which confirmed the same conclusion.

According to Hair (2014), in PLS, researchers can calculate the strength of intermediaries using the ratio of indirect effects to total effects, also called the variance accounted for (VAF). Furthermore, there was a full mediation effect when VAF > 80 %, a partial mediation effect when 20 % < VAF < 80 %, and no mediation effect when VAF < 20 %. Based on the results shown in Table 3, the VAF is 0.346, indicating a partial mediating effect of IB between IM and IP.

Thus, we conclude that innovative behavior plays a complementary and partially mediating role between motivation and innovation performance.

Moderating effect

According to Hair et al. (2019) and Becker et al. (2018), PLS-SEM is an effective approach for moderation analysis. Hypotheses H4a and H4b propose that innovation climate plays a positive moderating role between individual motivation and innovation performance and between innovative behavior and innovation performance, respectively. To test these hypotheses, we built the PLS-SEM with SmartPLS 3, as well as bootstrapping. As shown in Table 3, IC plays a positive moderation role between IB and IP ($\beta = 0.172$, $p = 0.033 < 0.05$), supporting Hypothesis H4b. We did not find any support for hypothesis H4a.

Robustness checks

It was necessary to test the robustness of the PLS-SEM model, particularly to check its nonlinearity and heterogeneity (Hair et al., 2016, 2019; Sarstedt et al., 2011; Sarstedt et al., 2019). Because the proposed variables are all assumed to be linear, it is a prerequisite to ensure the linearity of the model. Additionally, the exploratory model

Table 3
Descriptive data and the results of the structural model.

Hs	Relationships	Sample mean (IM)	Standard deviation (STDEV)	*t*-statistic (|O/STDEV|)	Path coefficient	*P* value	LLCI	ULCI	Decision
H1	IM -> IP	0.17	0.06	2.34	0.15	0.02*	0.091	0.263	Supported
H2a	IM -> IB	0.58	0.05	12.09	0.57	0.00**	0.46	0.66	Supported
H2b	IB -> IP	0.16	0.06	2.68	0.16	0.01**	0.04	0.27	Supported
H4a	Moderating effect of IC: IM -> IP	−0.07	0.07	0.75	−0.05	0.46	−0.21	0.05	Not supported
H4b	Moderating effect of IC: IB -> IP	0.19	0.08	2.14	0.17	0.03*	0.05	0.37	Supported
H3	IM -> IB -> IP	0.09	0.04	2.62	–	0.01**	0.02	0.16	Supported

Models	Coefficient β	S.E.	*T*-statistics	*P*-value	Effect size
$Y = cX + e1$	$c = 0.21$	0.06	3.62	0.00**	$ab/(ab + c') = 0.35$
$M = aX + e2$	$a = 0.43$	0.08	5.18	0.00**	
$Y = c'X + bM + e3$	$c' = 0.14$	0.06	2.20	0.03*	
	$b = 0.17$	0.06	2.69	0.01**	
Sobel test	ab	0.03	2.39	0.02*	

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; IM = individual motivation; IB = innovative behavior; IC = innovation climate; IP = innovation performance; Y denotes IP; X denotes IM; M denotes IB; ab = cross term of Sobel Test; S.E. = standard error; LLCI / ULCI = lower (2.5 %) / upper (97.5 %) limit of confidence interval.

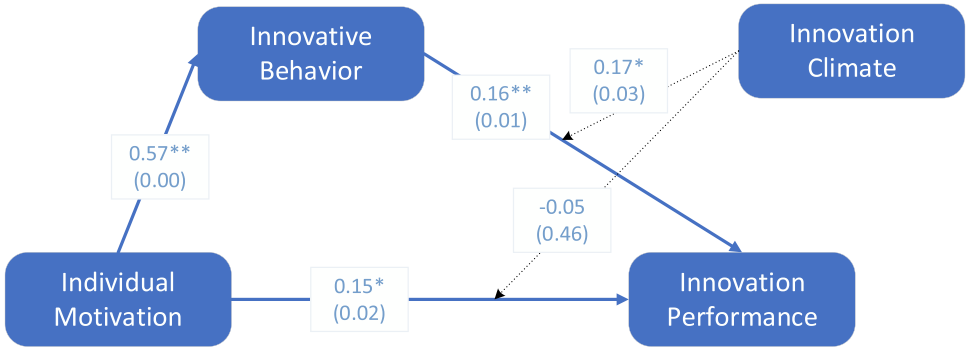

Fig. 2. Result of structural model.

used to check the hypotheses should be heterogeneous, and it is necessary to ensure that no latent variables can be divided into two or more variables.

Nonlinearity for robustness

To test whether the relationships are nonlinear, researchers can run Ramsey's regression equation specification error test (RESET) (Sarstedt et al., 2019). Ramsey's RESET test is a specific linearity test (Ramsey 1969). The common method of this test considers the squared values of the independent variables (i.e., x^2) and third powers (i.e., x^3) and tests whether these terms are significant (Sarstedt et al., 2019). The implementation of RESET in SPSS was used in our research. In Ramsey RESET, as shown in Table 4, the quadratic effects of IM on IP, IM on IB, and IB on IP (represented by IM*IM-> IP, IM*IM-> IB, and IB*IB-> IP, respectively) and the cubic effects of IM on IP, IM on IB, and IB on IP (represented by IM*IM*IM -> IP, IM*IM*IM -> IB, and IB*IB*IB -> IP, respectively) indicate that none of the nonlinear effects are significant. Therefore, we conclude that the linear PLS-SEM model is robust.

Heterogeneity for robustness

It is crucial to check the heterogeneity of the robustness to ensure that no variable can be divided into two or more variables (Sarstedt et al., 2019; Hair et al., 2016; Matthews et al., 2016). The FIMIX-PLS method in SmartPLS is an effective method for checking the heterogeneity of robustness (Hair et al., 2016). The segmentation results are listed in Table 4. In this method, we assumed that the set of latent variables could be segmented into one and two latent variables; that is, the criteria shown in the table could be 2 and 3. Matthews et al. (2016) and Hair et al. (2016) assert that Akaike's Information Criterion (AIC) overestimates the correct number of segments and the minimum description length with both MDL5 and Consistent Akaike's Information Criterion underestimates the segments. According to the results of the AIC, MDL5, and CAIC, two-segment criteria should be considered. However, according to Sarstedt et al. (2011), the modified AIC with factor four (AIC4) and Bayesian Information Criteria (BIC) indicate the best-performing criteria, which means that a three-segment solution should be considered. This contradiction indicates that the selected variables could not be segmented.

Discussions

A field study was conducted to investigate the effects of IM on IP. First, it explored the impact of IM on IP in task-oriented R&D teams. Second, this study investigated the mediating effect of IB on the relationship between IM and IP. Finally, the proposed moderating role of IC in the relationship between IB and IP is confirmed. The major findings of this study are as follows:

In this study, a questionnaire was designed to measure the IM of an R&D team, and the relationships between IM, IB, and IP were

Table 4
Results of non-linearity and heterogeneity for robustness.

Results of Ramsay RESET test Quadratic and cubic terms	*R*	*F*	*t*-value	*P*-value
IM*IM-> IP	0.03	0.25	0.50	0.62
IB*IB-> IP	0.03	0.27	0.52	0.61
IM*IM-> IB	0.05	0.52	0.72	0.47
IM*IM*IM-> IP	0.03	0.25	0.50	0.62
IB*IB*IB-> IP	0.00	0.00	0.03	0.98
IM*IM*IM-> IB	0.10	2.35	1.53	0.13
Results of segments Criteria	1	2	3	
AIC	38.00	−14.23	−76.65	
AIC3	51.00	12.77	−35.65	
AIC4	64.00	39.77	5.35	
BIC	83.47	80.20	66.73	
CAIC	96.47	107.20	107.73	
MDL5	369.32	673.89	968.27	
LnL	−6.00	34.11	79.33	
EN		0.41	0.59	

Notes: IM = individual motivation; IB = innovative behavior; IP = innovation performance; IM*IM = quadratic term of IM; IB*IB = quadratic term of IB; IM*IM*IM = cubic term of IM; IB*IB*IB = cubic term of IB; AIC: Akaike's information criterion; AIC3: modified AIC with factor 3; AIC4: modified AIC with factor 4; BIC: Bayesian information criteria; CAIC: consistent AIC; MDL5: minimum description length with factor 5; LnL: Log Likelihood; EN: entropy statistic.

explored. We found that all three constructs had positive relationships. The IM can improve the IP. The results show that the relationship between IM and IP is highly significant (IM -> IP path coefficient = 0.149, $p < 0.05$). This result is consistent with prior research (Janssen et al., 2004; Barron & Harackiewicz, 2000; Correia & Braga, 2023), namely that motivation positively influences R&D innovation performance. However, IB also plays a positive role in both IM and IP (IM -> IB path coefficient = 0.572 and, $p < 0.01$; IM -> IB path coefficient = 0.158, $p < 0.01$). These conclusions agree with those of previous studies as well (Amabile & Pratt, 2016; Janssen et al., 2004).

Individuals with a higher motivation to innovate may be more enthusiastic about participating in innovation and more willing to conduct innovation activities to obtain good performance. With higher individual motivation, team members devote more cognitive effort to pursue inner satisfaction and experience the fun of innovation, collect and excavate more information, and expand the depth of innovation processing. Individual motivation affects the learning and preparation of individual creativity, encourages team members to understand each other's expertise through role cognition, and promotes personal innovative behaviors, integration, and internalization through member trust. This helps increase the possibility and enthusiasm of team members to acquire and share new knowledge, meet the high-level cognitive needs brought about by high-level team motivation, and quickly improve team performance.

We also discovered the novel conclusion that IB acts as a mediator between them. The results also support the mediating effect, as IB positively and significantly influences the relationship between IM and IP (the p-value of "IM -> IB -> IP" is less than 0.01). With higher motivation, individuals pay more attention to ability improvement and R&D achievements, gain a higher sense of self-satisfaction and pride, have more positive cognitions of innovation, conduct more innovative behaviors, and produce more meaningful innovation performance. During this process, innovative behaviors act as mediators since behaviors such as pushing information flow, generating new ideas, looking for opportunities, and applying innovative ideas into practice (West & Farr, 1989; Janssen, 2005) all require individuals to carry out actions.

Additionally, this study contributes to the conclusion that IC moderates the relationship between IB and IP. In our study, the moderating effect of IC was checked, and came to the satisfactory result that there is a moderating effect of IC on the relationship between IB and IP (the path coefficient of Moderating effect of IC: "IB -> IP" = 0.172 and $p < 0.05$). A good climate can guide team members to become interested in and curious about innovation tasks and stimulate their internal willingness to innovate. Additionally, when team members agree on team values and support innovation, they become more independent and focus more on their actions. An innovative climate in which an organization emphasizes mutual respect, trust, and understanding is conducive to the improvement of creative performance. Conversely, a strong innovation climate constantly encourages team members to innovate and improve their levels of scientific creativity and innovation performance.

Our findings also show that H4a: "Innovation climate plays a positive moderating role between individual innovation motivation and innovation performance, which is an unsupported hypothesis." Based on this unsupported hypothesis, we infer that IC does not directly affect the transition from IM to IP. This conclusion supports the mediating role of IB. Specifically, IC requires the intermediation of IB to affect the process of IM to IP.

Conclusion and limitation

Conclusions

This study discusses the relationships between individual motivation, innovative behavior, and innovation performance and tests the moderating effect of innovation climate. SPSS 24 and SmartPLS 3 were used to preprocess the data, establish the explanatory model, conduct the analysis, and check robustness. The results of this field study were as follows:

Individual motivation has a positive role in promoting innovation.

Innovative behavior mediates the relationship between individual motivation and innovation performance.

The innovation climate moderates the relationship between innovative behavior and innovation performance.

To account for the results, the following possible explanations were proposed:

Individuals who have a high motivation to innovate tend to be more active in new idea generation, interact with others in suggestion exchanges, proactively engage in innovation behaviors, and try novel creativity, possibly leading to valuable innovation performance. During this process, if an organization's climate is suitable for advocating and encouraging innovation, members are more willing to show themselves, spread their innovative ideas, promote innovative behaviors, and participate in innovation programs; thus, they are more likely to output innovation performance.

This study had several important theoretical implications. The proposed model conducts an in-depth analysis of the factors influencing IP. This study also fills the theoretical gaps regarding the relationship between IM, IB, and IP under the moderating role of IC. Furthermore, the study introduced the Cognitive Evaluation Theory and the behavioral performance viewpoint to combine the elements of IM, IB, and IP and prove the positive relationship between IM and IP.

This study has several practical implications. For R&D projects, stimulators concerning motivation and climate should be primarily considered by managers to boost IP according to the results of this field study. Considering the positive effect of individual motivation on innovation performance, we deduce the following implications for stimulating innovation: Organizations can stimulate individual motivation by guiding team members to focus on the value of scientific and technological innovation, setting challenging goals to mobilize their enthusiasm, and providing more options.

Considering the mediating role of innovative behavior, we may concentrate on innovative behaviors that individuals engage in to stimulate the transition from IM to IP. In other words, organizational managers should pay more attention to team members' generation, exploration, promotion, and implementation of useful ideas and suggestions. Organizations should focus on the process of innovation activities and stimulate innovative behaviors by establishing a more innovation-encouraging evaluation system, such as providing rewards to those willing to generate new ideas and promote ideas into action.

Considering the moderating role of innovation climate, organizations should promote the construction of an innovative climate that encourages people to challenge and seek interest and offers an innovation platform to meet their internal needs and satisfaction by supporting individuals' innovation enthusiasm and encouraging team members to seek different innovation schemes.

Limitations and future research

The main limitation of our research is that the measurement data for IM, IB, and IC used the traditional form of respondents' self-reports, which inevitably has the problem of common method deviation. Future research should consider obtaining more objective data. Furthermore, the sample in this study comes from one university, and the lifecycle of science and technology competitions is shorter than that of enterprise research teams. Although the representativeness and distribution of the sample were well considered, it would be better to expand the sample to include more sources in the future.

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