The Impact of Research Collaboration Intention on Technology Transfer in Virtual Academic Communities: A Conditional Process Model

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ABSTRACT

This paper aims to explore the impact of research collaboration intention on technology transfer in virtual academic community, as well as the mediating role of collaboration behavior and the moderating role of perceived ease of use and intellectual property protection between them. Based on the Theory of planned behavior (TPB) and Technology acceptance model (TAM), this paper constructed a conditional process model demonstrating the relationship between research collaboration intention, research collaboration behavior and technology transfer. A self-administered questionnaire was employed on researchers of muchong.com, jg.com.cn et al. to collect data; subsequently, 558 usable responses were analyzed using SPSS and Amos. The result showed that (1) Research collaboration intention has a significant positive impact on technology transfer; (2) research collaboration behavior partly mediates the relationship between research collaboration intention and technology transfer; (3) perceived ease of use positively moderates the relationship between research collaboration intention and research collaboration behavior; (4) perception ease of use and intellectual property protection have a moderated mediation between research collaboration intention and technology transfer. This model plays a positive role in promoting the research collaboration behavior and technology transfer of Chinese VACs researchers.

CCS CONCEPTS

• **CSS CONCEPTS: Information systems**; • **Information systems applications**; • **Collaborative and social computing systems and tools**; • **Social networking sites**;

KEYWORDS

research collaboration intention, research collaboration behavior, technology transfer, perceived ease of use, intellectual property protection, moderated mediation

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1 INTRODUCTION

In the era of big science, research collaboration has become the primary method of knowledge innovation and the critical factor to promote scientific progress. With the continuous development of Internet technology, virtual academic communities (VACs) meet the diversified needs of researchers' academic exchanges. VACs make up for the shortcomings of the traditional research collaboration model, which gradually become essential platforms for researchers to exchange knowledge and transfer technology. Many scholars search, acquire and contribute professional knowledge in VACs, and find research partners in them. Researchers will produce many research results after participating in collaborative research in VACs. Only successful transformation and application of scientific and technological achievements can promote economic and social development [1, 2]. In order to create value for society, research results must be successfully commercialized [3]. Therefore, it is necessary to understand the influencing factors of research collaboration behavior and technology transfer in VACs.

The existing research proposed that research collaboration intention in VACs directly affects research collaboration behavior [4, 5]. Nevertheless, Cao and Wang [6] use the meta-analysis method to find that the community environment has a specific moderating effect between the intention and behavior of knowledge sharing through systematic collection and literature research related to virtual community knowledge sharing. However, till now, no research scholars have carried out empirical research on the proposed topic, and many scholars believe that network relationship [7, 8] and perceived ease of use [9, 10] in the virtual community have a significant influence on knowledge exchange and collaborative behavior. Therefore, based on TPB, we proposed the research question 1:

RQ1: How do perceived ease of use in VACs influence the relationship between research collaboration intention and research collaboration behavior?

Similarly, research on technology transfer mainly focuses on the triangular relationship between universities, governments, and enterprises to study the influencing factors and strategies of technology transfer [11–13], while there are few literatures on technology transfer in VACs are currently available. Intellectual property protection is a critical factor in the transfer of research technology in universities, which has a significant impact on the behavior of enterprises and researchers in research collaboration by reducing uncertainty and collaboration risk [14]. Under different levels of intellectual property protection, university researchers and enterprises will take different levels of technology transfer because of profit-seeking motivation. Therefore, this research takes intellectual property protection as a moderating variable and raises research question 2:

RQ2: Does intellectual property protection affect the relationship between research collaboration behavior and technology transfer?

2 RELATED WORK

2.1 Research collaboration behavior in VACs

According to Katz and Martin [15], research collaboration means that researchers cooperate and work together to create new knowledge. Compared with traditional offline research, Virtual research collaboration is a research project or task jointly completed by researchers scattered in different places with the help of modern information technology and communication systems. Most researchers have a very high level of professional knowledge and can cooperate to solve problems. They have a cooperative relationship by sharing intelligence, knowledge, reputation, funds, equipment, and other resources [16].

Because of the characteristic of virtual identity in the network environment, researchers who initiate research collaboration in VACs aim at knowledge creation and seek new academic support to advance research through cooperative ways [17]. The researchers involved in academic discussions are mainly to provide knowledge support and obtain research inspiration and generate new knowledge creation in the process of collaboration. A traditional stakeholder's motivation for cooperation is to obtain academic recognition by publishing a co-authored article [18]. Research collaboration has greater spontaneity in VACs, so material and honor have little impact on the motivation of research collaboration. Toral et al. [19] analyze the differences between communication themes and authoritative cognition in different VACs. The authors argue that researchers who browse information in virtual communities will discuss research based on their knowledge reserves and personal wishes and can further develop collaborative relationships with the poster.

2.2 Technology transfer in VACs

With the development of Internet technology and application, more and more technology transfer platforms are combined with the Internet day by day. The former research focuses on the research of technology transfer platforms in the internet environment. Yang et al. [20] find a breakthrough to improve the efficiency of technology transfer from the matching quality of supply and demand on the online technology transfer platform. In order to solve the problem of supply and demand text matching in the online technology transfer platform, He et al. [21] study the information matching of supply and demand of online technology. Liu and Shao [22] find that the transformation crowdfunding platform can provide transformation and intermediary services through the Internet, effectively linking financiers and investors and providing new ways and means for transforming scientific and technological achievements.

By reviewing the literature, we find few literature studies on research collaboration behavior and technology transfer in VACs. However, and those that exist have limited scope. There is no empirical study on the relationship between research collaboration intention and behavior and technology transfer in VACs, which bridges the research gaps for our study.

3 THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

Based on TPB and TAM, this study explores the relationship between research collaboration intention and technology transfer in VACs. Taking perceived ease of use and intellectual property protection as moderating variables, research collaboration behavior as mediating variable, we propose the following six hypotheses.

3.1 Research collaboration intention and research collaboration behavior

The theory of planning behavior holds that an individual's intention to carry out a particular behavior directly determines the possibility and degree of occurrence of the behavior [23]. Voluntary implementation of the behavior [24] only after the individual shows a strong behavior within himself. It has been proved that individual behavior intention plays a direct role in actual behavior. The research collaboration intention in VACs involves the intense degree of an individual's subjective intention to cooperate with others, and it is the subjective possibility tendency of individual research collaboration. Researching collaborative behavior is a practical action for individuals to cooperate with other community members to carry out scientific research. When individuals gain a pleasant experience in VACs, they generate an intention to share knowledge and do research collaboratively, and then promote the occurrence of research collaborative behavior. Therefore, the following hypothesis is proposed as below.

H1: Research collaboration intention has a positive influence on research collaboration behavior

3.2 Research collaboration behavior and technology transfer

Nordfors et al. [25] indicate that the technology transfer needs to cross the barriers of the 'Valley of death' and 'Darwin Sea'. Technology transfer in VACs will face more difficulties in crossing the valley of death and the sea of Darwin. One reason is that the research of VACs lacks application and has a small market prospect of technology commercialization. Another reason is that VACs have significant defects in technology transfer mechanism, service platform, and technical support, leading to the technology transfer not

being completed within the community [26]. Enterprises participating in research and innovation activities in VACs will create favorable conditions for technology transfer [27]. Researchers under the industry – university - research collaboration will meet the market's needs and create possibilities for the subsequent transformation of research results [26]. The industry-university-research collaboration in VACs brings sufficient funds for technology transfer, which is critical in promoting technology transfer. Therefore, the following hypothesis is proposed.

H2: Research collaboration behavior positively influences technology transfer

3.3 Research collaboration intention, perceived ease of use, and research collaboration behavior

Perceived ease of use is defined as an individual's perception of how easy to use information system platforms [28]. Researchers are more willing to use the information system platforms to complete tasks when perceived information technology is easy to understand and valuable [28]. Therefore, this proposed research work believes that the great perceived ease of use will promote an individual's research collaboration intention in VACs, which also directly promotes research collaboration behavior. In summary, this research work proposes a hypothesis:

H3: Perceived ease of use positively moderate the relationship between research collaboration intention and research collaboration behavior

3.4 research collaboration behavior, intellectual property protection, and technology transfer

Researchers' enthusiasm to participate in technology transfer is affected by many factors, while intellectual property protection is one of the critical factors [27]. A researcher can obtain the corresponding material reward in technology transfer under the protection of intellectual property rights; enterprises can use intellectual property rights to protect their legitimate interests and exclude the loss of interests caused by competitors [29]. Based on the above analysis, the following hypothesis is made in this proposed research work.

H4: Intellectual property protection plays a moderating role between research collaboration behavior and technology transfer

3.5 Research collaboration intention, research collaboration behavior, and technology transfer

The above analysis show that research collaboration intention has a positive impact on research collaboration behavior, and research collaboration behavior positively impacts technology transfer. Therefore, research collaboration behavior plays a mediative role between research collaboration intention and technology transfer. Moreover, Fontana et al. [30] believe that the research collaboration intention includes three aspects: voluntary disclosure of knowledge exchange technology to the outside world, active participation in external activities, and active acquisition of knowledge from the outside and that the research collaboration intention can directly promote the technology transfer of industry – university - research collaboration. Based on above analysis, we put forward the hypothesis.

H5: Research collaboration intention in VACs has a positive influence on technology transfer

H6: Research collaboration behavior mediates the relationship between research collaboration intention and technology transfer.

3.6 Research model

From the above discussion, the hypothesized conditional process model of this study is shown in figure 1. Research collaboration intention has a significant positive impact on technology transfer; research collaboration behavior partly mediates the relationship between research collaboration intention and technology transfer; perceived ease of use positively moderates the relationship between research collaboration intention and research collaboration behavior; intellectual property protection moderates the relationship between research collaboration behavior and technology transfer.

4 METHODOLOGY

The methodology of this study is quantitative, and we adopt a survey-based approach to collect data. The quantitative method in this study refers to statistical and mathematical methods to analyze data to verify the proposed hypothesis.

4.1 Measurement of variables

All the variables in the research model are latent, and their measures are mainly carried out by designing the corresponding scale. The scale items mainly refer to the mature scale in authoritative journals and are closely combined with the design of research requirements. For example, the scale design of perceived ease of use is from Davis et al. [31]; The scale design of research collaboration intention is from Fang et al. [32]; The scale design of research collaboration behavior is from Chen et al. [33]. The scale design of intellectual property protection is from Norman [34], Heiman and Nickerson [35], and Liu [36]. The scale design of technology transfer is from Ram [37] and Jin [38]. The target populations of this study are online registered researchers who usually use VACs. 558 valid questionnaires were collected in the survey. 50.7% of the respondents were male and 49.3% were female. 61.3% had master's degree or above, because most of the respondents were students and researchers. 50% of the respondents log in to VACs every week, indicating that half of the respondents often use VACs; About 65% of the respondents have more than half a year's experience in VACs.

5 DATA ANALYSIS AND HYPOTHESIS TEST

5.1 Reliability test

The reliability of the questionnaire was tested by the corrected item-total correction (CITC) index and Cronbach's Alpha coefficient. the Cronbach's alpha coefficient of the whole scale is 0.908. The Cronbach's alpha coefficients of the five subscales of perceived ease of use, research collaboration intention, research collaboration behavior, intellectual property protection, and technology transfer are 0.855, 0.849, 0.898, 0.766, and 0.833, respectively, which are higher than 0.6, indicating that the internal consistency of the scales is good. In addition, Cronbach [39] believes that CITC is an

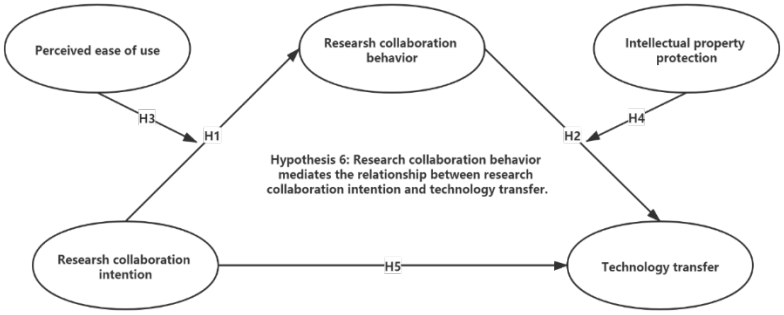

Figure 1: The hypothesized conditional process model

index to judge whether a particular measurement item is attributed to a specific structural variable with good internal consistency. Therefore, this paper tests the CITC index, and the results show that the correlation coefficients are all greater than 0.3. Therefore, we think that the questionnaire has good reliability.

5.2 Validity test

Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) test the validity of the questionnaire. Before factor analysis, the Kaise-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were used to verify the partial correlation and simple correlation coefficients among the variables. When the correlation is high, the data is suitable for factor analysis. The KMO value of the scale is 0.920, indicating a strong correlation between variables; The approximate Chi-square value is 5946.138, p< 0.05, that is, we can use the data obtained through the questionnaires to do factor analysis.

Using SPSS to carry out EFA on the data, we extracted a total of five common factors, the variance contribution rates of variables are 40.946%, 17.087%, 6.077%, 5.176%, and 3.896%, and the cumulative variance contribution rate is 73.182%, indicating that these five common factors represent most of the information the questionnaires. The standardized factor loading values in table 5 are greater than 0.6 and show significance, which means that the scale has a good measurement relationship. CFA was carried out for six factors and 20 analysis items. Average Variance Extracted (AVE) values of each factor are all greater than 0.5, and combined reliability (C.R.) values are all greater than 0.7, which means that the scales of this study have good convergent validity.

AMOS 24.0 was used for CFA. Table 5 showed that the absolute fitting index χ^2/df is 3.728, Root Mean Square Error of Approximation (RMSEA) is 0.070, Goodness-of-fit index (GFI) is 0.911, Normed fit index is (NFI) 0.923, Non-normed fit index is (NNFI) 0.929, Incremental fit index (IFI) is 0.942, Comparative fit index (CFI) 0.942. The absolute index values (χ^2/df, RMSEA) and relative index (GFI, NFI, NNFI, IFI, CFI) have reached ideal values, indicating that the model fits well.

5.3 Hypothesis testing

Hierarchical multiple regression analysis is used to verify the hypothesis. Table 8 presents the mean, standard deviation, and correlation coefficient of each variable. From the results, research

Table 5: Model fit index

Fit index	Standard	Value
χ^2/df	<5	3.728
GFI	>0.9	0.911
NFI	>0.9	0.923
IFI	>0.9	0.942
NNFI	>0.9	0.929
CFI	>0.9	0.942
RMSEA	<0.08	0.070

collaboration intention is positively correlated with research collaboration behavior (r=0. 51, p<0.01) and technology transfer (r=0. 43, p<0.01). In addition, there is a weak positive correlation between research cooperation behavior and technology transfer (r=0.08, p<0.05). Therefore, the hypotheses H1, H2, and H5 have been preliminarily verified, which provide feasible conditions for subsequent multiple regression analysis.

First, we examine the simple direct impact of research collaboration intention on technology transfer. In the pilot study, we found that covariates such as sex, position, academic frequency, and experience have a significant impact on the questionnaire survey results, so we added them as covariates in the hypothesis testing process. The data results show that research collaboration intention has a significant positive impact on technology transfer (β =0.43, p<0.01), which means H5 is supported.

Second, Hayes' [40] SPSS macro, PROCESS (model 7), was used to analyze the simple mediating effect of research collaboration behavior between research collaboration intention and technology transfer (see Table 9). The analysis results show that after adding the covariates, research collaboration intention has a significant positive impact on research collaboration behavior (M1, β = 0.64, p<.001), and H1 is supported. However, after putting research collaboration intention and research collaboration behavior into the regression model at the same time, the results show that research collaboration behavior has a weak negative impact on technology transfer (M2, β =-0.13, p <.001), which is contrary to the previous H2, so H2 is not supported. At the same time, bootstrapping with a 95% construct-bias corrected confidence interval is used to test the direct and indirect effect. The results show that the direct and

Table 8: Descriptive Statistics and inter-correlations for the Study Measures

Measures	M	SD	1	2	3	4	5
1 PE	5.43	0.86	1				
2 RCI	5.44	0.91	0.63**	1			
3 RCB	4.78	1.28	0.48**	0.51**	1		
4 IPP	5.69	0.83	0.48**	0.48**	0.15**	1	
5 TT	5.78	0.85	0.49**	0.43**	0.08*	0.72**	1

Note. M, Mean; SD, Standard deviation; *p<.05; **p<.01.

Table 9: Model Coefficients for RCB Simple Mediation Analysis with Four Covariates

Variable	M1(RCI)				M2(RCB)			
	β	se	T	p	β	se	t	p
constant	2.04	0.35	5.84	<.001	3.79	0.27	14.25	<.001
RCI	0.64	0.05	13.34	<.001	0.48	0.04	11.75	<.001
RCB	—	—	—	—	-0.13	0.03	-4.04	<.001
Sex	-0.35	0.09	-3.99	<.001	-0.04	0.07	-0.69	0.490
Position	0.36	0.05	7.54	<.001	0.01	0.04	0.38	0.701
Frequency of use	-0.25	0.07	-3.84	<.001	-0.09	0.05	-1.86	0.063
Member experience	-0.16	0.04	-4.44	<.001	0.05	0.03	2.04	<.05
R2	0.375				0.226			
F	66.218***				26.864***			

Note. ***p<.001.

indirect effect are significant, and Boot 95% confidence intervals do not include 0 ({0.00, 0.40}, {-0.13, -0.04}), which means that research collaboration behavior partly mediates the relationship between research collaboration intention and technology transfer, and H6 is supported. The values β in all the tables below are normalized regression coefficients, and the number of Bootstrap resamples is 5000.

Third, PROCESS (Model 21) was used to analyze the moderating effect of perceived ease of use on the relationship between research collaboration intention and research collaboration behavior, the moderating effect of intellectual property protection on the relationship between research collaboration behavior and technology transfer, and their moderated mediation of research collaboration behavior (see Table 10). The analysis results show that the interaction of research collaboration intention and perceived ease of use significantly impacts research collaboration behavior (M3, β =0.35, p<.05), which means the moderating effect of perceived ease of use is significant. H3 is supported. The interaction of research collaboration behavior and intellectual property protection has no significant impact on technology transfer (M4, β = 0.04, p>.05), which means intellectual property protection has no moderating effect on the relationship between research collaboration behavior and technology transfer. H4 is not supported.

Fig. 2 shows that the positive relationship between research collaboration intention and research collaboration behavior is weak (β =0.36, p<.001) under the low perceived ease of use; there is a strong positive relationship between research collaboration intention and research collaboration behavior when perceived ease of use is high (β =0.55, p<.001). Thus, the results indicate that perceived

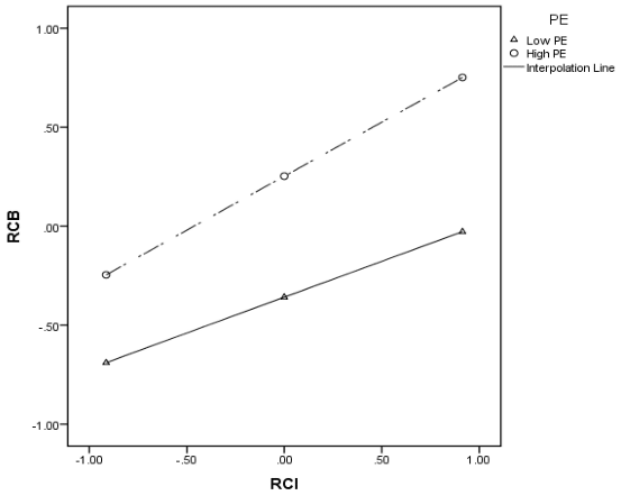

Figure 2: Simple slope diagram of the moderating effect

ease of use positively moderates the relationship between research collaboration intention and research collaboration behavior, and H3 is supported.

This study further examines the moderated mediation of perceived ease of use and intellectual property protection (see Table 11). The results show that when intellectual property protection is low,

Table 10: Model Coefficients of Conditional Process Analysis with Four Covariates

Variable	M3(RCB)				M4(TT)			
	β	se	t	p	β	se	t	p
Constant	0.72	0.22	3.24	<.001	5.67	0.13	43.18	<.001
RCI	0.45	0.06	7.64	<.001	0.16	0.04	4.39	<.001
PE	0.35	0.06	5.61	<.001	—	—	—	—
RCB	—	—	—	—	-0.09	0.03	-3.38	<.001
IPP	—	—	—	—	0.68	0.04	19.40	<.001
RCI* PE	0.11	0.05	2.09	<.05	—	—	—	—
RCB*IPP	—	—	—	—	0.04	0.02	1.43	0.154
Sex	-0.36	0.08	-4.31	<.001	0.00	0.05	-0.04	0.966
Position	0.33	0.05	7.21	<.001	0.04	0.03	1.41	0.159
Frequency of use	-0.21	0.06	-3.29	<.001	-0.04	0.04	-1.10	0.272
Member experience	-0.16	0.03	-4.59	<.001	0.03	0.02	1.65	0.099
R2	0.413				0.547			
F	55.307***				82.808***			

Note. ***p<.001.

Table 11: Analysis of moderated mediation

PE	IPP	Effect	BootSE	BootLLCI	BootULCI
Mean-1 SD	Mean-1 SD	-0.042	0.023	-0.0892	0.0001
Mean-1 SD	Mean	-0.031	0.014	-0.0624	-0.0057
Mean-1 SD	Mean+1 SD	-0.021	0.011	-0.0443	-0.0002
Mean	Mean-1 SD	-0.052	0.026	-0.1029	0.0002
Mean	Mean	-0.039	0.016	-0.0724	-0.0074
Mean	Mean+1 SD	-0.026	0.014	-0.0539	-0.0002
Mean+1 SD	Mean-1 SD	-0.063	0.031	-0.1223	0.0002
Mean+1 SD	Mean	-0.047	0.020	-0.0866	-0.0089
Mean+1 SD	Mean+1 SD	-0.031	0.017	-0.0666	-0.0003

Note. SD, Standard deviation.

whether perceived ease of use is low, average, or high, the mediating effect of research collaboration behavior between research collaboration intention and technology transfer is not significant (Boot 95% CI confidence interval includes 0). When intellectual property protection is average or high, whether perceived ease of use is low, average, or high, the mediating effect of research collaboration behavior between research collaboration intention and technology transfer is significant (Boot 95% CI confidence interval does not include 0). Therefore, the moderated mediation of perceived ease of use and intellectual property protection is significant.

6 DISCUSSION AND CONCLUSION

This study tested a conditional process model of the relationship between research collaboration intention and technology transfer in VACs based on TPB and TAM. In terms of simple mediation, we hypothesized that research collaboration intention would positively relate to technology transfer and that these associations would be mediated by research collaboration. Analysis results supported these predictions. In terms of moderated mediation, we hypothesized that research collaboration intention has a positive influence on research collaboration behavior, and the strength of effects would depend on researchers' perceived ease of use. Analysis results supported these predictions. In terms of conditional process, the conditional indirect effects of research collaboration intention on technology transfer were moderated by perceived ease of use and intellectual property protection. The conditional indirect effects were not significant with lower levels of intellectual property protection.

In contrast, the conditional indirect effects were significant for those who reported higher levels of intellectual property protection. From the research results, we also found a weak correlation between research collaboration behavior and technology transfer in VACs, which varies from the industry-university-research collaboration that can positively affect technology transfer [26]. The reason is that the technology transfer is more influenced by funding and human

resources input, reward policies, and legal systems of VACs. At last, we found that intellectual property protection positively impacts technology transfer, which agrees with Lach and Schankerman (2008) [27]and Paola et al. [29].

7 IMPLICATIONS FOR PRACTICE

The findings of this study with the most promise for providing implications include those suggesting that promotes research collaboration behavior and technology transfer in VACs. According to the research result, perceived ease of use positively affects research collaboration intention and research collaboration behavior in VACs. The ease of use of community platforms significantly impacts users with low computer self-efficiency and less use of network platforms. Therefore, managers of VACs need to constantly improve the internal functions and improve the ease of use, which will help researchers improve the self-efficiency and then put the research collaboration intention into practical behavior. The more straightforward the process is, the more attractive it will attract researchers and play a specific role in promoting research collaboration. It is suggested that community managers regularly update and improve the technical characteristics of the platform, such as regularly updating the website server equipment, improving the website's access speed, and making the website present a straightforward interface, easy to operate, and low access error rate. Furthermore, community managers should help researchers gain knowledge of added value and quickly and easily find partners, which helps researchers enhance the self-effectiveness of community use. At the same time, the community organizers should hold regular knowledge exchanges and seminars within the scope of the cognitive level of the researchers so that the participating learners can reduce the knowledge or platform barriers and improve their awareness of the ease of use of the platform.

In order to improve the technology transfer level of VACs, this paper puts forward the following suggestions: first, the government should strengthen the law enforcement of intellectual property protection and improve the laws related to technology transfer. Second, managers of VACs should establish a reward policy and benefit distribution mechanism for researchers, which can promote the motivation of technology transfer. Third, the managers of VACs should strengthen the relationship with researchers and enterprises and establish a collaborative system of technology transfer. Last, the government and VACs should increase the investment and set up a special fund for technology transfer.

8 LIMITATIONS AND FUTURE RESEARCH

Although the research results help extend the literature, there are some limitations. First, we selected the sample from four famous VACs with a large number of researchers in China. More types of VACs will be chosen to verify the theoretical model in further research. Second, most of the respondents consisted of teachers and students, compared with fewer researchers in other professions. In the future study, we will expand the scope of the respondents to increase the universality of the research. Third, we used Internet questionnaires to collect data, which is likely to increase data bias. Although recent studies suggest data are mainly similar between the Internet and traditional pencil-and-paper methods [41], we will add a part of the traditional pencil-and-paper questionnaire to improve the reliability of the data in further research.

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