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How Humble Leadership Influences the Innovation of Technology Standards: A Moderated Mediation Model

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Abstract: Management researchers have paid increasing attention to the role of humble leadership in innovation activities. The underlying mechanisms through which leader humility influences team innovation and outcomes, however, remain unclear. We aim to investigate the impact of humble leadership on the innovation of technology standards via knowledge exchange and combination and job complexity. We apply the Structural Equation Modelling (SEM) to the survey data from 354 individuals who participated in technology standard innovation activities in China. Our empirical results show that knowledge exchange and combination play a mediating role between humble leadership behavior and the innovation of technology standards. Particularly, we find that job complexity moderates the positive relationship between knowledge exchange and combination and the innovation of technology standards in a nonlinear way. This is the first time that the latent mechanisms of humble leadership have been identified in the innovation of technology standards based on knowledge-based theory.

Keywords: humble leadership; innovation of technology standards; knowledge exchange and combination; job complexity

1. Introduction

Technology standardization is an important innovation strategy for enterprises, industries and countries. Enterprises consider technology standardization as a strategy to build technical barriers, develop competition rules, and seek initiative market competition. Technology standards determine the technology level of an industry [1]. Blind and Jungmittag found that the stock of patents and technology standards significantly contributed to economic growth in the 1990s, and such contribution is more important for low R&D-intensity than high R&D-intensity industries [2]. Policy-makers often regard technology standardization as a national economic strategy [3]. In the past fifteen years, the UK, the USA, China, Germany, Japan, Russia, and Canada have witnessed the rapid development of national standardization strategies [3–5]. It is noticed that owning a technology standard nowadays often implies a great chance to lead innovation and market competition [6,7].

A technology standard has three components: The content, the range in which the technology can be applied, and the time period during which the technology standard is valid [8]. Its purpose is to enable relevant products or services to reach the threshold of market access, and to use the standard thresholds to regulate market structure and competition order, so that market competition enters an orderly state [8]. The International Standards Organization (ISO) defines technology standards as one or a series of documents with mandatory requirements or guiding functions which contain detailed technical requirements and technical guidance. Technical standards are the core content of technical trade barriers, and they are also powerful tools for enterprises to benefit economically [9,10]. Standard makers can earn revenue through standard licensing. Because a technology standard usually specifies one or a class of technical requirements, these technical requirements involve multiple patents [11]. Technology standards, as a large and complex technical system composed of patents, on the basis of intellectual property rights, are not freely disclosed; other new enterprises entering the industry must pay a certain cost to accept and apply this technology standard. Standard makers can transfer their technology and standards through obtaining technology licensing fees [12].

Technology standardization is the dynamic process of diffusing knowledge and innovation through technology standards [9,10]. Technology standardization contributes to innovation in three dimensions. First, technology standardization can increase the efficiency of economic activities by improving product compatibility and interoperability [13]. Allen and Sriram stated that technology standardization has promoted technology innovation [14]. Second, technology standardization, as a "trimmer" for technological innovation, can integrate disordered technology innovations into an ordered system [15,16]. Taking mobile communications as an example, Sadahiko argued that standardization plays an important role of synchronizing the disjointed technical innovations into a systemic innovation, which creates a new market [17]. Third, technology standardization can achieve structural and comprehensive innovation when the technology accumulates to a certain threshold. In general, standards are usually proposed and established by the enterprises that own or lead existing cutting-edge technologies in an industry [1]. With the rapid upgrading of technology, technology standards can help these enterprises establish structural strategy to innovate technology progressively. In this way, enterprises which innovate technology standards successfully (like creating completely new technology standards, revising or perfecting existing technology standards, benchmarking with other technology standards), can gain longer and more stable competitive advantages in the industry.

The innovation of technology requires the cooperation and support of team members. In these innovation activities of technology standards, members often come from different organizations in a specific field to form a temporary technology standard innovation team in a period of time; therefore, the leadership style will vary a lot across activities leading to different innovation performances [18–20]. Humility has been considered as a foundation for virtue and character strengths [21–23]. Leadership humility may help foster adaptive strengths within a team [24], which ultimately enhances team performance [25,26].

This study aims to fill in the current research gap in innovation through focusing on the effect of humble leadership on the innovation of technology standards while considering knowledge exchange and combination. To our knowledge, this is the first study to identify the latent mechanisms of humble leadership in innovation of technology standards. This research broadens the research perspective of technology standardization and improves the understanding of the innovation of technology standards, particularly in understanding the process of innovation of technology standards influenced by humble leadership in organizations. Moreover, it clarifies the mechanism of the impact of different-level job complexity for the innovation of technology standards. This research has important theoretical and practical implications to both technology innovation policies and businesses.

The rest of the paper is laid out as follows: We will introduce the theoretical background and hypotheses, then entail the methodologies, followed by a report on the results, discussions, and conclusions.

2. Theoretical Background and Hypotheses

2.1. Humble Leadership and Knowledge Exchange and Combination

Leadership humility is considered to be one of the key factors of leadership effectiveness, and researchers have suggested that leadership humility can have a positive impact on employees and organizations [22,27]. In the humble leadership theory, humility does not belong to the personal characteristics or personal qualities of the leader. Humility is the acquired leadership style that can be shaped by implementing a series of actions. In other words, humility is an act that leaders can actively choose and develop [24]. Humble leaders can correctly observe themselves and maintain the relationship between themselves and their subordinates by confessing their own deficiencies and negligence, admiring the advantages and contributions of subordinates, and learning modesty [28]. Based on the perspective of the leader's behavior, there are three main elements of humble leaderships: (a) Objectively evaluating and correctly understanding themselves, (b) appreciating the strengths and contributions of others and letting their members know that through public praise, (c) having an open attitude towards the opinions of subordinates and not feeling ashamed to ask and learn from their subordinates [29,30]. Owens et al. [31] defined humble leader behavior by dividing it into three parts: (a) A willingness to view oneself accurately, (b) an appreciation of others' strengths and contributions, and (c) teachability, or openness to new ideas and feedback. It is found that humble leaders can strengthen the intrinsic motivation of subordinates to learn and improve their self-efficacy, motivation, and willingness. Additionally, leader humility has a positive impact on their subordinates' psychological freedom and investment in work. Initial qualitative and quantitative evidence suggests that leader humility may help foster adaptive strengths within a team [24,25,32].

It is important to note that there are some other similar bottom-up leadership styles are similar to humble leadership, such as servant leadership. Servant leaders see themselves as servants first then leaders, and see the development of subordinates as an end and not just a tool to reach the goals of the leaders or their organizations [33]. Servant leadership are very similar to humble leadership and their humble performance is often seen by some people as a focus on serving subordinates. Humble leaders also demonstrate service awareness in three areas: A true will to service, respect for others, sharing rather than monopolizing [34]. Therefore, the importance of humility is repeatedly emphasized in the study of servant leadership [35]. The biggest difference between the two leadership styles is that servant leadership is completely oriented by others, while humble leadership is dual-oriented. For example, humble leaders will learn to be self-motivated and promote themselves, while servant leaders will not participate in such "selfish" behavior [28].

Supportive leadership is also closely linked to, but distinguished from, humble leadership and is defined as "expressing concern for followers and taking account of their individual needs" [36]. Supportive leaders advise employees on their careers, carefully observe and document their progress, and encourage them to participate in skills training [37]. Similarly, humble leaders also focus on employee development [38] and a clear development path for them [24]. However, compared to supportive leaders caring about employee skill and knowledge, humble leaders emphasize the development of their subordinates' thoughts and psychology. In addition, the two leaders use different ways to achieve their goals of developing subordinates. Supportive leaders do it via training, while humble leaders appreciate and encourage their subordinates and have equal two-way communication with them [28].

Previous studies reveal that leadership style is an important factor in the process of knowledge management [39,40]. There are four main elements in effective knowledge management including organizational culture, chief knowledge executive officers (CKOs), leadership style, and education levels [41]. The culture of organizations can generate cooperation and trust and relevant leadership styles in knowledge management [42,43]. The study investigated an integrative mechanism of team cooperative norms in order to link leadership to team knowledge sharing and innovation. They did two studies. In the first study, using temporarily assembled project teams working on knowledge-intensive tasks, it was found that transformational leadership promoted within-team knowledge sharing and team innovative performance through an integration mechanism manifest as team cooperative norms, and such a mediation process was significant even after controlling for another mediation process of team autonomy. In the second study, using permanent work teams in various functional areas, they replicated the integrative mechanism and associated transformational leadership with external team knowledge acquisition, which further moderated the relationship between knowledge sharing and innovation.

Knowledge exchange and combination are a process of creating new knowledge by individuals interacting with each other to acquire and learn knowledge [44]. Knowledge exchange refers to the exchange of knowledge and information among different knowledge subjects. Knowledge combination means the integration of previously unrelated knowledge elements or prevenient related knowledge elements in a new way, and that is an incremental change or fundamental innovation for current knowledge [45]. By exchanging and integrating knowledge, members of a department can rebuild the existing knowledge of their company, and integrate internal and external knowledge or knowledge from different sources to create new knowledge [46]. The process of knowledge exchange and combination happens inside the organization through relevant mechanisms that systematically organize and integrate stored knowledge scattered by individuals or teams, and then lay the foundation for better technology, service, and organizational innovation. Based on the technology innovation alliance, the knowledge integration mechanism is divided into two dimensions: Independent integration mechanisms and cooperation integration mechanisms, which analyze and emphasize positive impact on innovation performance [38]. On the basis of communication, members of an organization exchange their information and sort out the existing explicit knowledge to making the existing knowledge more organized. The scattered tacit knowledge possessed by different individuals is compiled and integrated so that tacit knowledge can be solidified and combined as much as possible, laying the foundation for future innovation [47].

The dynamics of leadership style play an important role in knowledge management. Politis [48] found that if the leadership style can advocate and encourage employees to actively participate in decision-making processes, it will have a positive impact on knowledge management. If leaders can build mutual trust with their subordinates, respect employee emotions, and adopt employee suggestions, this will have a positive effect on absorbing and gaining knowledge. In addition, leadership style can be seen as a solid foundation for the process of knowledge creation. However, knowledge sharing in a team does not happen spontaneously, and leadership style affects the knowledge sharing and knowledge integration behaviors of members of an organization [48,49].The process of technology standard innovation requires engaging members from different organizations to participate in the activity to facilitate an information flow through collecting, processing, analyzing, and integrating knowledge. Swain [50] has shown that the humility of a leader can smooth the information flow in a team. This implies that humble leadership may have a positive impact on the exchange and combination of knowledge in the team, so we propose:

Hypothesis 1. *Humble leadership is positively associated with knowledge exchange and combination.*

2.2. Knowledge Exchange and Combination and Innovation of Technology Standard

Collins and Smith [46] suppose that the ability of employees to collectively exchange and integrate knowledge is the driving force of creating new knowledge, which enables enterprises to innovate and surpass their competitors in a dynamic environment. They found that knowledge exchange and combination had a positive effect on enterprise performance.

The knowledge-based theory presumes that, as a social entity, the organization's ability to store and utilize its internal knowledge, competitive advantage, and talents will affect the survival, development, and success of itself. In [51,52], it was proven that enterprises that can search, absorb, and utilize new knowledge more effectively from both in- and outside will achieve relatively higher performance. However, it should also be noted that in an organization composed of knowledge workers, although the organization regards knowledge as the most important resource at the organizational strategy level, knowledge is actually created, stored, and used by a single individual rather than the whole organization [53]. Therefore, the exchange and combination of knowledge among individuals in an organization are key to solving complex team communication problems, then forming overall knowledge resources.

The knowledge created and stored by individuals or teams during the innovation process is often scattered. The scattered knowledge can be systematically collated and integrated through a series of mechanisms within the organization. The sharing and utilization of scattered knowledge within the organization will lay the foundation for innovation [38,54]. It is found that knowledge integration contributes to the improvement of cooperative innovation performance [55]. Further, Wu et al. [56] conducted a questionnaire survey on the status of independent knowledge creation in 300 alliance network enterprises. Their results show that there is a significant positive correlation between the two types of knowledge (technical and product knowledge) and organizational performance, and the positive correlation between organizational knowledge and organizational performance is not significant.

Knowledge exchange and combination is based on team communication. Through knowledge exchange and sharing among individuals, scattered knowledge can be integrated into integral organized knowledge resources. In the process of technology standard innovation, knowledge exchange and combination will gradually reduce the information incompleteness and asymmetry of organization through communication among individuals, and stimulate the sharing and integration of existing significant knowledge (information of industry technology development, existing related technology standards, etc.) as well as individual tacit knowledge, making the existing knowledge of the organization more orderly. Meanwhile it will build the foundation for forming new standards, increase in-depth exchanges of information on technology standards within organizations, accelerate consensus on new standards, and ultimately achieve the innovation of technology standards. It is hence important for individual organizations to exchange and integrate knowledge during the whole process of innovation of technology standards regardless the type of standards (national standards, industry standards, or internal standards of enterprise). Based on the discussion above, we have:

Hypothesis 2. *Knowledge exchange and combination have a positive impact on the innovation of technology standards.*

2.3. The Mediation Role of Knowledge Exchange and Combination

The relationship between humble leadership and the innovation of technology standards is not direct; knowledge exchange and combination may play a mediation role. The higher-order theory indicates that psychological characteristics can be used as a cognitive and value basis to shape how senior managers deal with information, make strategic decisions, allocate resources, guide employees, and ultimately connect with corporate performance. Ou et al. [57] used the higher-order theory to study the relationship between CEO characteristics and corporate performance. They believed that psychological characteristics can work as information filters to affect the response of executives to the external environment; therefore, CEO characteristics and corporate performance may be indirectly linked. Some scholars have attempted to explain that humble leadership may influence team and individual performances and creativity through psychological factors such as psychological safety, psychological capital, and perceived support [58–61].

We argue that the leader's behavioral style does not only affect the psychological factors (such as psychological safety, psychological capital, perceived support [58–61]) of individuals but also their working behavior in the organization. It has important influence on the behaviors between individuals in the organization. The humble leader can achieve the goal of knowledge sharing, exchanging, and combining by creating a group's modest atmosphere, increasing perceived support to staff, and improving their psychological safety. In such processes, many groups are often required to participate in the formulation of a standard, and there is generally no subordinate relationship between them. At this time, the humble leadership of the person in charge will be conducive to providing team support for psychological factors, creating a good atmosphere for innovation, promoting the exchange and combination of organizational knowledge, and ultimately achieving the purpose of the innovation of technology standards. Therefore, knowledge exchange and combination are mediation factors of the process where humble leadership behavior has impact on technology standard innovation. In summary, we propose:

Hypothesis 3. *Knowledge exchange and combination plays a mediating role between humble leadership behavior and the innovation of technology standards.*

2.4. The Moderator Role of Job Complexity

The complexity of a job is an important part of the job characteristics model. It has been proven to be an important situational factor affecting individual innovation behavior [62,63] and plays a role in the creativity of an organization [64,65]. It is found that job complexity does not work independently for organizations and employees. For example, Tierney and Farmer [62] found that the interaction between job complexity and leadership behavior will positively affect the innovative self-efficacy of employees in an organization. Bornay and Herrero [66] measured the complexity of job from three perspectives: Problem solving, discretion and technology knowledge application, and the study has shown that the job complexity of the work moderates the positive relationship between co-worker relationships and creative team environments. Sung et al. [67] argued that the complex task of performing intrinsic motivation can promote the risk taking and experimental behavior of employees in an organization. When employees face specific challenges, they will pay higher attention to try to create new methods. The authors discovered that the complexity of work indirectly affects the active and reactive creativity of employees through promoting psychological empowerment and cognitive overload. Shang and Li [68] measured the complexity of jobs from three dimensions including skill diversity, freedom, and feedback. They reported that job complexity can positively moderate the relationship between leadership behavior and subordinate creativity. Therefore, based on the above definitions and related discussions, it is theoretically and logically rational to see the job complexity as a conditional factor of explaining the relationship between leaders and members in a research and development team.

We suggest that job complexity can be added into the model as a moderator. Following the view of Cammann et al. [69], job complexity describes the worker's assessment of the difficulty of the job, whether it requires a lot of skills, and how long it takes to learn to get the job done. Job complexity is related to the intellectual flexibility and openness of employees [70]. Highly complex jobs require individuals with the job to have a high level of intelligence, a rich and comprehensive knowledge base, the ability to handle complex information comprehensively, and the ability to respond quickly and accurately to uncertainty [71]. Therefore, if the job itself is difficult, even if the manager assigns a job to a suitable worker, he/she will need time to acquire the relevant knowledge in order to achieve the abilities to finish the job. So in this study, we suggest that job complexity and humble leadership are not directly related. Job complexity will moderate the relationship between knowledge exchange and combination and the innovation of technology standards among team members in the innovation activities of technology standards. As the abovementioned research demonstrates, there is a positive impact of job complexity on employee creativity. However, in recent studies, some researchers have suggested that when the work gets more complicated, it may have an adverse effect on exchanging information and views among team members. Wang et al. [72] argued that when team work becomes more and more complex, team members need to participate in more exchanges of information and ideas. This means that as the complexity of job increases, the exchange of information among individuals in the organization will also need to increase. Man and Lam [73] suggested that for simple tasks there is only need to establish procedures, without too much discussion and coordination, but the more complex the task is, more support and understanding between team members are needed.

Job complexity exerts a positive moderation effect between knowledge exchange and combination and the innovation of technology standards. However, if the job complexity is too high, the complicated information exchange and knowledge integration among the team members will slow the innovation process down, and the mutual understanding among team members may not meet the requirements of knowledge sharing for the innovation of technology standards. Hence:

Hypothesis 4. *Job complexity will moderate (an "inverted-U" shape) the positive relationship between knowledge exchange and combination and the innovation of technology standards; with the increase of job complexity, knowledge exchange and combination will be conducive to the positive relationship at the first stage; however, when the job complexity is too high, the positive relationship between knowledge exchange and combination and innovation of technology standards will be weaker.*

3. Methods

3.1. Research Model and Metrics

Figure 1 given below is the research model after an in-depth literature review, as already mentioned above, to explain the model exhibited below. It depicts how humble leadership affects the innovation of technology standards through knowledge exchange and combination. In this model, humble leadership is the independent variable; the innovation of technology standards is a dependent variable; knowledge exchange and combination are the mediating variable; job complexity is a moderating variable.

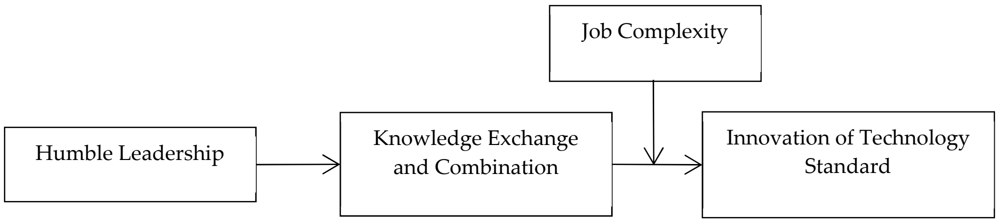

Figure 1. Conceptual model for humble leadership and the innovation of technology standards.

As shown in Figure 2, we measure the humble leadership exhibited by leaders in the process of technology standard innovation with nine items based on the approach proposed by Owens et al. [31] and Qu et al. [74]. Based on the definition from Owens et al. [31], humble leadership is divided into three variables including (a) a willingness to view oneself accurately, (b) an appreciation of others' strengths and contributions, and (c) teachability, or openness to new ideas and feedback. We measure knowledge exchange and combination among members in the team with eight items according to the scale compiled by Collins et al. [46]. The likelihood of knowledge exchange and combination among employees is dependent upon employee motivation and ability [45,75], and based on Collins et al. [46], we divided knowledge exchange and combination into two variables including motivation and ability. The variables assess participants' beliefs that knowledge exchange and combination can yield personal or organizational value (motivation) and the extent to which they believed that they themselves can exchange and combine information (ability) [46]. Job complexity for the innovation of technology standards is measured by three items compiled by Shaw and Gupta [76], including the need of knowledge, skill, and time. The innovation of technology standards is split into two variables including speed (with two items) and quality (with three items) [77,78]. All the items in this study adopt a 5-point Likert scale ranging from 1 = strongly agree, 5 = strongly disagree.

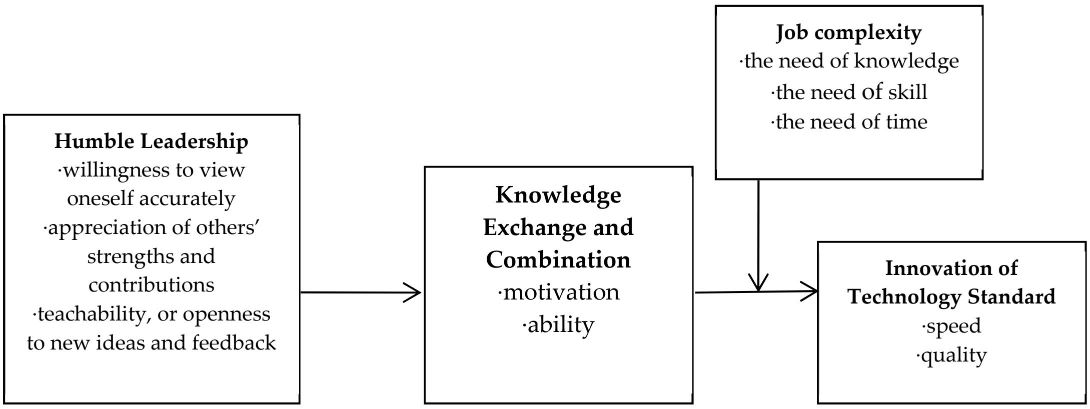

Figure 2. Empirical model for humble leadership and the innovation of technology standards.

In order to rule out the impact of types and level of standard innovation activities, we used three types of standard innovation activities (K1—creating completely new technology standards; K2—revising or perfecting existing technology standards; K3—benchmarking with other technology standards) and the level of standard innovation activities (represented by K4) as control variables.

3.2. Participants and Sample

Many creativity and innovation studies have conducted surveys on R&D teams [75,79,80]. The advantage of surveying R&D teams is that it includes scientists and engineers from different disciplines who are focused on the responsibility for integration and task completion [66]. Members participating in an innovation activity of technology standards are often from different organizations. They work and research together over a certain period of time, so the R&D team formed for the innovation activity of technology standards is often temporary. The members of the temporary R&D team may change frequently, and the leader and members cannot always have long-term cooperative relationships as it is difficult to match the data of leaders and the corresponding members. Thus, our questionnaires are completed by the participants who had joined a temporary R&D team for the innovation activities of technology standards but may not be from the same corporation. We used a technology standard webpage to identify the list of research organizations of innovation activities of technology standards. We employed a data agency to conduct the survey; the survey participants were comprised of engineers and technicians.

In total, we received 700 responses. We cleaned the data according to a set of criteria and ruled out the questionnaires completed in an unreasonably short time, or with a regular cycle of scores, or contradicting the logic of the corresponding answers. We eventually obtained 354 valid questionnaires which accounted for 50.6% of the total questionnaires received. All participants were from China, 88.98% participants were from enterprises and the others from universities, research institutes, or government organizations. Most of participants were from leading regions of standardization work, such as Guangdong (15.82%), Beijing (10.45%), Jiangsu (10.45%), Shandong (9.32%), and Shanghai (7.34%). Among the valid questionnaires, there were 46.05% for establishing new technology standards, 67.23% for revising existing technology standards, and 42.66% for matching technology standards from different systems (some participants were involved in more than one innovation activity of technology standards, so the sum of the three kinds does not equal to 100%). There are 5 levels of technology standards including 22.60% in international standards or national standards, 58.47% in industry standards, 25.71% in local standards, 27.96% in group or alliance standards, and 66.94% in enterprise standards (some members participated in more than one level of technology standards, so the aggregation of the percentages is not 100%). For the most number of people involved in innovation activities of technology standards, 26.55% of participants recalled that the total number involved was 10–20 people, 23.73% recalled it was 20–50 people, 23.73% recalled it was 5–10 people, 12.15% recalled it was 50–100 people, 8.76% recalled it was more than 100 people, and 5.08% recalled it was less than 5 people.

4. Results

The empirical study adopts structural equation modeling (SEM) to test the hypotheses laid out previously [81–85]. We tested the proposed theoretical model using structural model evaluation. We conducted confirmatory factor analysis (CFA) in SEM with AMOS 24 to test the measurement model (see Figure 3), and fitting results of CFA showed that the indicators of the four-factor model were in line with the standard (χ^2/df = 1.247 < 3, the root-mean-square error of approximation (RMSEA) = 0.026 < 0.08, the comparative fit index (CFI) = 0.986 > 0.9, incremental fit index (IFI) = 0.986 > 0.9, the mormed fit Index (NFI) = 0.933 > 0.9, the Tucker–Lewis index (TLI) = 0.984 > 0.9) Therefore, we considered that the proposed model has a good fit of the data.

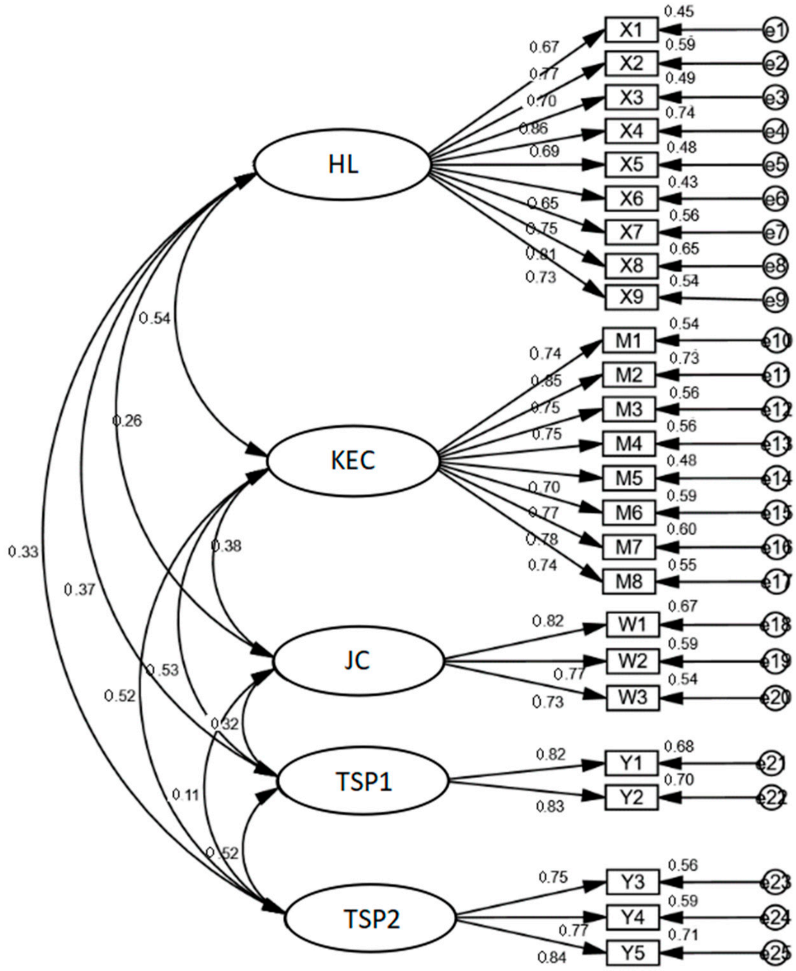

Figure 3. Confirmatory factor analysis of the study model.

First, we analyze the internal consistency of variables with Cronbach's α value. Table 1 shows all values of Cronbach's α are above 0.80, indicating that the variables are consistent and that this study has a good reliability.

Table 1. Reliability test results.

Latent Variables	Means	S.D.	Cronbach's α
HL	2.42	0.705	0.914
KEC	2.08	0.749	0.913
JC	2.44	0.861	0.811
TSP	2.49	0.699	0.807
TSP1	2.54	0.885	0.815
TSP2	2.45	0.779	0.822

Note: HL means humble leadership, KEC means knowledge exchange and combination, JC means job complexity, and TSP means innovation of technology standard. TSP1 represents the speed of innovation of technology standard and TSP2 represents the quality of innovation of technology standard.

Then we tested whether the variables chosen have correlations with the so-called convergent validity. We evaluated the convergent validity by the values of factor loading, composite reliability (CR), and average variance extracted (AVE). The criteria for valid questionnaires included: The factor loading values must be greater than 0.70 (although a value of 0.60 remains acceptable); CR values must be more than 0.7; and AVE values must be at least equal to 0.50 or higher [86–88]). The results in Table 2 show that the factor loading values are higher than 0.7, all the CR values are more than 0.7 and all the AVEs are more than 0.5. This means that humble leadership (HL), knowledge exchange and combination (KEC), job complexity (JC), and the innovation of technology standards (TSP) have convergent validity. The correlation coefficient matrix and discriminant validity are shown in Table 3.

Table 2. Factor loading, CR value, AVE value.

Latent Variables	Items	Factor Loading	CR	AVE	Latent Variables	Items	Factor Loading	CR	AVE
HL	HL1	0.67	0.916	0.549	KEC	KEC1	0.74	0.916	0.579
	HL2	0.77				KEC2	0.85		
	HL3	0.70				KEC3	0.75		
	HL4	0.86				KEC4	0.75		
	HL5	0.69				KEC5	0.70		
	HL6	0.65				KEC6	0.77		
	HL7	0.75				KEC7	0.78		
	HL8	0.81				KEC8	0.75		
	HL9	0.73			TSP1	TSP11	0.83	0.815	0.688
JC	JC1	0.82	0.816	0.597		TSP12	0.83		
	JC2	0.77			TSP2	TSP21	0.75	0.830	0.619
	JC3	0.73				TSP22	0.77		
						TSP23	0.84		

Note: HL means humble leadership, KEC means knowledge exchange and combination, JC means job complexity, and TSP means innovation of technology standard. TSP1 represents the speed of innovation of technology standard and TSP2 represents the quality of innovation of technology standard. The specific content of the item is in Appendix A.

Table 3. Correlation coefficient matrix and discriminant validity.

	Latent Variables	1	2	3	4	5
1	HL	**(0.741)**				
2	KEC	0.494 ***	**(0.761)**			
3	JC	0.220 ***	0.336 ***	**(0.773)**		
4	TSP1	0.326 ***	0.449 ***	0.256 ***	**(0.830)**	
5	TSP2	0.296 ***	0.452 ***	0.084	0.435 ***	**(0.787)**

Notes: * indicates 10% significance level, ** indicates 5% significance level and *** indicates 1% significance level.

We now test the direct effect of humble leadership on knowledge exchange and combination, and the mediating effect of knowledge exchange and combination exerted in the relationship between humble leadership and the innovation of technology standards. Model 1 tests Hypothesis 1 whether humble leadership (HL) is positively associated with knowledge exchange and combination (KEC). Model 2 and Model 3 test Hypothesis 2 on whether knowledge exchange and combination (KEC) is positively associated with the speed of technology standard innovation (TSP1) and the quality of technology standard innovation (TSP2), respectively. The results of Model 1 report that humble leadership is positively associated with knowledge exchange and combination at a 1% significance level, thus Hypothesis 1 is accepted. The results of Model 2 report that knowledge exchange and combination is positively associated with the speed of technology standard innovation at a 1% significance level and the quality of technology standard innovation at a 1% significance level, thus Hypothesis 2 is accepted.

For Hypothesis 3, we followed the traditional perspective provided by Baron and Kenny [89] and modified by Preacher and Hayes's [90] bootstrapping method. In Model 1 of Table 4, the coefficient of HL must be significant and we can observe that it is significant (so that HL is related to KEC); in Model 2 and Model 3 of Table 2, HL is not fully significant to TSP1 and TSP2 when the variable KEC is also in the equation. The indirect effect of HL on TSP is defined as the product of the path HL→KEC (a), and KEC→TSP path (b), or (ab). We adopt a bootstrapping method, a statistical re-sampling method which estimates the standard deviations of a model from a sample [91] to test for the significance of the indirect effect parameter [89]. We applied the bootstrapping method using SPSS 24 (n = 5000) and the results in Table 4 show that the indirect effect (equal to 0.240, 95% CI = [0.167, 0.328]) of Model 2 (HL on TSP1 through KEC) is significant and the direct effect (equal to 0.174, 95% CI = [0.040, 0.308]) of Model 2 (HL on TSP1) is also significant. These results indicate that the relationship between humble leadership and the innovation of technology standards (in the dimension of speed) is partly mediated by knowledge exchange and combination. We also find that the indirect effect (equal to 0.215, 95% CI = [0.152, 0.293]) of Model 3 (HL on TSP2 through KEC) is significant while the direct effect (equal to 0.107, 95% CI = [−0.012, 0.226]) of Model 3 (HL on TSP2) is no longer significant. These results suggest that the relationship between humble leadership and the innovation of technology standards (in the dimension of quality) is fully mediated by knowledge exchange and combination. Thus, Hypothesis 3 is partly supported (see Table 4).

We also tested the moderated effect of job complexity for humble leadership on innovation of technology standard in Table 4, which showed that the moderated effect of job complexity is non-significant (in Model 4) for humble leadership on the speed of innovation of technology standards, but it is significant ($p < 0.05$, in Model 5) for the humble leadership on the quality of innovation of technology standards (see Table 5).

We assume that the job complexity is not a linear moderated effect of the positive relationship between knowledge exchange and combination and the innovation of technology standards in Hypothesis 4. To identify this relationship, we divided job complexity into three groups on average as the moderator (based on the number of job complexities; finally, there are 102 questionnaires in the high job complexity group, 134 belong to middle job complexity group, and 118 in low job complexity group) and conduct regressions on knowledge exchange and combination and the speed of technology standard innovation, respectively. It can be seen from Table 6 that with job complexity at the middle level, knowledge exchange and combination has a significant positive effect on the speed of innovation of technology standard ($p < 0.001$, F-value = 18.376, β equals to 0.655). With job complexity at the low level, knowledge exchange and combination also has a significant positive effect on the speed of innovation of technology standards ($p < 0.001$, F-value = 4.973, β equals to 0.393). As for job complexity at the high level, knowledge exchange and combination also has a significant effect on the speed of innovation of technology standards ($p = 0.084 < 0.1$, F-value = 2.237, β equals to 0.172). Compared with the relationship of knowledge exchange and combination and the innovation of technology standards in Model 2 of Table 4, the β equals to 0.464 ($p < 0.001$), job complexity at the middle level makes the positive relationship stronger, and the degree of the role of low- and high-level job complexity is lower than at the middle level.

Table 4. Results from mediation analysis.

	Model 1			Model 2			Model 3		
	Dependent Variable: Knowledge Exchange and Combination			**Dependent Variable: The Speed of Technology Standard Innovation**			**Dependent Variable: The Quality of Technology Standard Innovation**		
	Beta	**SE**	***p* Value**	**Beta**	**SE**	***p* Value**	**Beta**	**SE**	***p* Value**
(constant)	0.654 ***	0.170	0.000	1.618 ***	.207	0.000	1.292 ***	0.185	0.000
K1	0.035	0.073	0.632	−0.098	0.087	0.262	−0.046	0.078	0.554
K2	0.081	0.077	0.291	−0.146	0.092	0.111	0.054	0.082	0.511
K3	0.119	0.074	0.108	−0.090	0.089	0.308	0.069	0.079	0.383
K4	0.016	0.026	0.528	−0.083 **	0.031	0.008	−0.002	0.028	0.940
HL	0.517 ***	0.050	0.000	0.174 *	0.068	0.011	0.107	0.061	0.079
KEC				0.464 ***	0.064	0.000	0.415 ***	0.057	0.000
R^2	0.251			0.239			0.215		
Adj. R^2	0.240			0.226			0.202		
Sig (F)	0.000			0.000			0.000		
Indirect effect (Model 2)				0.2400 CI (95%): (LLCI = 0.1674, ULCI = 0.3283)					
Direct effect (Model 2)				0.1738 CI (95%): (LLCI = 0.0402, ULCI = 0.3075)					
Indirect effect (Model 3)				0.2147 CI (95%): (LLCI = 0.1519, ULCI = 0.2927)					
Direct effect (Model 3)				0.1069 CI (95%): (LLCI = −0.0125, ULCI = 0.2263)					

Notes: K1 to K3 respectively represent three types of standard innovation activities: K1—creating completely new technology standards; K2—revising or perfecting existing technology standards; K3—benchmarking with other technology standards. K4 represent the level of standard innovation activities. SE—standard error. * indicates 10% significance level, ** indicates 5% significance level and *** indicates 1% significance level.

Table 5. Results for moderated effect between humble leadership (HL) and innovation of technology standards (TSP).

	Model 4 (Dependent Variable: The Speed of Technology Standard Innovation)			**Model 5 (Dependent Variable: The Quality of Technology Standard Innovation)**		
	Standardized Coefficients	t	Sig.	Standardized Coefficients	t	Sig.
	Beta			Beta		
K1	−0.043	−0.805	0.421	−0.010	−0.181	0.857
K2	−0.054	−1.029	0.304	0.065	1.223	0.222
K3	−0.019	−0.365	0.715	0.076	1.428	0.154
K4	−0.112 **	−2.222	0.027	0.012	0.229	0.819
HL	0.328 ***	6.474	0.000	0.287 ***	5.603	0.000
HL × JC	0.033	0.646	0.519	0.102 **	1.985	0.048

Notes: * indicates 10% significance level, ** indicates 5% significance level and *** indicates 1% significance level.

From Table 7, we can see that with job complexity at the middle level, knowledge exchange and combination has a significant positive effect on the quality of innovation of technology standards ($p < 0.001$, F-value = 44.041, β equals to 0.801), and with job complexity at the low level, knowledge exchange and combination also has a significant positive effect on the speed of innovation of technology standards ($p < 0.001$, F-value = 4.001, β equals to 0.379). As to job complexity at the high level, knowledge exchange and combination also does not have a significant positive effect on the speed of innovation of technology standards ($p = 0.193 > 0.05$, F-value = 0.587, β equals to 0.135). Compared with the relationship of knowledge exchange and combination and the innovation of technology standards in Model 3 of Table 4, the β equals to 0.415 ($p < 0.001$), job complexity at the middle level makes the positive relationship stronger, and the high-level job complexity makes the relationship become not significant. Therefore, Hypothesis 3 is supported by the above results.

Table 6. Results for moderated effect between knowledge exchange and combination (KEC) and TSP1.

Job Complexity		Standardized Coeff. Beta	Adjusted R^2	F
High	K1	−0.057	0.058	2.237
	K2	−0.155		
	K3	−0.011		
	K4	−0.251 **		
	KEC	0.172 *		
Mid	K1	0.021	0.395	18.376
	K2	−0.006		
	K3	−0.074		
	K4	−0.146 **		
	KEC	0.655 ***		
Low	K1	−0.118	0.145	4.973
	K2	−0.115		
	K3	−0.085		
	K4	0.013		
	KEC	0.393 ***		

Notes: * indicates 10% significance level, ** indicates 5% significance level and *** indicates 1% significance level.

Table 7. Results for moderated effect between KEC and TSP2.

Job Complexity		Standardized Coeff. Beta	Adjusted R^2	F
High	K1	0.018	−0.021	0.587
	K2	0.029		
	K3	0.099		
	K4	−0.041		
	KEC	0.135		
Mid	K1	−0.084	0.618	44.041
	K2	0.008		
	K3	−0.016		
	K4	−0.009		
	KEC	0.801 ***		
Low	K1	−0.073	0.114	4.001
	K2	0.028		
	K3	−0.014		
	K4	0.004		
	KEC	0.379 ***		

Notes: *** indicates 1% significance level.

5. Discussion and Conclusions

This study aimed to explore the mediation role of knowledge exchange and combination in the relationship between humble leadership and the innovation of technology standards, and, further, to examine how the outcomes of knowledge exchange and combination may be moderated by job complexity.

While technology standards have been widely used in innovation activities, understanding how humble leadership influences the innovation of technology standards is meaningful to managers and team leaders. Humility is an act that leaders can actively choose to develop [24]. Our findings imply that managers/leaders can promote knowledge sharing and exchange and cooperation among team members through acknowledging the merits and contributions of subordinates and learning modesty [28]. Furthermore, managers/leaders can also promote knowledge exchange and combination, encourage members from different organizations to exchange information for setting new technology standards, revising current technology standards, and benchmark technology standards in different systems. It should be noted that high job complexity may off-set this positive effect in the innovation for technology standards. It is important for managers/leaders to control the job complexity of each part of the tasks for technology standards innovation. In case of high complex jobs, team leaders should consider reducing job complexity, for example, by dividing the tasks of technology standards innovation into smaller parts.

It is often believed that humble leaders can also influence their employees' psychology, such as psychological safety and self-efficacy. For example, humble leaders can promote the establishment of trust relationships and form a mutual trust atmosphere [92] which enables employees to get psychological release and focus on innovation itself [93,94]. Or when challenging traditional ideas, humble leaders will also show their interest and desire to listen and be able to respond positively, which will help employees overcome anxiety and enable employees to speak out their own ideas [95,96]. Humble leaders make employees feel the recognition and support of their work by appreciating others and making a statement, so employees are less likely to have negative emotions (such as anxiety, worry and stress) [97]. The enthusiasm from humble leaders for employee psychology and willingness ultimately translates into employee actions to innovate. This will promote the exchange and combination of organizational knowledge, and ultimately achieve the purpose of the innovation of technology standards. Hence humble leadership influences innovation by influencing knowledge exchange and combination.

Previous studies have argued that job complexity could bring a positive effect to the innovation process [67,68]. Complex and difficult tasks result in higher intrinsic motivation; the more complex the tasks, the more motivated, satisfied, and productive employees feel [59–68]. The need for further information and knowledge for task complexity, however, may mean that more feedback is necessary between colleagues [98]. We argue that job complexity is not a simple linear moderation for the positive relationship between knowledge exchange and combination and the innovation of technology standards. Complex tasks generally require more interaction within the group, higher coordination, and interdependence [99]). Complex tasks can be characterized as being ambiguous, ill-structured and complicated, which means that group members need cooperation and coordination in order to carry them out successfully [66]. We find an "inverted-U" shape moderation of job complexity between knowledge exchange and combination and innovation of technology standard in the process of the innovation of technology standards. Meanwhile we also find that job complexity moderates the relationship between humble leaders and the quality of innovation of technology standards but does not moderated the relationship between humble leaders and the speed of innovation of technology standards.

This research is limited by the particular nature of our sample and the innovation of technology standard temporary teams with established innovation purposes. It can only identify an association but not a cause. It would be interesting to conduct an experiment in the future to identify a causal relationship. Furthermore, our findings are based on self-reported data from the members in different innovation activities of technology standards and the predictive powder of our model is limited by the validity of self-reported data. Moreover, this study only examined knowledge exchange and combination as a mechanism that links humble leadership and the innovation of technology standards based on knowledge-based theory. However, other relevant theories in innovation might be worth exploring in the future. Furthermore, the analysis is built in Chinese text and whether and to which extent that this research is applicable to the other counties remains unknown.

In this study, we attempted to categorize the technology standard innovation activities and analyze their impact by groups but the results were not significant. It was noticed that team members may also have different characteristics in each kind of innovation activity of technology standards in different industries. This elicits a different research question: Whether member characteristics and their industries are related to the innovation of technology standards, and how member characteristics and their industries influences team innovation of technology standards. It would be interesting in future research, for example, to conduct a comparable study with European countries [100] or to develop a model to find out how the balance of humble behaviors and other leadership styles influence the innovation of technology standards.

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Appendix A

Humble leadership

1. He/she actively seeks feedback, even if it is critical
2. Will he/she admit it when he/she doesn't know how to do something
3. He/she acknowledges this when the person has more knowledge or skills
4. He/she focuses on the other person's strengths
5. He/she will often compliment others on their good qualities
6. He/she appreciates someone's special contribution
7. He/she likes to learn from others
8. He/she is open to other people's ideas
9. He/she is open to suggestions from others

Knowledge exchange and combination

1. Members can foresee the benefits of exchanging and borrowing ideas from each other
2. Members felt that the exchange and borrowing of ideas could advance the creation of new standards faster than working alone
3. At the end of the day, members feel they have learned a lot from exchanging and borrowing ideas
4. In he process of technical standard innovation, members are good at using exchange and reference ideas to solve problems
5. embers are good at sharing expertise to make innovation of technical standards successful
6. In the process of technical standard innovation, members do not share their views (reverse scoring)
7. Members are happy to exchange and borrow ideas from their colleagues
8. Members rarely exchange and borrow ideas from each other to seek solutions to problems (reverse scoring)

Job complexity

1. Innovation of technology standard requires a lot of technical knowledge
2. Innovation of technology standard requires a lot of professional skills
3. It takes a long time to learn relevant skills in order to complete the work of innovation of technology standard

Innovation of technology standard

1. The participating units can issue new technology standards or compete with other standards in a relatively short time
2. The participating units can implement new technology standards in a relatively short time
3. The new technology standard developed will be implemented after a period of time
4. The new standards developed are of high quality
5. The new standards developed can penetrate the technical field

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