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Research on the Double-Edged Sword Effect of Online Telecommuting on Employee Innovation Performance

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Abstract

Under the trend of economic globalization, the scale of enterprise organizations has expanded, the business model has changed, and the transnational, cross-border and cross-regional work forms have emerged. 5G, artificial intelligence, big data, etc., can provide online telecommuting technical support for high-tech enterprises, and online telecommuting comes into being. Based on resource conservation theory and social cognitive theory, this paper aims to explore the mechanism of the influence of online telecommuting on employee innovation performance. A total of 529 valid samples were collected. The empirical results show that there is a double-edged sword effect between online telecommuting and employee innovation performance, in which job autonomy and tacit knowledge sharing play an intermediary role, and the developmental feedback of superiors plays a moderating role. Among them, job autonomy can significantly enhance the impact of online telecommuting and employee innovation performance; tacit knowledge sharing will weaken the influence between online telecommuting and employee innovation performance. The developmental feedback of superiors can enhance the promotion effect of job autonomy on employees' innovation performance, and at the same time, it can correct the negative impact of insufficient tacit knowledge sharing on innovation performance. The results enrich the research on the relationship between online remote work and employee innovation performance, and have some implications for the effective implementation of remote work in enterprises.

Keywords

Online Telecommuting, Employee Innovation Performance, Work Autonomy, Tacit Knowledge Sharing, Superior Developmental Feedback

1. Introduction

Under the trend of economic globalization, the scale of enterprise organizations has expanded, business models have changed, and cross-border, cross-border, and cross regional work forms have emerged. At the same time, in the era of digitalization, emerging technologies such as 5G and artificial intelligence have provided tremendous technical support for online remote work of high-tech enterprises, such as collaborative document editing, Tencent Meeting, Ding Talk and other online remote work software. Online remote work has emerged and gradually become a trend. Part of the intellectual work, such as design, short video, and online literature writers, is difficult to generate inspiration in traditional office forms and requires a free working environment. Online remote work environments make it easier to stimulate work autonomy and innovation. Highly qualified, disciplined, and goal oriented employees may be more valuable in the flexible mode of online remote work.

In the online remote work environment, it has brought dual impacts to both enterprises and individual employees, with opportunities and challenges coexisting. On the one hand, online remote work can stimulate employees' work autonomy. Employees can freely arrange their work methods, working hours, and workflow, and carry out their work in the most suitable and effective way. When employees are immersed in the working atmosphere, it is easy for them to explore and innovate. Remote work can reduce work pressure, minimize role conflicts, and increase autonomy, enhancing work autonomy (Sardeshmukh et al., 2012). Meanwhile, autonomy plays a positive mediating role between the degree of remote electronic work and job satisfaction, which can improve work efficiency (Bailey & Kurland, 2002). Remote work has a certain positive effect on productivity, organizational commitment, employee retention, and performance (Harker Martin & MacDonnell, 2012). All innovative ideas, positive actions taken, innovative activities implemented, and innovative effects produced by employees in the organization belong to the innovation process (Janssen & Van Yperen, 2004). The self-awareness of positive emotions and innovative efficacy can stimulate more potential and create higher innovation performance (Zhang et al., 2017).

Based on the theory of resource conservation, in the environment of online remote work, the sense of spatial isolation among employees reduces social interaction, lacks encouragement from colleagues and friends, and may even lead to the deterioration of interpersonal relationships. Under such social pressure, employees may experience a sense of crisis in resource consumption. In order to protect their own resources, employees may be unwilling to share their knowledge, methods, skills, and experience.

Knowledge sharing is usually divided into implicit knowledge sharing and explicit knowledge sharing, which refers to the exchange of knowledge, information, skills, etc. among members of an organization through different ways and channels (Lin, 2005). The difference between explicit knowledge sharing and implicit knowledge sharing lies in the formal and informal dissemination channels, as well

as the speed of dissemination (Bean, 1958). A smooth communication atmosphere promotes knowledge sharing among employees (van den Hooff & De Ridder, 2004). Allocation fairness and procedural fairness are ways to predict employee organizational commitment, which can to some extent promote implicit knowledge sharing behavior among employees (Lin & Lee, 2004). When the implicit knowledge sharing willingness of employees decreases, on the one hand, it reduces the opportunities for experience sharing, thinking collision, and other mutual learning and communication among employees, which may lead to duplication of work, waste of time and energy, and hinder the generation of innovative performance among employees.

When employees receive developmental feedback from both their superiors and colleagues, their job performance significantly improves (Li et al., 2011). Developmental feedback from superiors can help enhance employees' confidence in innovation, increase their sense of innovation effectiveness, promote job satisfaction and performance (Guo & Liao, 2014) and thus promote innovative behavior (Deng & Wang 2018). It can also stimulate employees' investment in innovation and improve their innovative behavior (Cao et al., 2018).

Based on social cognitive theory, in the process of remote work, when superiors provide beneficial guidance to employees' work, offer constructive suggestions, respect and support their work, they will stimulate internal motivation, promote employees' independent innovation, and ultimately improve performance. Based on the theory of resource conservation, when external resources supplement their own resources, employees will reduce stress. The implicit knowledge shared by superiors, such as experiences and methods, can also promote tacit knowledge sharing among teams, thereby compensating for tacit knowledge sharing and reducing the negative impact of insufficient tacit knowledge sharing on innovation performance.

Based on the above analysis, this study investigates the double-edged sword effect between online remote work and employee innovation performance, with job autonomy and tacit knowledge sharing as mediating variables and developmental feedback from superiors as moderating variables. The research conclusion obtained through empirical analysis can correctly view online remote work, seek benefits and avoid harm, and propose feasible management strategies and suggestions for employee innovation performance.

2. Theoretical Basis and Research Hypotheses

2.1. Online Telecommuting and Employee Innovation Performance

Nilles (1994) first proposed the concept of "remote work", which is an early form of virtual work defined as employees working outside of traditional workplaces through electronic information or computer communication technology (Nilles, 1994). Golden et al. (2008) further defined the content of remote work, which involves employees moving away from traditional office areas and using information

tools such as email, phone, and online databases for work communication, work design, and collaborative editing (Golden et al., 2008). Effective remote work requires compatibility between job nature, technology, and job roles; the mutual support between corporate culture and remote work; compatibility of family relationships, available physical space, and related work facilities; the compatibility between remote work mode and personal attitudes, values, norms, qualities, and needs. A flexible office space allows companies to truly identify employees with strong work abilities, high self-restraint, and strong initiative, and this remote work model is also highly favored by these employees (Baruch & Nicholson, 1997; Mahlon Apgar, 1998).

Innovation performance refers to employees facing difficulties or troubles in the work process with a positive attitude and attempting to adopt new ideas or methods to solve problems (Amabile, 1993). At the same time, all innovative ideas, positive actions taken, innovative activities implemented, and innovative effects produced by employees within the organization belong to the innovation process (Janssen & Yperen, 2004). Innovation performance is also a proactive behavior of knowledge sharing, which not only helps employees continuously acquire new knowledge, but also enhances their personal core competitiveness on this basis (Han et al., 2011). The self-awareness of positive emotions and innovative efficacy can also stimulate more potential and create higher innovation performance (Zhang et al., 2017).

Remote work gives employees more autonomy in time and space, so that employees can flexibly adjust the work order, work content, work process, etc., according to their own working state, which is conducive to stimulating creativity and exploration spirit in a free environment (Hoeven & Zoonen, 2015). At the same time, under the remote working mode, employees will focus more on the value and significance of the work itself, while ignoring the external constraints such as employee relations, which is conducive to stimulating internal motivation and enthusiasm for innovation. Telecommuting reduces commuting time and reduces office interference, and employees can focus more on deep thinking and knowledge accumulation without being superficial, laying the foundation of knowledge and ability for innovation. In telecommuting mode, using virtual reality, augmented reality and other technologies to build an immersive virtual collaboration platform can not only promote the interaction and collaboration between remote team members, but also inspire creative inspiration. Under the telecommuting mode, the organization's emotional, information and material support will encourage employees to work positive behavior, and then stimulate innovative behavior (Xiao, 2019). The creativity of telecommuting employees depends on the resources provided by managers and organizations (Smale, 2016), the organization's fault-tolerant atmosphere (Isaksen, 2023), organizational support (Zhan & Li, 2020), superior and subordinate relationship, leadership style and other (Zhu et al., 2021).

However, the telecommuting environment also poses challenges for the collabo-

rative work between employees. In telecommuting mode, face-to-face communication between employees is reduced, mainly through online tools. This mode of communication may lead to incomplete and inefficient information transmission, especially the sharing of tacit knowledge. Implicit knowledge is often difficult to express accurately through words and relies more on face-to-face interaction, observation, and imitation. Telecommuting reduces opportunities for face-to-face communication and interaction, leading to a reduced of tacit knowledge sharing (Golden et al., 2008). This kind of long-term face-to-face interaction among employees is easy to lead to social isolation and occupational isolation among employees, workplace indifference and workplace tension, which is not conducive to the generation of employees' innovation performance (Wang & Zhao, 2011).

2.2. The Positive Mediating Effect of Work Autonomy on the Relationship between Online Remote Work and Employee Innovation Performance

Work autonomy refers to the degree to which employees have the freedom to arrange work processes, choose work methods and working hours, and access relevant resources (Hackman & Oldham, 1975). It not only reflects the flexibility and degree of freedom in completing work, but also reflects the expectations and degree of employee autonomy in decision-making. The higher the flexibility of an individual in terms of workplace and work environment, the higher their work autonomy (Hoeven & Zoonen, 2015). In a remote work environment, employees can choose a location that better meets their work requirements, independently arrange work time and methods, and improve work efficiency while completing corresponding work tasks (Wang & Xiao, 2022). Remote work can reduce work pressure, minimize role conflicts, and increase autonomy, thereby enhancing work autonomy (Mahlon Apgar, 1998).

Compared with the traditional office office, let employees in the same physical environment, to coordinate the commuting time, and want to deal with the relationship with superiors, colleagues, the most important thing is to do the job, which makes personal energy is scattered, let employees cannot focus on office, and produce a kind of oneself in the passive office.

Based on social cognitive theory, online telecommuting enables employees to decide the time, place, order and method to complete work tasks, with: freedom of time and space, freedom of office form, freedom of office process and freedom between office and rest. These discretionary time allocation enhances the positive psychological resources of employees, which can not only devote employees to the office, but also enable employees to have a certain right to decide, optimize working procedures, enhance their office efficiency, and then promote the generation of employees' innovative performance.

The quality of the working environment also has an impact on the innovation performance of employees. The adverse working environment will reduce job satisfaction and thus affect the willingness to innovate (Lee et al., 2011). A good team learning atmosphere can promote the generation of innovative performance among

employees, and positive emotions are the mediating variable (Zhang & Yan, 2020). At the same time, the diversity of team members, team openness, and team cohesion included in the team play a promoting role in innovation performance (Shin & Zhou, 2003). Work autonomy is not only the feedback of employees to obtain the support of the enterprise, but also the performance of employees' recognition and sense of belonging to their work and the enterprise. Work autonomy can increase employees' job satisfaction and organizational commitment. The higher their work autonomy, the more they love the organization and the more responsible they can be for the work (Ahuja et al., 2007). Work autonomy can increase the active behavior and behavior behavior of employees. The more autonomy employees work, the more they want the enterprise to develop better. They will not only put forward more developmental suggestions, but also make independent efforts for the development of the enterprise, such as active overtime (Grant & Ashford, 2008). Du et al. conducted a data survey on innovative enterprises in Anhui Province, and concluded that work autonomy will reduce the silent behavior of employees, enhance work autonomy, employees will become more responsible, more actively for the enterprise risk, reduce the silent behavior of employees (Du et al., 2014). Other scholars have found that work autonomy can enhance employees' innovation performance from the aspects of work motivation and learning goal orientation (Joo et al., 2011; Wang & Zhao, 2011).

Based on this, the following assumptions are proposed:

H1a: Online remote work positively affects work autonomy.

H1b: Work autonomy positively affects employee innovation performance.

H1c: Work autonomy plays a positive mediating role between online remote work and employee innovation performance.

2.3. The Negative Mediating Effect of Tacit Knowledge Sharing on the Relationship between Online Remote Work and Employee Innovation Performance

Knowledge sharing is usually divided into implicit knowledge sharing and explicit knowledge sharing, which refers to the exchange of knowledge, information, skills, etc. among members of an organization through different ways and channels (Lin, 2005).

The tacit knowledge is replicable and difficult to imitate, which is one of the key points of enterprise development. The vision, mission and working atmosphere of the organization are in the form of tacit knowledge, and the sharing of tacit knowledge among organizations is encouraged (Smith, 2001). Employees who are willing and enthusiastic to share their accumulated tacit knowledge, information, skills and experience with others are more innovative (Lu & Liang, 2009). The owner of tacit knowledge to share after their own knowledge and affirmation and recognition on the one hand, increased his reputation, and motivate its self-efficiency, motivate the innovation, on the other hand, the tacit knowledge to accelerate the flow of knowledge, in the process of knowledge integration absorption can stimulate the whole innovative thinking, and improve

organizational performance (Wang et al., 2014). At the same time, employees' willingness to share knowledge is enhanced, and the continuous improvement of knowledge in the sharing can greatly promote the innovation performance of employees (Peng et al., 2020). Team tacit knowledge sharing will promote the team innovation mission, and thus enhance the team innovation performance (Yao & Zhang, 2021).

A smooth communication atmosphere promotes knowledge sharing among employees (van den Hooff & De Ridder, 2004). Allocation fairness and procedural fairness are ways to predict employee organizational commitment, which can to some extent promote implicit knowledge sharing behavior among employees (Lin & Lee, 2004). The communication atmosphere, trust atmosphere, and fairness atmosphere not only significantly affect employees' implicit knowledge sharing behavior, but also affect their innovation performance (Wang et al., 2014). Based on the relationship strength theory in social network theory, individual characteristics such as motivation and ability for knowledge sharing can also affect implicit knowledge sharing (He et al., 2013).

In the online telecommuting mode, the difficulty of tacit knowledge sharing will weaken the relationship between online telecommuting and innovation performance. The tacit knowledge itself is replicable and difficult to imitate, and cannot be expressed in simple words and words, which is the result of human nonverbal intellectual activities. For example, the unique operation skills and intuitive judgment of the market understood by the employees in the long-term work practice are difficult to convey to the telecommuting colleagues in clear language, which leads to the difficulty in sharing tacit knowledge and limits the generation and communication of innovative ideas. Online telecommuting allows employees to work independently most of their time, without other colleagues around. It is impossible to discuss the spread of tacit knowledge from non-language clues such as body language and face expression of face-to-face communication just like traditional office work. For example, when discussing the plan, on-site communication can perceive the other person's attitude and potential ideas by observing their expressions and actions, while telecommuting is easy to cause communication misunderstanding, which makes it difficult to share hidden knowledge accurately and accurately.

There are also many factors affecting the communication of online meetings, such as information loss, low efficiency, spatial and temporal differences, instant messaging tools and other (Golden, 2007), which affect the quality of online information communication and weaken knowledge sharing to a certain extent. Long-term telecommuting and lack of face-to-face communication with colleagues may evolve into social isolation and occupational isolation, and there may be of adverse phenomena such as jealousy among colleagues (Morganson et al., 2010). Telecommuting reduces the contact and affinity between team members, makes it difficult to participate in informal social activities and team building, and reduces the sense of team belonging, which makes it difficult to build trust and

rapport. According to the resource preservation theory, in the environment of online telecommuting, the sense of spatial isolation between employees reduces social interaction, has concerns about each other's ability and work attitude, and has doubts and distrust of shared tacit knowledge. Under this social pressure, employees develop a sense of crisis of resource consumption. In order to protect their own resources, employees may not be willing to share their knowledge, methods, skills and experience. Compared than explicit knowledge sharing.

When employees "implicit willingness to share knowledge is reduced, on the one hand, experience sharing, thinking collision and other opportunities for mutual learning and communication are reduced, which may lead to duplication of work among employees, waste of time and energy, and hinder the production of employees" innovation performance. On the other hand, the reduction of tacit knowledge sharing will reduce the degree of cooperation among employees and the cohesion of the team. In order to complete work tasks quickly, employees will reduce the quality of work, and even the innovative performance of employees.

Therefore, the following hypothesis is proposed:

H2a: Negative impact of online remote work on tacit knowledge sharing.

H2b: The positive impact of tacit knowledge sharing on employee innovation performance.

H2c: Implicit knowledge sharing plays a negative mediating role between online remote work and employee innovation performance.

2.4. The Moderating Effect of Developmental Feedback from Superiors on the Relationship between Online Remote Work and Employee Innovation Performance

Zhou (2003) first proposed developmental feedback from superiors, defining it as a valuable and effective way for superiors to provide feedback to subordinates to help them learn, develop, and improve performance (Zhou, 2003). It has three characteristics: firstly, the information source of developmental feedback comes from its immediate supervisor; secondly, the information provided is beneficial, effective, and valuable, which is helpful for the growth of employees; the third is a feedback method that focuses only on describing subordinates' work, performance, and guiding future development suggestions, rather than mandatory requirements for subordinates to complete a specific goal or task.

The pro social motivation of superiors and the trust of superiors both promote the generation of developmental feedback from superiors (Yan & Hao, 2020; Liu & Liu, 2020). From the perspective of interaction between superiors and subordinates, the self-esteem of subordinate organizations and the fit between individuals and organizations play a positive promoting role in the relationship between superiors' developmental feedback and knowledge sharing (Su & Lin, 2020).

The ultimate goal of providing developmental feedback to subordinates by superiors is to improve employee performance. When new employees receive de-

velopmental feedback from both their superiors and colleagues, their job performance significantly improves (Li et al., 2011). Developmental feedback from superiors can help enhance employees' confidence in innovation, increase their sense of innovation efficacy, promote job satisfaction and performance11, and thus promote innovative behavior (Deng & Wang, 2018). It can also stimulate employees' investment in innovation and improve their innovative behavior (Cao et al., 2018).

The online remote work environment enhances employees' work autonomy and to some extent promotes their innovative performance. However, the isolation of physical space reduces the implicit knowledge sharing behaviors such as observation, imitation, and information feedback among employees, and lowers the generation of innovation performance. Developmental feedback from superiors is beneficial guidance for employees' work, constructive suggestions, and respect and support for their work. Based on social cognitive theory, when employees recognize that external factors are also actively promoting their work, they are more likely to stimulate internal motivation, promote independent innovation, and ultimately improve performance. Based on the theory of resource conservation, when external resources supplement their own resources, employees will reduce stress. The implicit knowledge shared by superiors, such as experiences and methods, can also promote tacit knowledge sharing among teams, thereby compensating for tacit knowledge sharing and reducing the negative impact of insufficient tacit knowledge sharing on innovation performance. Therefore, the following hypothesis is proposed:

H3a: Developmental feedback from superiors can enhance work autonomy and promote employee innovation performance.

H3b: Developmental feedback from superiors can correct the negative impact of insufficient tacit knowledge sharing on innovation performance.

2.5. Model Construction

This article is based on social cognitive theory and resource conservation theory, with work autonomy and tacit knowledge sharing as mediating variables, and superior developmental feedback as moderating variables, to construct a model as shown in **Figure 1**.

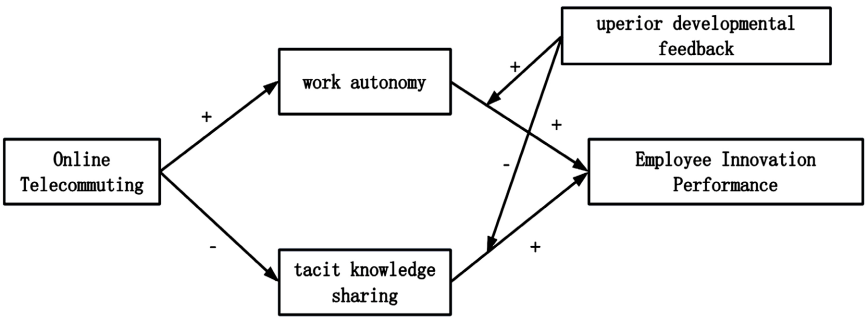

Figure 1. Theoretical model diagram.

3. Research Design

3.1. Data Collection and Research Samples

This questionnaire survey was conducted in high-tech enterprises in Shanghai, Jiangsu, Zhejiang, Guangdong, Shaanxi and other places with the help of internship and research group resources. It specifically covers information technology, biomedicine, intelligent manufacturing and other high-tech industries, as well as research and development, production, sales and other departments. Two rounds of questionnaires were collected with an interval of one month. Before conducting the formal survey, the questionnaire matching method and filling details were explained in detail to the leaders and employees of the participants, and it was emphasized that this survey is only for academic research and will be applied to management practice in the future, without any impact on the participants. When collecting data, attention should be paid to the accuracy of the data, reducing the bias of survey results caused by information such as age, gender, and functional type of the surveyed objects. During the survey, efforts should be made to balance various age groups and functions as much as possible to maintain the accuracy of the data.

A total of 560 questionnaires were distributed for this survey on online remote work. 31 unqualified questionnaires were removed, and 529 valid questionnaires were collected, with an effective rate of 94.29%.

According to the sample statistical data, in terms of gender, males account for 51.1% and females account for 49.8%, with a relatively balanced proportion. In terms of age, the age group of 26 - 35 years old has the highest proportion, followed by 36 - 45 years old and 46 - 55 years old, and the age groups under 25 and over 56 years old have the lowest proportion. Among the educational backgrounds, undergraduate students account for the highest proportion, followed by master's and doctoral students, while junior college and high school and below account for the lowest proportion. In the current working hours of enterprises, the proportion of 1 - 3 years and less than 1 year is the highest, followed by 4 - 6 years, and the lowest is 7 - 9 years and 10 years or more. In terms of job levels, the distribution is relatively balanced, but the middle level accounts for a relatively large proportion. In terms of job types, functional categories account for the largest proportion, followed by professional and technical categories and marketing categories, while production and other categories have the lowest proportion. Working time with immediate superiors. Concentrated in less than 1 year, followed by 1 - 3 years and 4 - 6 years, and the least in 7 years and above. It can be seen that age, education level, current working hours in the company, job level, job type, and working time with immediate superiors all play a controlling role in online remote work. As shown in Table 1.

After analyzing demographic variables, further descriptive statistical analysis is conducted. Use SPSS 26.0 statistical analysis software to obtain the maximum and minimum values, mean, and standard deviation of five variables. The results are shown in Table 2.

Table 1. Descriptive statistical analysis.

Demographic variables		Number of people	Proportion (%)
Gender	male	271	51.1
	female	258	49.8
Age	Under 25 years old	66	12.5
	26 - 35 years old	183	34.6
	36 - 45 years old	137	25.9
	46 - 55 years old	108	20.4
	56 years old and above	35	6.6
education	High school and below	27	5.1
	junior college	58	11
	undergraduate	246	46.5
	Master's students	131	24.8
	PhD or above	67	12.7
Current working hours of the enterprise	Less than 1 year	154	29.1
	1 - 3 years	168	31.8
	4 - 6 years	142	26.8
	7 - 9 years	31	5.9
	10 years or more	34	6.4
Position level	the basic level	191	36.1
	middle level	226	42.7
	high-level	112	21.2
Job type	Functional category	182	34.4
	Professional technical category	147	27.8
	Market category	111	21
	Production category	33	6.2
	other	56	10.6
Working time with immediate superiors	Less than 1 year	255	48.2
	1 - 3 years	135	25.5
	4 - 6 years	126	23.8
	7 years or more	13	2.5

Table 2. Basic values of variables.

variable	Sample size (N)	Maximum value	minimum value	mean value	standard deviation	variance
Online remote work	529	5	2.50	4.4223	0.66609	0.444
Employee innovation performance	529	5	2.88	4.0123	0.51593	0.266
Work autonomy	529	5	2.14	3.9022	0.69298	0.480
Implicit knowledge sharing	529	5	1.67	3.3081	0.60389	0.365
Superior developmental feedback	529	5	1.33	2.7171	0.74280	0.552

3.2. Variable Measurement

This study selected mature scales from both domestic and international sources, ensured the accuracy of the content through a "translation back translation" process, and then combined with the Chinese management context to select the appropriate word order; invite one professor and two associate professors to adjust the scale after completion; choose another team from the company, invite them to fill out the questionnaire, answer their questions, and modify and improve the questionnaire items. In this study, all scales were scored using Likert 5-point scoring, with statements ranging from "strongly disagree" to "strongly agree".

Online remote work adopts the processing method of Golden et al. (2008), which calculates the time employees spend working remotely or away from the office each week. Simultaneously using the ratio of remote work time to work week time to validate this index.

The employee innovation performance refers to the views of Zhou (2003), Wang and Zhu (2008) and combines with the actual situation of Chinese enterprises, with a total of 8 items.

The work autonomy is measured using the scale developed by Kirmeyer & Shirom (1986), which has been adjusted to a total of 7 items.

Implicit knowledge sharing adopts the scale developed by Tang, Ai, and Gong (2011), which translates the scale developed by Bock et al. (2005) into Chinese and includes three questions.

The developmental feedback from superiors is based on the three item scale developed by Zhou (2003). This article draws on the method of Yin and Zheng (2011) to transform the reverse scoring into positive scoring.

Control variables: According to the existing studies on online telecommuting and employee innovation performance, gender, age, educational background, current working hours, working level, working years and working term are taken as control variables. Basic demographic characteristics such as gender, age and education background may influence their working style, innovation motivation and ability. The current working time, position level and type of work reflect the working background and responsibilities of employees in the organization, which may affect their innovation opportunities and resource acquisition ability. The time working with immediate superiors reflects the quality of the relationship between employees and may affect the extent to which they receive feedback and support.

4. Data Analysis and Results

4.1. Common Method Deviation Test

To reduce the impact of homology bias on sample data, Harman single factor test was used in this study. Factor analysis was conducted on 23 items, and a total of five principal component factors were identified with eigenvalues greater than 1. The variance explanation rate of the first factor that has not been rotated is 34.156% (lower than the set judgment standard of 40%), indicating that the impact

of common method bias on this study is relatively small and further research can be conducted.

4.2. Questionnaire Reliability Analysis

This article uses SPSS 26.0 data analysis software to conduct reliability analysis on five variables, and the analysis results are shown in Table 3.

Table 3. Reliability analysis of questionnaire.

Gauge	Number of measurement questions	Internal consistency coefficient
Online remote work	2	0.945
Employee innovation performance	8	0.808
Work autonomy	7	0.903
Implicit knowledge sharing	3	0.747
Superior developmental feedback	3	0.730

4.3. Questionnaire Validity Analysis

After conducting reliability analysis of the questionnaire, the validity of the questionnaire needs to be verified. Only after the reliability and validity of the questionnaire have been tested can the next step of research be carried out. This article will use SPSS 26.0 data analysis software for exploratory factor analysis, and then use AMOS 25.0 for confirmatory factor analysis, presenting the test results of each variable in tabular form.

1) Exploratory Factor Analysis of Questionnaire

According to Table 4, the KMO value of the independent variable online remote work is 0.5, indicating a moderate effect. After principal component analysis, one principal component was extracted, and the cumulative explanatory power was 94.848%, which is an acceptable level. The loadings of all factors are greater than 0.5, indicating that the validity of the scale results is good.

Table 4. Exploratory factor analysis of online remote work.

Factor name	Question items	Component	Cumulative variance contribution rate (%)	KMO value	Bartlett Card	Sig.
Online remote work	1	0.974	94.848	0.5	857.785	0.000
	2	0.974				
Employee innovation performance	1	0.872	66.102	0.924	2934.365	0.000
	2	0.842				
	3	0.858				
	4	0.825				
	5	0.848				
	6	0.788				
	7	0.739				
	8	0.718				

Continued

Work autonomy	1	0.697	63.415	0.863	2367.383	0.000
	2	0.733				
	3	0.743				
	4	0.849				
	5	0.876				
	6	0.818				
	7	0.840				
Implicit knowledge sharing	1	0.934	83.448	0.705	1136.805	0.000
	2	0.945				
	3	0.859				
Superior developmental feedback	1	0.943	85.654	0.707	1314.430	0.000
	2	0.956				
	3	0.876				

The KMO value of the dependent variable Employee Innovation Performance Scale is 0.924, indicating good performance. After principal component analysis, one principal component was extracted, and the cumulative explanatory power was 66.102%, which is an acceptable level. The loadings of each factor are greater than 0.5, indicating good validity of the scale results.

The KMO value of the mediator variable work autonomy scale is 0.819, indicating good performance. After principal component analysis, one principal component was extracted, and the cumulative explanatory power was 60.890%, which is an acceptable level. The loadings of each factor are greater than 0.5, indicating good validity of the scale results.

The KMO value of the mediator variable implicit knowledge sharing scale is 0.705, which meets the standard. After principal component analysis, one principal component was extracted, and the cumulative explanatory power was 83.448%. This result is an acceptable level, and the factor loadings are all greater than 0.5, indicating good validity of the scale results.

The KMO value of the upper level developmental feedback scale for adjusting variables is 0.707, indicating good performance. After principal component analysis, one principal component was extracted, and the cumulative explanatory power was 85.654%, which is an acceptable level. The loadings of each factor are greater than 0.5, indicating good validity of the scale results.

2) Confirmatory Factor Analysis of Questionnaire

Based on the above analysis, all five scales have passed exploratory factor analysis, indicating the feasibility of scale dimension division. Next, use AMOS25.0 software for confirmatory factor analysis of the scale.

Before conducting confirmatory factor analysis on the scale, it is necessary to clarify the criteria for determining the values of each indicator of the confirmatory factors. The standard values are shown in Table 5.

Table 5. Standard values of confirmatory factor analysis indicators.

index	χ^2/df	CFI	NFI	RFI	TLI	RMR	RMSEA
Model estimation value	Less than 3 good Less than 5 generally	Greater than 0.9	Greater than 0.9	Greater than 0.9	Greater than 0.9	Less than 0.05 Or less than 0.1	Less than 0.05 is good Less than 0.08 generally

In order to better test the effectiveness of the overall model, all variables are included in the unified model structure and confirmatory factor analysis is carried out. The conclusions are shown in Table 6. The results showed that the fitted values of all items were within a fixed range, indicating a good overall fit of the scale.

Table 6. Confirmatory factor analysis of the overall scale.

index	χ^2/df	CFI	NFI	RFI	TLI	RMR	RMSEA
Model estimation value	4.488	0.921	0.902	0.991	0.906	0.047	0.037

4.4. Relevant Analysis

Perform Pearson correlation coefficient using SPSS 26.0 to detect linear correlation between two variables, and determine the direction of correlation between variables based on the positive or negative nature of the coefficient.

Through data analysis, Table 7 was obtained, and it was found that online remote work was significantly positively correlated with work autonomy (r = 0.313, $p < 0.01$) and significantly negatively correlated with tacit knowledge sharing (r = −0.178, $p < 0.01$); there is a significant positive correlation between job autonomy and employee innovation performance (0.485, $p < 0.01$); there is a significant positive correlation between tacit knowledge sharing and employee innovation performance (r = 0.223, $p < 0.01$). This basically indicates that the correlation between variables is consistent with the content of the research hypothesis, laying the foundation for the next step of regression analysis and model validation.

Table 7. Pearson correlation coefficient of variables.

Pearson	1	2	3	4	5
Online remote work	1.000				
Employee innovation performance	0.555**	1.000			
Work autonomy	0.313**	0.485**	1.000		
Implicit knowledge sharing	−0.178**	0.223**	−0.087*	1.000	
Superior developmental feedback	0.039	0.083	0.175**	0.019	1.000
average value	4.421	0.988	1.113	2.025	2.149
standard deviation	0.665	0.165	0.195	0.551	0.625

Note: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

4.5. Regression Analysis

4.5.1. Mediating Effect Test of Work Autonomy

In order to effectively test the mediating effect of work autonomy between online remote work and employee innovation performance, this study conducted Bootstrap validation using the Process 4.1 program. According to the requirements of Process 4.1 program, first, place the corresponding variables in the designated location; secondly, select the specified parameters; finally, export the corresponding results. The results are shown in Table 8: After controlling for the control variables, in M1, online remote work significantly positively affects employee innovation performance (β = 0.371, $p < 0.001$), and in M2, online remote work significantly positively affects work autonomy (β = 0.669, $p < 0.001$), indicating that hypothesis H1a holds true; in M3, job autonomy significantly positively affects employee innovation performance (β = 0.092, $p < 0.001$), indicating that hypothesis H1b holds true; meanwhile, the mediation effect value obtained by Bootstrap test is shown in Table 9, and the mediation effect value of work autonomy is 0.061, and the 95% confidence interval is [0.040, 0.086], and the interval does not include 0. Therefore, hypothesis H1c holds, that is, work autonomy plays a positive mediating role between online remote work and employee innovation performance.

Table 8. Mediating effect test of work autonomy.

variable	Employee innovation performance	Work autonomy	Employee innovation performance
	M1	M2	M3
control variable			
Gender	−0.038**	−0.013	−0.037**
Age	0.011	0.003	0.011
education	−0.020**	−0.005	−0.020**
Current working hours of the enterprise	0.004	0.128***	−0.008
Position level	0.004	0.007	0.003
Job type	−0.016**	−0.028	−0.013**
Working time with immediate superiors	0.028**	0.073*	0.022**
independent variable			
Online remote work	0.371***	0.669***	0.310***
Intermediary variable			
Work autonomy			0.092***
R side	0.369	0.177	0.456
F	37.989	14.019	48.314

Note: N = 529, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

Table 9. Bootstrap test for job autonomy.

	Bootstrap analysis results		95% confidence interval		Proportion of effect quantity
	Effect coefficient	standard deviation	lower limit	upper limit	
Total effect	0.371	0.058	0.272	0.501	
Direct effect	0.310	0.056	0.217	0.435	83.46%
Indirect effects	0.061	0.012	0.040	0.086	16.54%

4.5.2. Mediating Effect Test of Implicit Knowledge Sharing

The Bootstrap method was also used to verify the negative mediating effect of tacit knowledge sharing between online remote work and employee innovation performance using the Process 4.1 program. Referring to the mediation effect test framework, the specific test results are shown in Table 10: after controlling for the control variables, in M4, online remote work significantly negatively affects employee innovation performance ($\beta = -0.252$, $p < 0.001$); in M5, online remote work significantly had a negative impact on tacit knowledge sharing ($\beta = -0.555$, $p < 0.001$), indicating the validity of hypothesis H2a; in M6, implicit knowledge sharing significantly positively affects employee innovation performance ($\beta = 0.207$, $p < 0.001$), indicating the validity of hypothesis H2b; at the same time, the effect value through the Bootstrap test is shown in Table 11, and the mediation effect value of implicit knowledge sharing is 0.149, with a 95% confidence interval of [0.194, 0.206], whose interval does not contain 0. Therefore, hypothesis H2c holds, that is, implicit knowledge sharing plays a negative mediating role between online remote work and employee innovation performance.

Table 10. Mediating effect test of implicit knowledge sharing.

variable	Employee innovation performance	Implicit knowledge sharing	Employee innovation performance
	M4	M5	M6
control variable			
Gender	−0.127*	−0.009	−0.124*
Age	−0.047	−0.079*	−0.026
education	−0.015	0.006	−0.017
Current working hours of the enterprise	−0.019	0.021	−0.025
Position level	0.023	0.045	0.011
Job type	0.008	−0.007	0.010
Working time with immediate superiors	0.094*	0.001	0.094**
independent variable			
Remote work	−0.252***	−0.555***	−0.104***
Intermediary variable			

Continued

Implicit knowledge sharing			0.207***
R side	0.215	0.391	0.312
F	17.831	41.640	26.178

Note: N = 529, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

Table 11. Bootstrap test for implicit knowledge sharing.

	Bootstrap analysis results		95% confidence interval		Proportion of effect quantity
	Effect coefficient	standard deviation	lower limit	upper limit	
Total effect	0.252	0.024	0.207	0.302	
Direct effect	0.104	0.027	0.052	0.157	40.87%
Indirect effects	0.149	0.022	0.194	0.206	59.13%

4.5.3. Adjustment Effect Test of Superior Developmental Feedback

1) The positive moderating effect of superior development on implicit knowledge sharing and employee innovation performance

This study used Bootstrap method to verify the positive moderating effect of superior developmental feedback on the relationship between job autonomy and employee innovation performance. Using the Process 4.1 program, place the corresponding variables in the corresponding positions according to the relevant requirements and set the parameters. After judgment, the adjustment model in this article is consistent with Model 14 in the Process 4.1 program, so Model 14 is selected for verification. The verification results are shown in **Table 12**: The interaction term between job autonomy and developmental feedback from superiors significantly positively affects employee innovation performance ($\beta = 0.3857$, $p < 0.001$). At the same time, a simple slope analysis was conducted on the moderating effect, which was divided into "high-level developmental feedback" and "low-level developmental feedback", as shown in **Figure 2**. The positive impact of high-level developmental feedback on work autonomy and employee innovation performance was enhanced. Under low-level developmental feedback, its positive impact on work autonomy and employee innovation performance was improved. Under high-level developmental feedback, the positive impact of work autonomy on employee innovation performance was stronger.

Table 12. Moderation effect test of superior developmental feedback.

variable	Employee innovation performance				
	β	se	t	BootLLCI	BootULCI
control variable					
Gender	−0.1616*	0.0658	−2.4554	−0.2909	−0.0323
Age	−0.0517	0.031	−1.6657	−0.1126	0.0093
education	−0.0343	0.0331	−1.0388	−0.0993	0.0306

Continued

Current working hours of the enterprise	−0.0567	0.0341	−1.6639	−0.1237	0.0103
Position level	−0.0043	0.0443	−0.0972	−0.0913	0.0827
Job type	0.0225	0.0265	0.8496	−0.0296	0.0746
Working time with immediate superiors	0.0849*	0.0421	2.0152	0.0021	0.1677
independent variable					
Online remote work	−0.1951***	0.0276	−7.0725	−0.2493	−0.1409
Intermediary variable					
Work autonomy	−0.4336***	0.1972	−2.1989	−0.8209	−0.0462
Adjusting variables					
Superior developmental feedback	−1.3582***	0.2908	−4.6713	−1.9295	−0.787
Interactive items					
Work autonomy x feedback from superiors for development	0.3857***	0.0739	5.2196	0.2405	0.5309
R side			0.0346		
F			27.2441		

Note: N = 529, $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$.

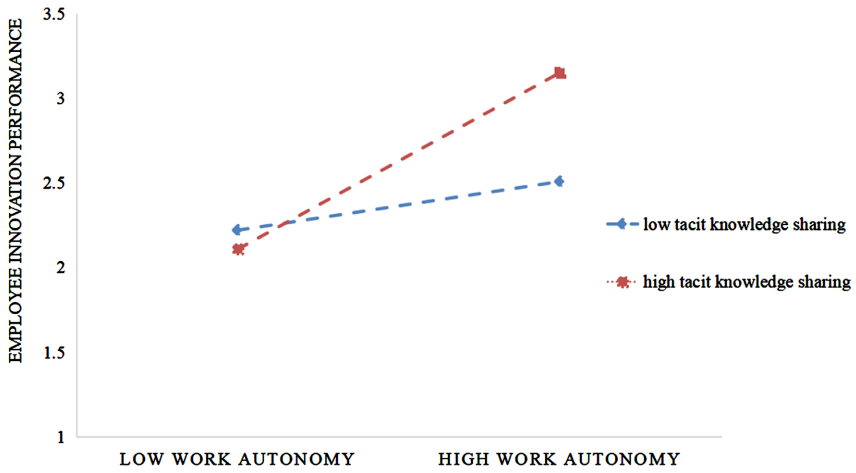

Figure 2. The moderating effect of superior developmental feedback on work autonomy and employee innovation performance.

2) The negative moderating effect of superior development on implicit knowledge sharing and employee innovation performance

This study used Bootstrap method to verify the negative moderating effect of developmental feedback from superiors on the relationship between tacit knowledge sharing and employee innovation performance. Using the Process 4.1 program, place the corresponding variables in the corresponding positions according to the

relevant requirements and set the parameters. After judgment, the adjustment model in this article is consistent with Model 14 in the Process 4.1 program, so Model 14 is selected for verification. The verification results are shown in Table 13: The interaction term between tacit knowledge sharing and developmental feedback from superiors significantly negatively affects employee innovation performance (β = −0.0865, $p < 0.001$). At the same time, a simple slope analysis was conducted on the moderating effect, which was divided into "high-level developmental feedback" and "low-level developmental feedback", as shown in Figure 3: the high-level developmental feedback had a corrective effect on the negative impact of tacit knowledge sharing and employee innovation performance. Under high-level developmental feedback, the negative impact of tacit knowledge sharing on employee innovation performance was alleviated, while under low-level developmental feedback, its corrective effect on tacit knowledge sharing and employee innovation performance was not significant.

Table 13. The regulating effect of superior developmental feedback.

variable	Employee innovation performance				
	β	se	t	BootLLCI	BootULCI
control variable					
Gender	−0.1234*	0.0543	−2.2724	−0.2302	−0.0167
Age	−0.024	0.0258	−0.9325	−0.0746	0.0266
education	−0.0133	0.0273	−0.4867	−0.0669	0.0403
Current working hours of the enterprise	−0.0305	0.0274	−1.1162	−0.0843	0.0232
Position level	0.0112	0.0365	0.3057	−0.0606	0.083
Job type	0.0104	0.0218	0.4798	−0.0323	0.0532
Working time with immediate superiors	0.0995**	0.0346	2.8718	0.0314	0.1675
independent variable					
Online remote work	−0.0988***	0.0291	−3.3919	−0.1561	−0.0416
Intermediary variable					
Implicit knowledge sharing	0.2697***	0.0314	8.5851	0.208	0.3314
Adjusting variables					
Superior developmental feedback	−0.0181	0.0364	−0.4976	−0.0896	0.0534
Interactive items					
Implicit knowledge sharing New feedback from superiors on development	−0.0865***	0.0357	−2.4247	−0.1565	−0.0164
R side			0.0077		
F			5.8792		

Note: N = 529, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

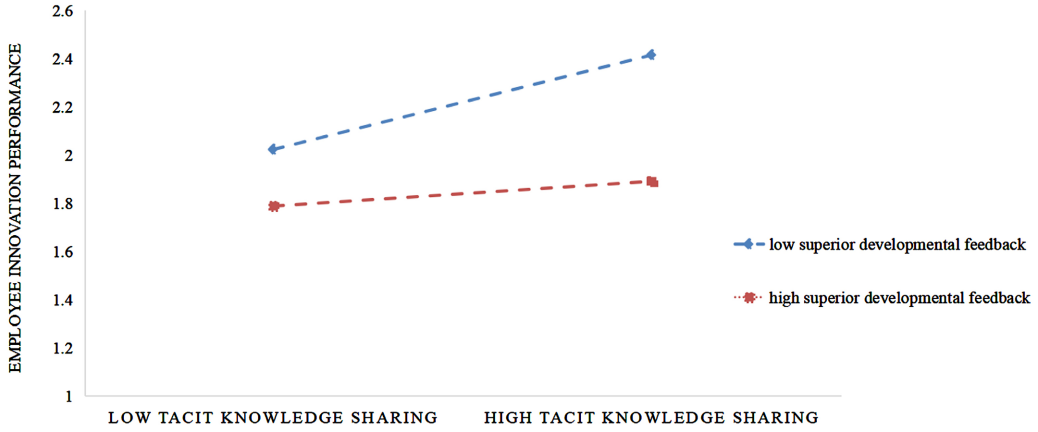

Figure 3. The moderating effect of developmental feedback from superiors on implicit knowledge sharing and employee innovation performance.

5. Research Conclusions and Prospects

5.1. Research Conclusion

This study combines the Chinese management context, based on social cognition theory and resource conservation theory, and uses SPSS 26.0 and AMOS 25.0 data analysis tools to explore the double-edged sword effect of online remote work on employee innovation performance from two aspects: work autonomy and tacit knowledge sharing. The results show that work autonomy enhances the relationship between online remote work and employee innovation performance; the implicit knowledge sharing weakens the relationship between online remote work and employee innovation performance; superior developmental feedback can enhance work autonomy and promote employee innovation performance; Superior developmental feedback can correct the negative impact of insufficient tacit knowledge sharing on innovation performance.

This study not only enables managers and employees of enterprises to dialectically examine the impact of online remote work on individuals and organizations, but also provides suggestions for the development of multinational and cross regional enterprises through remote work.

5.2. Theoretical Contributions

Firstly, it enriches the research on online remote work. On the basis of reviewing previous research, this article focuses on exploring the mediating relationship between work autonomy and tacit knowledge sharing variables in the impact of online remote work on employee innovation performance, using resource conservation theory and social cognition theory as the foundation. At the same time, with developmental feedback from superiors as the moderating variable, the article comprehensively analyzes the positive and negative effects of online remote work on employee innovation performance.

The second is to expand the relevant research on the factors influencing employee innovation performance. There are many studies on employee innovation

performance, focusing on aspects such as employees, organizations, and leaders, but there is relatively little research on online remote work. This article takes work autonomy and tacit knowledge sharing as mediating variables to study the double-edged sword effect of online remote work on employee innovation performance.

The third is to focus on the mediating role of work autonomy and tacit knowledge sharing. There is little research exploring the relationship between online remote work and innovation performance through dual paths. Based on social cognition theory and resource preservation theory, this article analyzes the dual paths of work autonomy and tacit knowledge sharing, explores the double-edged sword effect of online remote work, and confirms that online remote work can promote work autonomy and improve employee work performance, but it will reduce the willingness to share tacit knowledge and lower employee innovation performance.

The fourth is to add developmental feedback from superiors as a moderating variable and supplement the research scenario. The double-edged sword effect between online remote work and employee innovation performance is not irreversible and is also influenced by many situational factors, such as communication between superiors and subordinates, and the overall fault-tolerant atmosphere of the organization. Developmental feedback from superiors is a type of communication between superiors and subordinates. It mainly refers to the timely feedback of developmental and constructive information from immediate superiors to subordinates, which can better enhance employees' work autonomy, support innovation, and correct the negative impact caused by insufficient tacit knowledge sharing.

5.3. Management Insights

As an emerging working mode, online telecommuting has a double-edged sword effect on employees' innovation performance. Based on the research of this paper, the following suggestions can be provided for employees, managers and enterprises, in order to give full play to the advantages of online telecommuting, stimulate the innovation vitality of employees, and enhance the competitiveness of enterprises.

At the employee level, we should constantly improve our self-management ability and balance our family and work to stimulate the potential for innovation. First of all, telecommuting puts forward higher requirements for employees' self-management ability and self-discipline. Employees should strengthen their time management ability, arrange working time reasonably, avoid delay and analysis, and ensure work efficiency. Secondly, we should strengthen the communication and cooperation with our colleagues and superiors, actively participate in online meetings and discussions, overcome the communication barriers, and promote team cooperation and tacit knowledge sharing. In addition, employees should take advantage of the flexibility of telecommuting, actively learn new knowledge and skills, pay attention to industry trends, and constantly improve their innovation ability. Finally, we should maintain the balance between work and life, and set a clear boundary between work and life.

At the management level, we should change the management mode and em-

power employees to innovate. First of all, leaders should change the traditional management mode based on supervision and control, establish a management mode based on trust, and give employees more autonomy and responsibility. Secondly, leaders should communicate their work objectives and performance expectations with subordinates, provide developmental feedback, help employees clarify their work direction, and avoid ambiguous goals caused by telecommuting. Finally, leaders should provide necessary online guidance for employees, use Tencent meetings and instant communication tools to maintain regular communication with subordinates, provide timely feedback and guidance, and jointly promote work performance.

At the organizational level, the mixed office mode combining online and offline work should be discussed to build an organizational environment that supports innovation. First, develop a flexible telecommuting policy. The organization should formulate flexible telecommuting policies according to the nature of the work and task needs of the employees, and clarify the applicable positions, applicable tasks, working hours and performance evaluation standards of telecommuting. At the same time, organizations should establish a results-based performance evaluation system, focus on employees' work results rather than working hours, and encourage employees to remain efficient and innovative in telecommuting. Second, strengthen technical support and digital infrastructure construction. The organization should invest in the construction of a stable and efficient network environment, a safe remote access system and collaborative office software, so as to provide technical support for the remote office. Organizations can also analyze employees' work behavior patterns through big data, identify innovation opportunities, use artificial intelligence technology to assist creative generation solutions, and improve innovation efficiency. Finally, create an organizational culture that supports innovation. Organizations can build online experience banks that encourage employees to share experiences, skills, and best practices to facilitate the flow of tacit knowledge. Organize online sharing meetings and virtual team building activities regularly to enhance the interaction and collaboration between team members, make up for the communication barriers brought about by telecommuting, encourage cross-department and cross-team collaboration, promote the cross-integration of knowledge, and stimulate the innovative inspiration of employees. At the same time, the organization should strengthen the training of leaders' developmental feedback ability, establish a trust leadership style, regularly communicate with employees, provide constructive feedback and guidance, give employees more autonomy and responsibility, and stimulate their innovation potential.

5.4. Lack of Research and Prospects

There are still some deficiencies in discussing the double-edged effect of online telecommuting and employee innovation performance. First, this paper uses cross-section to obtain data. Although data are collected through two rounds of questionnaires, the time interval is only one month, which makes it difficult to

capture the long-term impact of online telecommuting on employees' innovation performance. Future longitudinal studies could be considered to further track the dynamic changes of online telecommuting at different stages and its impact on employee innovation performance.

Secondly, the research samples in this paper are mainly concentrated in Chinese high-tech enterprises. Although they cover information technology, biomedicine, intelligent manufacturing and other industries in Shanghai, Jiangsu, Zhejiang, Guangdong, Shaanxi and other regions, the regional and industrial distribution of the samples is still limited, which may limit the universality of the research results. Future studies could expand the sample range to cover more industries and regions, especially in different cultural backgrounds, to enhance the universality of the research results.

Finally, although this paper mentions the support of 5G, artificial intelligence and other technologies for telecommuting, it does not deeply explore the impact of the specific use of these technical tools on employees' innovation performance. Future studies can further analyze the difference of remote office effects on the use of different technical tools.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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