

# Influencing Factors of Research Collaboration Intention in Virtual Academic Communities in China

**Chunlai Yan** 

Rattanakosin International College of Creative Entrepreneurship,  
Rajamangala University of Technology Rattanakosin, Phutthamonthon,  
Thailand  
E-mail: wingvestige@163.com

**Hongxia Li\*** 

Rattanakosin International College of Creative Entrepreneurship,  
Rajamangala University of Technology Rattanakosin, Phutthamonthon,  
Thailand  
School of Management Science and Engineering,  
Chongqing Technology and Business University, Chongqing, China  
E-mail: lihongxia@ctbu.edu.cn

## ABSTRACT

Research collaboration is an important strategy to improve research output, and virtual academic communities (VACs) have become an important platform to collaborate on. This paper reveals the influencing factors of researchers' collaboration intention in VACs from two attributes: individual, and inter-members. On the basis of the Social Cognitive Theory, Social Exchange Theory, social network theory, and Five-Factor Model, this paper constructed a model demonstrating the influencing factors of VACs researchers' collaboration intention. A self-administered questionnaire was employed on members of four VACs in China to collect data; subsequently, 558 usable responses were analyzed using structural equation modeling. The result showed that openness, conscientiousness, reciprocity, trust, and the social network characteristic had a significant influence on the collaboration intention of researchers in VACs, while self-efficacy, agreeableness, extroversion, neuroticism, and experience had no significant effects on the collaboration intention of researchers in VACs. This model plays a positive role in promoting the research collaboration intention of Chinese VACs researchers and in guiding the construction of VAC platforms.

**Keywords:** virtual academic communities, research collaboration, influencing factors, Five-Factor Model, China, social network characteristic

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**\*Corresponding Author:** Hongxia Li  
 <https://orcid.org/0000-0002-6386-8152>  
**E-mail:** lihongxia@ctbu.edu.cn



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## 1. INTRODUCTION

### 1.1. Research Background

With the development of new knowledge communication carriers, the mode of academic exchange has also changed, and more scientific research scholars share their knowledge and collaborate in scientific research through online academic exchange platforms. The advancement of Web 2.0 technology makes it possible for researchers from different nations to work together with the support of online collaborative platforms, such as virtual academic communities (VACs) (Berdun & Armentano, 2019). VACs are online learning communities for researchers to exchange academic-related views and resources (Lin, 2007). With the coming era of big science and the globalization of science and technology, research collaboration has increasingly become the mainstream style way of scientific research. The collaborative behavior of research is becoming more and more critical in the process of scientific research and is becoming an essential way of academic innovation. VACs such as ResearchGate, Academic.edu, Mendeley, and muchong.com have gradually become sites for research collaboration.

### 1.2. Need for the Study

At present, VACs have been regarded by researchers as an essential place for the exchange of academic knowledge and data sharing. Nevertheless, more scholars have studied the exchange and sharing of information or knowledge in VACs. There is limited state-of-the-art research on the collaborative behavior of researchers in VACs, and the related research is still in its start. The collaboration between researchers in VACs has been carried out, but no research scholars have yet studied what factors affect collaborative intention. Although VACs have become a platform for researchers to communicate and collaborate, more researchers tend to collaborate offline. To fill the above research gaps and promote the collaboration behavior of researchers in VACs, this paper addresses the following two research questions:

- (1) What factors influence the collaboration intention of researchers in VACs?
- (2) What strategies can promote the collaboration intention of researchers in VACs and involve more researchers in collaborative research projects online?

This study is helpful to enhance the enthusiasm and efficiency of researchers' participation in collaboration in

VACs and to promote the healthy development of research collaboration activities in VACs. In addition, this research also constructs the theoretical basis of VACs and research collaboration and establishes a relatively perfect theoretical system of collaborative behavior in VACs.

## 2. LITERATURE REVIEW

### 2.1. Virtual Academic Communities

Rheingold (1993) concludes that a "virtual community" relates to a group of people who interact with each other over the social network to share data and knowledge, to develop a group of personal connecting society in the cyberspace world. Harrison and Stephen (1995) proposed for the first time that academic communities can be understood as discourse communities that share data and communication protocols. Shade (1995) believes that the Internet has become an essential tool to maintain and cultivate academic culture, and the concept of the "invisible college" has mainly been transformed into a virtual community. Lin (2007) define VACs as learning communities, which they believe are virtual learning communities for researchers to exchange ideas, experiences, documents, comments, and reviews related to the academic culture. Therefore, VACs not only have the principle of the virtual community, but also make academic knowledge exchanges, which require them to meet three key conditions, firstly the computer as the medium, secondly academic knowledge as the exchange content, and finally, the researchers as the participants.

### 2.2. Research Collaboration

At present, there are different definitions of research collaboration in academia. Katz and Martin (1997) define research collaboration as the common desire of researchers to work together to create new knowledge. Ziman (1994) proposes that research collaboration is the product of scientific development to a certain "stable period," and the collaborative effect after entering the "stable period" plays an increasingly important role in improving the output of scientific knowledge. Heffner (1981) believes that research collaboration is a form of researcher interaction. Researchers in the process of scientific activities through ideological and intellectual communication form the ideal research collaboration model. Bergstrom (2008) found that some scholars opposed the idea of teacher-student collaboration as a kind of research collaboration, and believed that real research collaboration should occur between researchers of the same rank or similar status. This

research work defines research collaboration based on the above analysis: Research collaboration refers to a scientific activity in which two or more researchers or organizations achieve the goal of enhancing research output through collaboration to complete the same research task or proposed project.

### 2.3. State-of-the-Art of Research Collaboration in VACs

The activities of researchers in VACs are mainly scientific research, which will gradually produce research collaborative behavior within the community. Research about research collaboration in VACs is still lacking. Most of the previous research efforts focus on knowledge sharing and communication in VACs. By reading the literature related to virtual academic community topics, the proposed research study found that virtual academic community research collaboration is gradually developed by knowledge exchange and sharing among researchers. Collaboration behavior occurs mainly because of the research demands of researchers in VACs (Qu, 2010). In the process of reaching cooperation, communication within the community is an essential linkage. The state-of-the-art on knowledge exchange of VACs researchers mainly focuses on the following three aspects: (1) the influencing factors of knowledge exchange in the virtual academic community; (2) the evaluation of knowledge exchange in the virtual academic community; and (3) the strategy improvement of knowledge exchange in the virtual academic community. There is limited literature related to the collaborative topic of virtual academic community research. Chia and Pritchard (2014) use the case study method to analyze transnational cooperation in the virtual academic community; it is concluded that the community is of considerable significance to promote transnational collaboration. Maxwell et al.'s (2017) research found that medium and long-term cooperation in VACs is better than short-term collaboration. With an in-depth understanding of each other's relationship, they can form a great academic understanding.

By reviewing the literature, we find that there are few literature studies on research collaboration in VACs, however, and those that exist have limited scope. There is no empirical study on influencing factors of research collaboration in VACs, which bridges the research gaps for our study.

## 3. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

This study explores the factors that affect the intention

of research collaboration in VACs from the dimension of individual factors and inter-member factors and takes Social Cognitive Theory (SCT), Social Exchange Theory (SET), Big-five personality model, and Social Network Theory (SNT) as the theoretical basis. Based on the above theories, this study puts forward the following hypotheses from six dimensions: self-efficacy, personality traits, reciprocity, experience, trust, and the social network characteristic.

### 3.1. Self-Efficacy and Research Collaboration Intention

Self-efficacy refers to individuals' anticipation of the impact of their behavior, which is the individual's perception of their own ability and self-confidence (Lu et al., 2006). The higher the self-efficacy is, the more feasible it is for individuals to choose and decide to carry out an action. Many researchers pointed out that knowledge sharing self-efficacy can affect users' sharing behavior in a virtual community (Almahamid et al., 2010; Cabrera & Cabrera, 2002; Hazzan & Seger, 2010).

This study anticipates that researchers who believe they can contribute and acquire knowledge in VACs also prefer to collaborate with others to finish research projects. Therefore, the following hypothesis is proposed.

H1: Self-efficacy has a positive influence on research collaboration intention in VACs.

### 3.2. Personality Trait and Research Collaboration Intention

The personality trait is a stability index used to describe comprehensive individual traits, and it is also the fundamental factor (Costa & McCrae, 1992a) that affects individual psychological attitudes and behavior activity. Nonnecke and Preece (2001) proposed that shyness and privacy are the main factors that affect researchers' reluctance to share in virtual communities. Among the research efforts on researcher personality trait correlation, the Five-factor model of personality structure is one of the most widely used personality trait theories (Costa & McCrae, 1992b). The FFM of personality traits divides personality traits into five dimensions, such as agreeableness, openness, extroversion, conscientiousness, and neuroticism (Gosling et al., 2003).

People with high agreeableness are friendly and helpful, and they are willing to give up their interests (Wang et al., 2012) for others. Moore and McElroy (2012) believe that researchers with high agreeableness regret sharing incorrect information. Ryan and Xenos (2011) find that researchers with high agreeableness are more willing to share information in virtual communities. Therefore,

researchers with higher agreeableness tend to prefer to collaborate with virtual community members rather than compete, for altruistic reasons. Based on the above analysis, the following hypothesis is made in this proposed research work.

H2(a): Agreeableness positively influences research collaboration intention in VACs.

People with high openness are imaginative and creative and are more sensitive to wonderful things. Cabrera et al. (2006) believe that openness is a significant antecedent variable of knowledge sharing, and 'High-Open' researchers are more willing to share knowledge and meet the needs of the team for knowledge acquisition. Therefore, high openness people have more intention of knowledge sharing in the virtual academic community. Based on the above analysis, the following hypothesis is made in this research work.

H2(b): Openness positively influences research collaboration intention in VACs.

Extroversion reflects the strength and dynamic characteristics of the individual nervous system. Highly extroverted people are passionate and adventurous; in a group, they are talkative and enjoy attracting attention (Barrick et al., 1998). These characteristics indicate that highly extroverted people prefer to communicate and collaborate with others in virtual communities. Accordingly, the hypothesis is made as below.

H2(c): Extroversion positively influences research collaboration intention in VACs.

Conscientiousness reflects the ability to self-discipline and the sense of responsibility to achieve. Highly conscientious people have a strong sense of responsibility, for which they may be more willing to help others. Yoo and Gretzel (2011) believe that people with high conscientiousness are more willing to share knowledge. Therefore, conscientiousness has a significant positive effect on knowledge sharing. Based on the above analysis, the following hypothesis is made in this proposed research work.

H2(d): Conscientiousness positively influences research collaboration intention in VACs.

Neuroticism refers to the situation in which the emotional state of a person fluctuates with the change of external conditions. People with high neuroticism are more likely to feel negative emotions such as anger, anxiety, and depression. Their response to external stimuli is stron-

ger than the average person's, and their ability to regulate emotions is relatively weak. They are often unwilling to collaborate with others. Wang et al. (2012) find that highly neurotic people have fewer status updates in virtual communities. The following hypothesis is made.

H2(e): Neuroticism negatively influences research collaboration intention in VACs.

### 3.3. Experience and Research Collaboration Intention

The father of experience marketing, B. H. Schmitt (1999), believes that experience is the perception generated by brain stimulation during activity. Nambisan and Watt (2011) put forward the idea of "online community experience," which is defined as the all-around feeling that people get in the process of network community interaction. This study defines experience as the subjective feelings gained by researchers in the process of using VACs. Scholars have identified cognitive and emotional aspects that affect people's experiences in the field of psychological research (Hirschman & Holbrook, 1982; Overby & Lee, 2006; Voss et al., 2003). Hars and Ou (2002) believes that creating reciprocal social norms within a virtual community allows people to experience intimacy. Moreover, the activities of members of VACs mainly include obtaining valuable academic information and looking for academic partners. Therefore, the experience of VACs includes not only utilitarian experience and emotional experience but also a social experience. When the researcher acquires the knowledge needed from others in the academic community, and the process of communicating and contacting the researcher produces a pleasant experience, it will promote the intention of the researcher to collaborate in research. Based on the above analysis, the following hypothesis is made in this research work.

H3: Experience positively influences research collaboration intention in VACs.

### 3.4. Reciprocal Benefit and Research Collaboration Intention

The theory of social exchange shows that the mechanism to ensure the success of exchange is reciprocity, and any interaction in society can be explained by reciprocity (Coyle-Shapiro & Conway, 2005). Many researchers believe that reciprocity promotes collaborative research in the virtual academic community, because it improves relationships among researchers and increases the expectations of helping others to ensure ongoing collaboration (Bock et al., 2005; Davenport & Prusak, 1998; Kankanhalli et al., 2005; Lin, 2007; Lin et al., 2009). Research collabo-

ration involves the contribution and absorption of knowledge. On the surface, research collaboration is a kind of cooperation based on knowledge exchange, but it is a kind of reciprocity based on material or spiritual return. Research collaboration depends on reciprocal mechanisms between collaborators. If one party's actions benefit the other's, it can move the whole group towards reciprocity. On the contrary, if one party's efforts cannot be rewarded, or if both parties agree that the gains are not worth the losses, the collaborative relationship will not be sustainable. Therefore, the following hypothesis is proposed.

H4: Reciprocal benefit positively influences research collaboration intention in VACs.

### 3.5. Trust and Research Collaboration Intention

According to the theory of social exchange, trust is the basis of human communication and collaboration (Jarvenpaa et al., 2004; Zaheer et al., 1998). Trust is essentially a kind of interpersonal relationship (Powell et al., 2004). Emotional trust can effectively adjust the relationship between enterprise employees, which is considered one of the tacit assets of the enterprise (Reina & Reina, 2006; Vangen & Huxham, 2003). Researchers in VACs do not know others and need to increase their trust in each other to promote collaboration and communication. If there is no trust, deception may occur. If trust arises among researchers in VACs, they will enhance their knowledge sharing intention and collaborate with other researchers in the community. The stronger this emotional trust, the more urgent the desire for knowledge sharing (Black et al., 2003). Therefore, the following hypothesis is proposed.

H5: Trust positively influences research collaboration intention in VACs.

### 3.6. Social Networks Characteristics and Research Collaboration Intention

The research collaboration behavior in VACs depends on a multi-dimensional relationship of social networks. Because human beings are creatures with social attributes who pay attention to the construction of interpersonal relationships, individuals tend to show their tacit knowledge in their respective small-scale networks to realize the exchange and sharing of knowledge. These kinds of offline activities also hold the attitude and tendency of sharing after moving to the virtual academic community. Kotlarsky and Oshri (2005) finds that relationship orientation can promote knowledge transfer between enterprises. Okoli and Oh (2007) believe that the higher density of the network nodes, the higher the performance of their knowl-

edge contribution; Lu and Yang (2011) shows that online interactive connections in virtual communities have a significant impact on knowledge sharing behavior among community members. Coleman (1988) believes that social connections between people can promote group coherence and facilitate group knowledge sharing. Many studies show that node density and connection strength in social networks promote the transfer and sharing of knowledge (Reagans & McEvily, 2003; Uzzi & Lancaster, 2003). In summary, this research work proposes the hypothesis:

H6: Social network characteristics are positively related to research collaboration intention.

### 3.7. Research Model

From the above discussion, the final research model of the study is shown in Fig. 1. The variables in the research model include independent variables (self-efficacy, agreeableness, openness, extroversion, conscientiousness, neuroticism, experience, reciprocity, trust, social networks characteristic) and dependent variables (research collaboration intention). In terms of individual attributes, researchers' self-efficacy, agreeableness, openness, extroversion, conscientiousness, and experience positively affect research collaboration intention, but neuroticism negatively affects research collaboration intention. From the aspect of the inter-member attribute, the reciprocity, trust, and social network characteristics between researchers positively affect research collaboration intention.

## 4. METHODOLOGY

The methodology of this study is qualitative, 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 confirm the findings of the qualitative analysis.

### 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 items of the scale mainly refer to the mature scale in authoritative journals and are closely combined with the design of research requirements. The scale design of self-efficacy is by Chen and Hung (2010); The scale design of personality trait is from Hsu et al. (2007a); The scale design of experience is from Leung (2003) and Flanagan and Metzger (2001); The scale design of reciprocity is from Kankanhalli et al. (2005); the scale design of trust is from Fang and Chiu (2010) and Hsu et

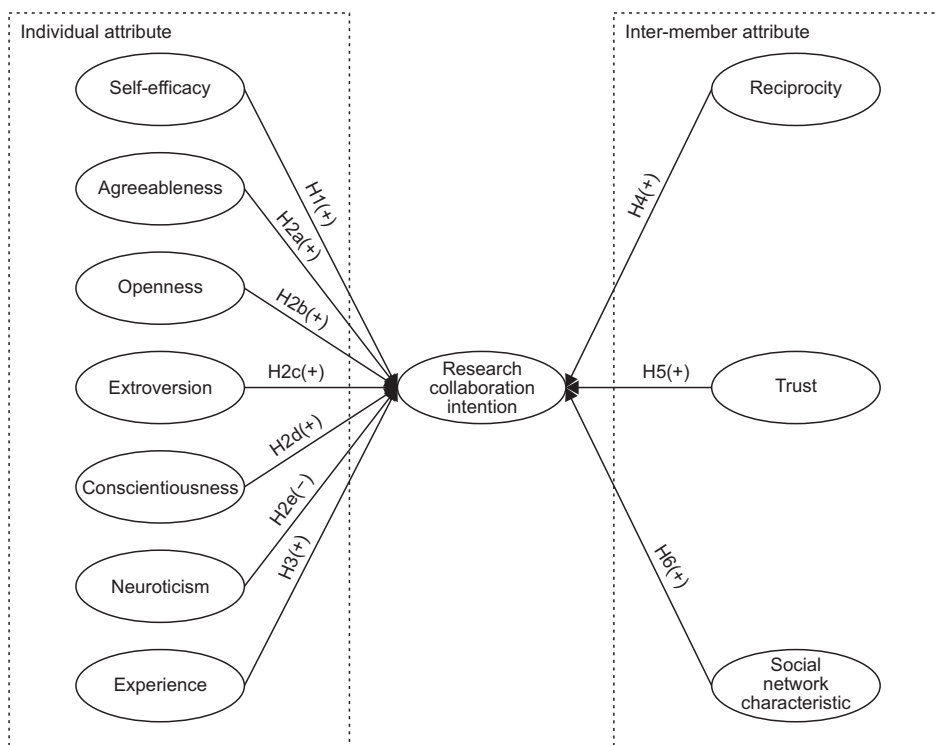


Fig. 1. Research model.

al. (2007b); the scale design of social networks is from Chen et al. (2009). All measurement items are presented in Appendix.

#### 4.2. Population and Sample

The target populations of this study are online registered researchers who usually use VACs. Sample selection is limited to VACs with a large number of researchers in China, such as muchong.com, jg.com.cn, sciencenet.cn, and DXY.CN. The sampling technology combines two approaches, such as simple random sampling and snowball sampling. The questionnaires were made on the Wenjuanxing Website, and sent to the relevant VACs. We collected 558 valid questionnaires in this survey. Table 1 shows the descriptive statistics of respondents.

As shown in Table 1, 50.7% of the respondent were male and 49.3% were female, which indicated that the sex distribution was uniform. The age range of 18-25 years and 26-35 years of age accounted for the most, and 61.3% of them had a master's degree or above, which was consistent with the fact that most of the respondents were researchers and students. The largest number of respondents used VACs once per week, accounting for 50 percent, indicating that half of the respondents were active in VACs; about 65 percent of the respondents had more than half a year of experience using VACs.

## 5. DATA ANALYSIS AND HYPOTHESIS TEST

### 5.1. Reliability and Validity Test

The Cronbach's alpha coefficient was used to test the reliability of the scale. Cronbach's alpha value is between 0 and 1. If  $\alpha$  value is lower than 0.6, this indicates that the reliability of the scale is not good; when it reaches 0.7-0.8, it means that the scale has considerable reliability. When it reaches 0.8-0.9, it means that the reliability of the scale is very good. In the aspect of validity, the scale of this paper comes from the mature scale, and a small part has been modified to combine the research practice. Exploratory factor analysis (EFA) and confirmatory factor analysis were used to test the structural validity of the scales. In EFA, we delete items with factor loading less than 0.5 and cross-factor loading greater than 0.4. The reliability and validity analysis of the scale is shown in Table 2.

As shown in Table 2, the values of Cronbach's of each variable are more than 0.7, which indicates that the scale of this study has good reliability. The values of Corrected Item-Total Correlation are between 0.497 and 0.631, which means the correlation between items is strong. The values of factors loading of each item are all more than 0.5, indicating that factors have a good explanation for the corresponding latent variables. Therefore, the scale of this study has good structural validity.

**Table 1.** Descriptive statistics

| Measure                           | Items                       | Frequency | Percent |
|-----------------------------------|-----------------------------|-----------|---------|
| Sex                               | Male                        | 283       | 50.7    |
|                                   | Female                      | 275       | 49.3    |
| Age                               | Under 18 years              | 0         | 0.0     |
|                                   | Between 18 and 25 years     | 240       | 43.0    |
|                                   | Between 26 and 35 years     | 218       | 39.1    |
|                                   | Between 36 and 45 years     | 67        | 12.0    |
|                                   | Over 45 years               | 33        | 5.9     |
| Education background              | College and below           | 20        | 3.6     |
|                                   | Bachelor degree             | 196       | 35.1    |
|                                   | Master degree               | 235       | 42.1    |
|                                   | Doctor degree and above     | 107       | 19.2    |
| Disciplinary background           | Science and engineering     | 163       | 29.2    |
|                                   | Literature and philosophy   | 87        | 15.6    |
|                                   | Economics and management    | 266       | 47.7    |
|                                   | Medical                     | 35        | 6.3     |
|                                   | Law                         | 7         | 1.3     |
| Position                          | Students                    | 228       | 40.9    |
|                                   | Researchers and teachers    | 160       | 28.7    |
|                                   | Civil servants              | 139       | 24.9    |
|                                   | Private owners              | 31        | 5.6     |
| Frequency of use                  | Every day                   | 199       | 35.7    |
|                                   | Weekly                      | 279       | 50.0    |
|                                   | Monthly                     | 80        | 14.3    |
| VACs member experience (in years) | Within one month            | 39        | 7.0     |
|                                   | Between 1 and 6 months      | 157       | 28.1    |
|                                   | Between 6 months and 1 year | 136       | 24.4    |
|                                   | Between 1 and 3 years       | 109       | 19.5    |
|                                   | More than 3 years           | 117       | 21.0    |

VACs, virtual academic communities.

Before factor analysis, the Kaise-Meryer-Olkin 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 commonly used Kaiser-Meyer-Olkin (KMO) metrics are as follows: 0.9 or more is strongly suitable for factor analysis; 0.8-0.9 is relatively suitable; 0.7-0.8 is suitable; 0.6-0.7 is acceptable; 0.5-0.6 means relatively not suitable; less than 0.5 is strongly not suitable. The KMO and Bartlett's test results

are shown in Table 3.

As shown in Table 3, the KMO value of the scale is 0.946, and Bartlett's Test of Sphericity is 16141.902,  $p < 0.01$ , which means the structure of each item of the scale is reasonable and suitable for factor analysis.

## 5.2. Model and Hypothesis Testing

After the reliability and validity test, the software AMOS 24.0 (IBM Corp., Armonk, NY, USA) was used to study the fitting degree of the model. The structural

**Table 2.** Reliability and validity analysis of scale

| Variables                        | Items | Corrected item-total correlation | Cronbach's alpha if item deleted | Cronbach's alpha of variables | Factor loading |
|----------------------------------|-------|----------------------------------|----------------------------------|-------------------------------|----------------|
| Self-efficiency                  | SE1   | 0.597                            | 0.935                            | 0.832                         | 0.815          |
|                                  | SE2   | 0.589                            | 0.935                            |                               | 0.858          |
|                                  | SE3   | 0.624                            | 0.935                            |                               | 0.717          |
| Agreeableness                    | AG1   | -0.193                           | 0.944                            | 0.913                         | 0.869          |
|                                  | AG2   | -0.191                           | 0.944                            |                               | 0.866          |
|                                  | AG3   | -0.167                           | 0.944                            |                               | 0.912          |
| Openness                         | OP1   | 0.497                            | 0.936                            | 0.751                         | 0.764          |
|                                  | OP2   | 0.485                            | 0.936                            |                               | 0.777          |
|                                  | OP3   | 0.498                            | 0.936                            |                               | 0.611          |
| Extroversion                     | EX1   | 0.535                            | 0.935                            | 0.808                         | 0.687          |
|                                  | EX2   | 0.629                            | 0.935                            |                               | 0.826          |
|                                  | EX3   | 0.576                            | 0.935                            |                               | 0.781          |
| Conscientiousness                | CO1   | 0.584                            | 0.935                            | 0.757                         | 0.750          |
|                                  | CO2   | 0.509                            | 0.936                            |                               | 0.696          |
|                                  | CO3   | 0.518                            | 0.936                            |                               | 0.681          |
| Neuroticism                      | NEU1  | 0.528                            | 0.935                            | 0.907                         | 0.850          |
|                                  | NEU2  | 0.557                            | 0.935                            |                               | 0.890          |
|                                  | NEU3  | 0.545                            | 0.935                            |                               | 0.885          |
| Experience                       | UE1   | 0.567                            | 0.935                            | 0.886                         | 0.787          |
|                                  | UE2   | 0.505                            | 0.936                            |                               | 0.742          |
|                                  | UE3   | 0.553                            | 0.935                            |                               | 0.674          |
| Reciprocal                       | RE1   | 0.621                            | 0.935                            | 0.868                         | 0.737          |
|                                  | RE2   | 0.551                            | 0.935                            |                               | 0.765          |
|                                  | RE3   | 0.626                            | 0.935                            |                               | 0.798          |
|                                  | RE4   | 0.631                            | 0.935                            |                               | 0.793          |
| Trust                            | TR3   | 0.582                            | 0.935                            | 0.881                         | 0.711          |
|                                  | TR4   | 0.614                            | 0.935                            |                               | 0.772          |
|                                  | TR5   | 0.571                            | 0.935                            |                               | 0.765          |
|                                  | TR6   | 0.618                            | 0.935                            |                               | 0.768          |
| Social networks characteristic   | CS1   | 0.596                            | 0.935                            | 0.899                         | 0.843          |
|                                  | CS2   | 0.640                            | 0.935                            |                               | 0.846          |
|                                  | ND1   | 0.557                            | 0.935                            |                               | 0.844          |
|                                  | ND2   | 0.579                            | 0.935                            |                               | 0.819          |
| Research collaboration intention | RCI1  | 0.596                            | 0.935                            | 0.861                         | 0.777          |
|                                  | RCI2  | 0.582                            | 0.935                            |                               | 0.820          |
|                                  | RCI3  | 0.599                            | 0.935                            |                               | 0.828          |



**Table 3.** KMO and Bartlett's test

|                                  |                    |           |
|----------------------------------|--------------------|-----------|
| KMO measure of sampling adequacy |                    | 0.946     |
| Bartlett's test of sphericity    | Approx. Chi-Square | 16141.902 |
|                                  | df                 | 903       |
|                                  | Sig.               | 0.000     |

KMO, Kaiser-Meyer-Olkin; Approx., approximate chi-square test; df, degree of freedom; Sig., significance.

equation model (SEM) was used to study the relationship between variables. The goodness of fit index is an indicator used in the structural equations to test the fit degree of the model and the data. Commonly used indicators are the  $\chi^2/df$ , Root Mean Square Error of Approximation (RMSEA), Goodness-of-fit index (GFI), Non-normed fit index (NNFI), Comparative fit index (CFI), Normed fit index (NFI), and Incremental fit index (IFI). It is generally believed that if  $\chi^2/df$  is below 3, RMSEA is below 0.08, and GFI, NNFI, CFI, NFI, and IFI are above 0.9, the fitted model is a "good" model. The model fit index of this study is shown in Table 4.

From Table 4, we find that absolute fit index  $\chi^2/df$  is 2.120 and smaller than 3; RMSEA is 0.044 and smaller than 0.05; relative fit index NFI is 0.918 and greater than 0.9; IFI is 0.955 and greater than 0.9; NNFI is 0.945, and greater than 0.9; CFI is 0.954, and greater than 0.9. That means all model parameters meet reasonable standards and the proposed research model fit data well. Based on the results of Table 4, we tested the previously proposed hypothesis by using the path coefficient. The path diagram is shown in Fig. 2. The path coefficient of the SEM is shown in Table 5.

Fig. 2 is a model path diagram drawn after importing the questionnaire data into the AMOS, which can visually express the linear relationship between the variables. Within the elliptical box are the latent variables, containing all the independent variables of this paper. Within the rectangular box are the observation variables, which consist of the scale items of each variable. Within small circles are measurement errors (such as e1 to e37). A one-way arrow connecting two variables assumes a causal relationship between them, and the arrow points from the independent variable to the factor variable. The curved two-arrow represents a correlation between the two variables. The value on the connector is the path coefficient to measure the degree of influence or correlation between variables. The path coefficient values between the independent variables and dependent variable in Fig. 2 are

**Table 4.** Model fit index

| Fit index   | Standard | Value |
|-------------|----------|-------|
| $\chi^2/df$ | <3       | 2.120 |
| GFI         | >0.9     | 0.908 |
| NFI         | >0.9     | 0.918 |
| IFI         | >0.9     | 0.955 |
| TLI (NNFI)  | >0.9     | 0.945 |
| CFI         | >0.9     | 0.954 |
| RMSEA       | <0.05    | 0.044 |

df, degree of freedom; GFI, Goodness-of-fit index; NFI, Normed fit index; IFI, Incremental fit index; TLI, Tucker-Lewis index; NNFI, Non-normed fit index; CFI, Comparative fit index; RMSEA, Root Mean Square Error of Approximation.

included in Table 5.

In Table 5, path coefficient is the non-standardized regression coefficient of the research model. S.E. is used to estimate the standard error of parameters, and C.R. is used to test the critical ratio of statistics. If the C.R. is greater than 1.96 and  $p < 0.05$ , it indicates that the path coefficient has reached a significant level, and the hypothesis is supported. If the contrary applies, the hypothesis is not supported.

From Fig. 2 and Table 5, we found that for individual attributes the path coefficient of self-efficacy, agreeableness, extroversion, neuroticism, and experience impacting on research collaboration intention are -0.142, 0.002, -0.282, 0.023, and -0.097, and their  $p$ -value is greater than 0.05 ( $p > 0.05$ ), therefore H1, H2a, H2c, H2e, and H3 are not supported; openness and trust have a significant positive function on research collaboration intention (C.R. > 1.96,  $p < 0.05$ ), therefore H2b and H2d are both proven. For inter-members attributes, we know that reciprocal, trust, and social network characteristics have a significant positive function on research collaboration intention (C.R. > 1.96,  $p < 0.05$ ), so H4, H5, and H6 are all supported.

For the supported hypothesis, reciprocal (H4) is an important factor of research collaboration intention in VACs. Reciprocal has the most significant influence on research collaboration intention, and this is consistent with the results of Lin (2007). Hence, members were more likely to have a higher tendency to collaborate with others in VACs, if they obtain reciprocal benefits from other researchers by contributing knowledge. Social network characteristics (H6) have a significant positive correlation to research collaboration intention, and this is consistent

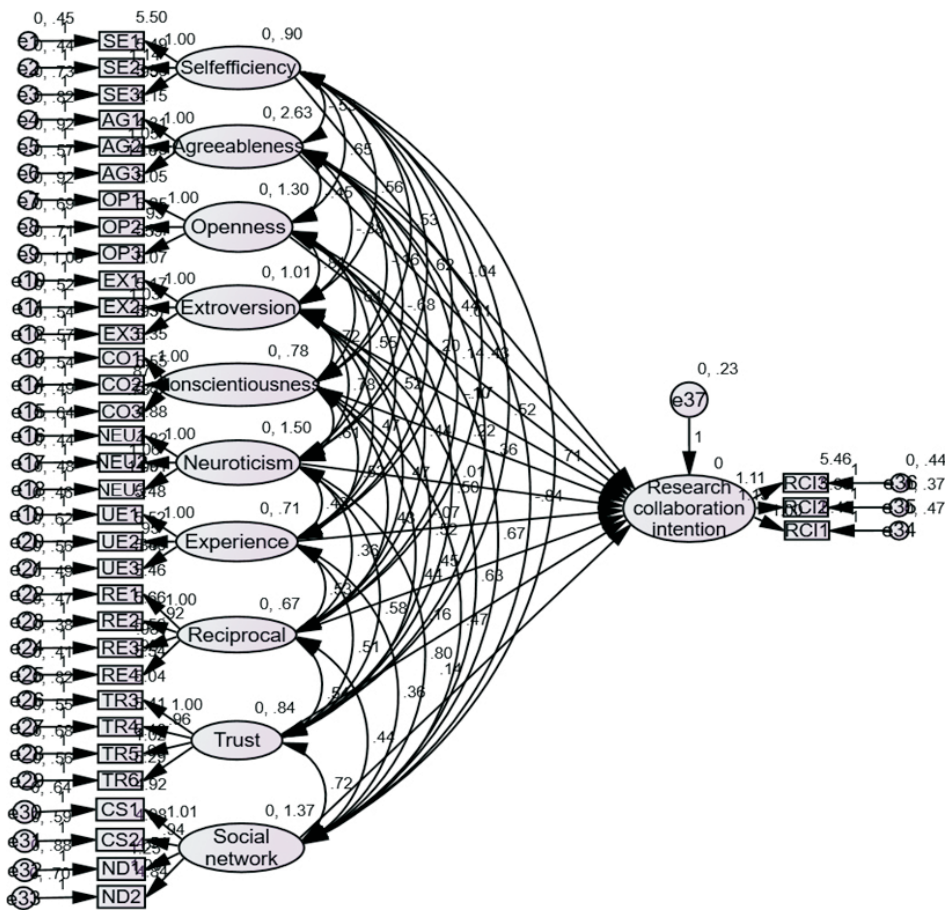


Fig. 2. Path diagram of the model.

Table 5. Path coefficient of structural equation model

| Hypothesis | Path hypothesis                      | Path coefficient | S.E.  | z (C.R.) | p-value | Test results  |
|------------|--------------------------------------|------------------|-------|----------|---------|---------------|
| H1         | RCI ← Self-efficacy                  | -0.142           | 0.112 | -1.267   | 0.205   | Not Supported |
| H2a        | RCI ← Agreeableness                  | 0.002            | 0.024 | 0.072    | 0.942   | Not Supported |
| H2b        | RCI ← Openness                       | 0.146            | 0.063 | 2.334    | 0.020   | Supported     |
| H2c        | RCI ← Extroversion                   | -0.282           | 0.156 | -1.805   | 0.071   | Not Supported |
| H2d        | RCI ← Conscientiousness              | 0.393            | 0.179 | 2.195    | 0.028   | Supported     |
| H2e        | RCI ← Neuroticism                    | 0.023            | 0.043 | 0.540    | 0.589   | Not Supported |
| H3         | RCI ← Experience                     | -0.097           | 0.112 | -0.862   | 0.389   | Not Supported |
| H4         | RCI ← Reciprocal                     | 0.453            | 0.098 | 4.656    | <0.001  | Supported     |
| H5         | RCI ← Trust                          | 0.164            | 0.060 | 2.789    | 0.005   | Supported     |
| H6         | RCI ← Social network characteristics | 0.144            | 0.046 | 3.139    | 0.002   | Supported     |

S.E., standard error; C.R., critical ratio.

with the results of Lu and Yang (2011) and Okoli and Oh (2007). Therefore, social network characteristic is an important factor in research collaboration in VACs. Trust (H5) is a significant positive correlation with research

collaboration intention, and this is consistent with the results of Vangen and Huxham (2003), Reina and Reina (2006), and Black et al. (2002). Trust building and maintaining trust mechanisms are the topic for most research-

ers, which suggests that trust is a core factor in the three terms of collaboration, coordination, and cooperation. Openness (H2b) and conscientiousness (H2d) of the FFM have a significant influence on the research collaboration intention in VACs, which are consistent with the results of Cabrera et al. (2006) and Yoo and Gretzel (2011).

For the hypotheses that are not supported, self-efficacy (H1) has no significant effect on research collaboration intention. Analysis of the reasons may be related to the respondents from different VACs. Because VACs have many uncertain factors, such as trust, capital, completion time, and so on, agreeableness (H2a) and extroversion (H2c) have no significant effect on research collaboration intention, which is consistent with the result of Hughes et al. (2012). The individuals with higher agreeableness and extroversion have better interpersonal relationships offline, therefore they do not need to find partners in the VACs. On neuroticism (H2e), this study found that it was not significantly related to research collaboration intention in VACs, which is consistent with the results of Ross et al. (2009). Highly neurotic people often feel anxious and lonely in their research work (Ebeling-Witte et al., 2007), and will use VACs more frequently to seek psychological comfort. But because of their inner sensitivity and suspicion, it is difficult for them to believe in others, and then they do not want to cooperate with others in VACs. The researcher's experience (H3) in VACs has no significant impact on research collaboration intention. Most studies have found that good experience can increase the intention of researchers to use VACs continuously (Qu & Zhang, 2015; Qu et al., 2016), but it has no significant correlation with the research collaboration intention.

## 6. DISCUSSION AND CONCLUSION

This study provides a new theoretical model for the research of VACs. On the basis of the theories of SCT, SET, SNT, and FFM, this paper constructed a model demonstrating the influencing factors of VACs researchers' research collaboration intention. The result shows that openness, conscientiousness, reciprocity, trust, and social network characteristic have a significant influence on the collaboration intention of researchers in VACs. In order to strengthen the research collaboration behavior and accelerate the development of VACs, we should improve the regulatory system, punish the researchers who have broken their promises, and create a safe cooperation environment. We also should create a good collaboration culture, atmosphere, and incentive mechanism to encourage in-

teraction between members, so that they can establish an effective network connection and mutual understanding. From the attribute of the individual, increasing openness, enhancing conscientiousness, and self-reputation will gain more partners in VACs.

According to the above research results, this paper proposes several suggestions to promote the research collaboration intention and community development. First, managers of VACs should establish management norms and trust mechanisms, because the community management norms and trust mechanisms are the necessary guarantees for the trust between researchers. The perfect trust management norms and mechanism will promote the researchers' intention to collaborate. Second, community managers should create a cultural atmosphere and enhance researchers' loyalty, belonging, and identity to the community, thus prompting them to find partners in the VACs to complete research tasks. Finally, the reward and punishment system in VACs should be improved. Managers should join research institutions and academic conferences to release research tasks and strengthen collaborative researchers' motivation to collaborate again by improving the reputation and distributing community gold coins.

We select the sample from four famous VACs in China. Future research will select more types of VACs to further verify the theoretical model. The sample mainly comes from college students and teachers, while the other occupations' groups are relatively few. We will expand the target population scope of the questionnaire survey in future study. The research model of this paper mainly considers the individual attributes and inter-member attribute of researchers in VACs, and future study will add the attributes of community to perfect the theoretical model.

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## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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## APPENDIX. Data collection tool and measurement items

The 7-point Likert scale was used in the survey of questionnaires (i.e., ranging from 1=strongly disagree to 7=strongly agree). The questionnaire had 43 items, and all derived from the previous maturity scale. We used a pilot study to correct ambiguous places. The questionnaires were made on the Wenjuanxing Website, and sent to the relevant VACs.

### Self-efficiency

SE1: I have confidence in my ability to provide knowledge that other members in this virtual community consider valuable.

SE2: I have the expertise, experiences, and insights needed to provide knowledge valuable for other members of this virtual community.

SE3: I have confidence in responding or adding comments to messages or articles posted by other members of this virtual community.

### Agreeableness

AG1: Some people think I'm selfish and egotistical.

AG2: I tend to be cynical and skeptical of others' intentions.

AG3: Some people think of me as cold and calculating.

### Openness

OP1: Poetry has little or no effect on me.

OP2: Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.

OP3: I have little interest in speculating on the nature of the universe or the human condition.

### Extroversion

EX1: I often feel as if I'm bursting with energy.

EX2: I am a cheerful, high-spirited person.

EX3: I really enjoy talking to people.

### Conscientiousness

CO1: I am a productive person who always gets the job done.

CO2: I strive for excellence in everything I do.

CO3: I try to perform all the tasks assigned to me conscientiously.

### Neuroticism

NEU1: I am seldom sad or depressed.

NEU2: I rarely feel lonely or blue.

NEU3: I rarely feel fearful or anxious.

### Experience

UE1: I can get the information or knowledge I need in this community.

UE2: When I'm in trouble, I come to the community for help.

UE3: The community is well organized and rich in content.

UE4: I can relax in the community.

UE5: I feel less tense in the community.

UE6: Joining the virtual academic communities makes me meet new research partners.

UE7: I can get support and encouragement from other members in the community.

UE8: I can communicate with people who have similar ideas in the community.

### Reciprocal

RB1: When I share my knowledge through VACs, I believe that I will get an answer for answering.

RB2: When I share my knowledge through VACs, I expect somebody to respond when I'm in need.

RB3: When I contribute knowledge to VACs, I expect to get back knowledge when I need it.

RB4: When I share my knowledge through VACs, I believe that my queries for knowledge will be answered in the future.

### **Trust**

TR1: Management at the VACs shows concern for members' needs.

TR2: Management at the VACs does not take advantage of members when the opportunity arises.

TR3: Management at the VACs is very capable of performing tasks in managing the community.

TR4: Researchers in the VACs do not take advantage of other members when the opportunity arises.

TR5: The other members at VACs would not knowingly do anything to disrupt conversation/interactions.

TR6: The other members at VACs have adequate knowledge about the subject we discuss.

### **Social networks characteristic**

CS1: I maintain close social relationships with some members in the virtual learning community.

CS2: I intensively exchange ideas with some members in the virtual learning community.

ND1: I know some members in the virtual learning community on a personal level.

ND2: I have frequent communication with some members in the virtual learning community.

### **Research collaboration intention**

RCI1: If I can, I would like to continue collaborating with others at VACs in the future.

RCI2: I will likely continue collaborating with others at VACs in the future.

RCI3: I expect to continue collaborating with others at VACs in the future.