Research on Motivating Factors for Knowledge Innovation Behavior of Virtual Community Users from Endogenous and Exogenous Perspectives: Postprint

Authors: Li He, Peng Lihui, Hong Chuang, Liu Jincheng, Zhu Linlin

Date: 2023-07-26T00:00:00+00:00

Abstract

[目的/意义] This study investigates the motivational factors influencing user knowledge innovation behavior in virtual communities, which contributes to a deeper understanding of the underlying motivations and provides insights and recommendations for enhancing knowledge exchange and innovation within these communities. [方法/过程] From the dual perspectives of "endogenous motivation" and "exogenous motivation," the research integrates the Theory of Planned Behavior, Expectancy Theory, and virtual community perception factors to revise the Theory of Planned Behavior model, with data collected through questionnaire surveys and subjected to empirical testing. [结果/结论] The results reveal that membership, influence, and knowledge self-efficacy within virtual community sense positively affect "self-interest" knowledge innovation intention; subjective norms and group norms are positively correlated with "altruistic" knowledge innovation intention; the virtual community interactive environment significantly moderates the relationship between "altruistic" knowledge innovation intention and both knowledge source innovation and the development of new problems and ideas; both "self-interest" and "altruistic" knowledge innovation intentions positively influence knowledge source innovation and the development of new problems and ideas, with the effect of "self-interest" knowledge innovation intention being stronger than that of "altruistic" knowledge innovation intention.

Full Text

Preamble

Research on Motivation Factors of User Knowledge Innovation Behavior in Virtual Communities from Endogenous and Exogenous Per-

spectives

Li He, Peng Lihui, Hong Chuang, Liu Jincheng, Zhu Linlin
School of Management, Jilin University, Changchun 130022

Abstract

[**Purpose/Significance**] Investigating the motivational factors behind user knowledge innovation behavior in virtual communities helps deepen our understanding of the motivations driving such behavior and provides references and recommendations for enhancing knowledge exchange and innovation in virtual communities. [**Method/Process**] From the dual perspectives of "endogenous motivation" and "exogenous motivation," this study integrates the Theory of Planned Behavior, Expectancy Incentive Theory, and virtual community perception factors to revise the Theory of Planned Behavior model. Data were collected through questionnaire surveys and empirically tested. [**Result/Conclusion**] The results indicate that: membership, influence, and knowledge self-efficacy within virtual community perception positively affect the willingness for "self-interested" knowledge innovation; subjective norms and group norms are positively correlated with the willingness for "altruistic" knowledge innovation; the virtual community interactive environment significantly moderates the relationships between altruistic knowledge innovation willingness and both knowledge source innovation and new problem/idea development; both self-interested and altruistic knowledge innovation willingness positively influence knowledge source innovation and new problem/idea development, with self-interested knowledge innovation willingness demonstrating a stronger effect than altruistic knowledge innovation willingness.

Keywords: endogenous motivation, exogenous motivation, virtual community, knowledge innovation

1. Introduction

The 42nd "Statistical Report on China's Internet Development" reveals that as of June 30, 2018, China's internet user population exceeded 800 million for the first time, with internet penetration reaching 57.7%. As netizens' information literacy improves, virtual communities in China have gradually become more diversified and specialized, evolving from social networking communities such as Baidu Tieba and QQ groups to professional knowledge-based communities like Zhihu and Xiaomuchong. Knowledge sharing and knowledge innovation represent two critical components of knowledge management activities [1]. Knowledge innovation emerges during the process of maximizing knowledge sharing, with knowledge sharing serving as the prerequisite for knowledge innovation. Virtual communities provide a new platform for members' knowledge sharing and create new development space for knowledge innovation. I. Nonaka and colleagues propose that innovative knowledge in communities is achieved through continuous dialogue between tacit and explicit knowledge, with members gen-

erating knowledge innovation behaviors during the knowledge sharing process [2].

However, while domestic virtual community users can effectively exchange information and share knowledge, only a minority of communities can sustain user engagement and achieve user knowledge innovation [3]. The 21st century is the era of the knowledge economy, and virtual community innovation has attracted widespread attention from both industry and academia. Many domestic and international enterprises have built open innovation communities to attract and absorb external users' opinions and creativity, such as American wireless companies soliciting user ideas for new mobile phone product design online [4], and domestic Xiaomi encouraging customers to design T-shirts through open online communities. Academic communities, as professional knowledge communities, not only enhance the efficiency of academic exchanges within disciplines but also provide platforms and opportunities for knowledge innovation within fields. Therefore, exploring user knowledge innovation behavior in virtual communities not only helps improve users' personal qualities and values but also holds significant meaning for the sustainable development of virtual community knowledge services.

In recent years, research on user knowledge innovation in virtual communities has received extensive academic attention, but theoretical explanations remain immature and incomplete. Based on relevant literature and virtual community characteristics, this study posits that knowledge innovation in virtual communities originates from knowledge sharing within the community. Through the exchange and diffusion of explicit knowledge, members achieve deeper understanding, absorption, and integration of knowledge, stimulating the transfer and transformation of tacit knowledge through group interaction, ultimately forming dynamic evolutionary processes for new knowledge such as new concepts, new methods, and innovative knowledge sources. Since motivation guides behavior, virtual community managers and operators need to understand the factors influencing members' participation in knowledge innovation. Accordingly, this study constructs a research model of motivational factors for user knowledge innovation behavior in virtual communities and conducts empirical analysis to expand the theoretical perspective on virtual community user knowledge innovation behavior and provide reasonable pathways and scientific practical guidance for motivating user knowledge innovation behavior.

2. Literature Review

Domestic and international scholars have studied knowledge innovation behavior in virtual communities from various theoretical perspectives. Foreign researchers have examined user knowledge innovation behavior from different angles including motivation and content. S.W. Chou synthesized previous research to first elaborate on the relationship between knowledge innovation and community members' personal factors and innovation motivations in virtual communities. His empirical research confirmed that personal factors such as computer

self-efficacy and information technology innovativeness have direct positive effects on innovation motivation, which in turn positively affects knowledge innovation through member satisfaction [5]. M.M. Wasko and S. Faraj studied knowledge sharing behavior in electronic practice networks using social capital theory and personal motivation, concluding that personal reputation, reciprocity, and responsibility significantly influence community members' knowledge innovation [6]. H. Yli-Renko et al. found that knowledge sharing positively affects knowledge innovation behavior, which helps communities gain competitive advantages through new product/service development, unique technical design, and sales cost efficiency [7]. C.L. Hsu and J.C.C. Lin studied blog usage based on the Theory of Reasoned Action, examining technology acceptance, knowledge sharing, and social influence, and proposed that convenience and enjoyment, altruism, reputation, and social factors motivate users' continuous participation [8]. M.M. Al-Debei et al. suggested that virtual communities provide convenient collaborative spaces, making user value exchange and innovation have effective channels, and that motivating user knowledge innovation behavior is important for improving virtual community knowledge service quality and promoting personal development [9].

Domestic research has also yielded valuable findings. Long Xiaowen and Pang Jiangang used principal component analysis to empirically study academic community members' knowledge innovation behavior motivations from three aspects: external motivation, internalized external motivation, and internal motivation, concluding that internal motivation composed of self-efficacy and community identity is the primary driver [10]. Long Xiaowen further found that social capital factors such as group interaction, personal expertise, values, trust, reciprocity, and community recognition significantly affect knowledge innovation behavior and knowledge source innovation in academic network communities [11]. Liu Qi and Du Rong found that high-quality knowledge sharing improves community innovation and member satisfaction, with higher community innovation leading to higher member satisfaction [12]. Wu Qiong and Deng Shengwei argued that virtual communities represent a new environment for user knowledge innovation, and that studying influencing factors is crucial for improving knowledge innovation services, identifying self-worth, reputation, and knowledge self-efficacy as having significant positive effects on knowledge innovation quality and quantity [13]. Zhang Yongyun et al. analyzed interview data from 75 members across six online virtual communities, identifying cyberspace as an important venue for individual and enterprise knowledge innovation [14].

Literature review reveals that most theoretical studies domestically and internationally adopt perspectives from social capital theory and social cognitive theory, with less exploration from incentive theory. Incentive has long been regarded as the source of individual behavioral motivation and extensively studied in sociology and psychology. This study therefore attempts to analyze knowledge innovation willingness by combining the Theory of Planned Behavior and Expectancy Incentive Theory. Most existing research focuses on behavioral motivation while neglecting behavior itself. Although motivation can largely explain behavior,

they are not equivalent. This study examines knowledge innovation willingness from both "endogenous motivation" and "exogenous motivation" dimensions and considers knowledge innovation behavior through its impact on "new problem/idea development" and "knowledge source innovation." While scholars have studied knowledge innovation from dimensions such as knowledge sharing, information technology, and community factors, research lacks exploration from the emotional perspective of individuals and communities. Therefore, this study introduces virtual community perception as an important dimension of endogenous motivation for user knowledge innovation behavior.

3. Theoretical Foundations

3.1 Virtual Community Perception

Research has long established that humans are social animals who gain security through group membership. With changing social environments, virtual communities on the Web have emerged alongside real-life groups. Blanchard et al. proposed the concept of virtual community perception based on community perception, defining it as members' subjective feelings about membership, influence, need fulfillment, and emotional connection within virtual communities [15]. They developed a new virtual community perception scale based on the widely used traditional community perception scale [16]. Tontéri et al. empirically found from an individual perspective that both forms of participation (reading and posting) positively correlate with virtual community perception [17]. Sánchez-Franco analyzed the influence of virtual community perception on personal innovativeness and familiarity with virtual communities using the Spanish social networking platform Tuenti as an example [18].

Foreign scholars have thus identified virtual community perception as a key factor in studying virtual community user behavior, with ongoing discussion and deepening of scale design and application scope, while domestic research on virtual community perception remains limited. Knowledge innovation behavior in virtual communities cannot be separated from members' subjective feelings. Literature on virtual community knowledge innovation often discusses issues from perspectives of trust, reciprocity, personal value, reputation, and recognition, which align with the dimensions of membership, influence, and immersion in virtual community perception. This study therefore introduces virtual community perception theory to analyze knowledge innovation behavior, enriching domestic research content and providing a new perspective.

3.2 Theory of Planned Behavior Model

In the 1990s, I. Ajzen added "perceived behavioral control" to the Theory of Reasoned Action, forming the Theory of Planned Behavior (TPB) model comprising five factors: attitude, subjective norm, perceived behavioral control, behavioral intention, and behavior [19]. Ajzen also suggested that the theory could incorporate additional dimensions and measurement variables as needed

to improve explanatory power. TPB helps understand how people implement or change behavior patterns, positing that behavior results from thoughtful planning with behavioral intention as the core element—representing the degree of difficulty individuals are willing to attempt and the effort they plan to exert. The "attitude-intention-behavior" framework of TPB effectively explains motivational factors for knowledge innovation behavior in virtual communities. This study uses TPB as the theoretical foundation, integrating virtual community perception and expectancy incentive theory to enrich TPB while improving model explanatory power. Virtual community perception serves as an alternative variable for attitude, combined with knowledge self-efficacy and normative beliefs to analyze motivational factors for knowledge innovation willingness.

3.3 Expectancy Incentive Theory

Incentive has long been regarded as the source of individual behavioral motivation and widely studied in sociology and psychology. Initially considered a singular concept, research later expanded incentive sources from external environments to individuals themselves. Porter and Lawler first divided incentive into endogenous and exogenous motivation based on expectancy incentive theory [20]. Endogenous motivation emphasizes individual importance attached to behavior itself, stemming from feelings of competence and self-control, which originate internally and are unrelated to external factors [21]. Exogenous motivation emphasizes that regardless of whether individuals pursue material or non-material rewards, such rewards are unrelated to behavior itself and can include material compensation, organizational recognition, or improved interpersonal relationships—in essence, individual behavior aims to obtain expected organizational rewards [22].

Virtual community knowledge innovation forms the foundation of technological innovation and the source of new technologies and inventions. Studying knowledge innovation incentive factors is important for technological progress and social development. However, current research focuses primarily on exogenous motivation while neglecting endogenous motivation's role in promoting knowledge innovation behavior, with few scholars examining both in virtual community contexts. This study therefore explores the relationship between endogenous/exogenous motivation and knowledge innovation willingness in academic virtual communities to reveal the internal mechanisms and provide suggestions for enhancing knowledge innovation behavior.

4. Research Hypotheses and Model Construction

4.1 Influence of Virtual Community Perception on Self-Interested Knowledge Innovation Willingness

Virtual community perception represents a key characteristic distinguishing virtual communities. Blanchard et al. argue that only virtual groups where members develop a sense of virtual community can be called virtual communities [23].

Virtual community perception reflects users' subjective feelings and emotional attitudes toward virtual communities. Stronger virtual community perception leads to greater member loyalty and responsibility [24], facilitating positive attitudes toward knowledge innovation behavior. This study therefore analyzes virtual community perception as an attitudinal factor affecting knowledge innovation willingness.

As expectancy incentive theory suggests, endogenous motivation refers to individuals acting to satisfy internal needs such as achievement and pleasure. In virtual communities, users engage in knowledge innovation not for external material rewards but for internal self-value enhancement and knowledge skill improvement—an internally driven process generating "self-interested" knowledge innovation willingness. Cui Xuan et al. analyzed foreign virtual community perception scales and developed a scale suitable for Chinese netizens comprising three factors: membership, influence, and immersion [25]. Koh and Kim [26] note that membership reflects belongingness to virtual communities; influence reflects members' perceived impact on other members or the community; immersion represents members' engrossment in the community. These factors represent internal perceptions related to spiritual benefits. This study analyzes how these three dimensions affect self-interested knowledge innovation willingness to explore how emotional connections between members and communities influence behavior.

H1: Membership positively affects self-interested knowledge innovation willingness.
H2: Influence positively affects self-interested knowledge innovation willingness.
H3: Immersion positively affects self-interested knowledge innovation willingness.

4.2 Influence of Knowledge Self-Efficacy on Altruistic Knowledge Innovation Willingness

With TPB's development, self-efficacy is often considered part of perceived behavioral control. Cheung et al. found that knowledge self-efficacy and satisfaction significantly affect continuous knowledge contribution behavior in virtual communities—stronger confidence in knowledge abilities leads to more continuous contribution [27]. This study defines knowledge self-efficacy as users' confidence in their knowledge repository and expertise level, specifically their belief that their knowledge can help themselves or others solve problems or improve learning efficiency. When individuals have stronger knowledge self-efficacy, they perceive innovation behavior as less difficult and have stronger innovation willingness. Higher knowledge self-efficacy enables solving others' problems, forming positive altruistic knowledge innovation willingness. During knowledge exchange and innovation, others' new ideas also enhance members' knowledge self-efficacy, forming self-interested knowledge innovation willingness. Ajzen noted that perceived behavioral control can directly predict behavior [19], and many studies show it directly affects behavior [28]. Therefore:

H4a: Knowledge self-efficacy positively affects self-interested knowledge innovation willingness.
H4b: Knowledge self-efficacy positively affects altruistic knowledge innovation willingness.
H4c: Knowledge self-efficacy positively affects knowledge source innovation.
H4d: Knowledge self-efficacy positively affects new problem/idea development.

4.3 Influence of Normative Beliefs on Altruistic Knowledge Innovation Willingness

In organizational behavior research, norms ensure effective organizational operation. This study divides normative beliefs into subjective norms and group norms. In TPB, subjective norm refers to perceived social pressure regarding whether to perform a specific behavior, reflecting the influence of important others or groups on individual behavioral decisions. When virtual community users experience greater external pressure, higher subjective norms strengthen behavioral intentions to meet others' knowledge needs, forming altruistic knowledge innovation willingness. Wang Chenxing confirmed subjective norms' significant effect on knowledge sharing willingness in social Q&A communities [29]. Group norms are standards set by community managers that all members must follow, creating a mutual assistance atmosphere. Nahapiet and Ghoshal found that members' group recognition affects their motivation to create and exchange knowledge [30], which can be understood as recognition of group norms. People tend to store knowledge they master, only contributing when they recognize a group or follow group norms. Exogenous incentive theory suggests individual behavior is significantly influenced by organizational image and altruism. This study posits that expectations from important others or group pressure create altruistic knowledge innovation willingness.

H5: Subjective norm positively affects altruistic knowledge innovation willingness.
H6: Group norm positively affects altruistic knowledge innovation willingness.

4.4 Moderating Role of Virtual Community Interactive Environment

Nonaka argued that while new knowledge is developed by individuals, organizations play key roles in its formation and maturation [31]. From an organizational innovation perspective, virtual community architecture can be viewed as the interactive environment structure for member exchanges, with interactive environment innovation being an important community innovation component. Hagel et al. defined interactive environment as members' feelings about community management systems, interface design, and member interaction relationships, suggesting that good interactive environments enhance belongingness, trust, and satisfaction [32]. Virtual community interactive environment is a key factor for knowledge services, providing necessary conditions for knowledge exchange and sharing while objectively affecting user knowledge innovation. This

study introduces virtual community interactive environment as a moderating variable:

H7a: Virtual community interactive environment positively moderates the relationship between self-interested knowledge innovation willingness and knowledge source innovation.
H7b: Virtual community interactive environment positively moderates the relationship between self-interested knowledge innovation willingness and new problem/idea development.
H7c: Virtual community interactive environment positively moderates the relationship between altruistic knowledge innovation willingness and knowledge source innovation.
H7d: Virtual community interactive environment positively moderates the relationship between altruistic knowledge innovation willingness and new problem/idea development.

4.5 Influence of Self-Interested and Altruistic Knowledge Innovation Willingness on Knowledge Innovation Behavior

Scholars consider behavioral intention highly correlated with behavior itself, with intention predicting behavior. Zhang Yi et al. confirmed that employee innovation willingness significantly positively affects innovation behavior including idea generation and implementation [33]. Knowledge innovation involves exploring new knowledge based on existing knowledge. This study divides knowledge innovation behavior into: (1) new problem/idea development—users reorganizing, processing, and transforming existing knowledge to generate new problems and ideas; and (2) knowledge source innovation—collecting, revising, adjusting, and feeding back knowledge within virtual communities to form richer, more complete, and valuable innovative knowledge sources. Stronger innovation willingness leads to more new problems/ideas and innovative knowledge sources.

H8a: Self-interested knowledge innovation willingness positively affects knowledge source innovation.
H8b: Self-interested knowledge innovation willingness positively affects new problem/idea development.
H9a: Altruistic knowledge innovation willingness positively affects knowledge source innovation.
H9b: Altruistic knowledge innovation willingness positively affects new problem/idea development.

Based on these hypotheses, this study constructs a research framework (Figure 1 [Figure 1: see original paper]) integrating TPB with virtual community perception and expectancy incentive theory, treating virtual community perception as an "endogenous motivation" variable and perceived norms as an "exogenous motivation" variable to examine their effects on knowledge innovation behavior, with virtual community interactive environment as a moderator.

5. Empirical Analysis

5.1 Questionnaire Design and Data Collection

Academic virtual communities are widely recognized as important venues for online academic exchange. This study uses academic virtual communities as research subjects to provide basis for general virtual community knowledge innovation research. The study employs online questionnaires and snowball sampling for quantitative analysis. Using Wenjuanxing platform, we distributed questionnaire links to 10 different academic virtual community members via internal messages, email, and QQ private messages, obtaining 193 valid questionnaires (81% valid response rate). The measurement scales were adapted from established domestic and international literature, using a 7-point Likert scale. The questionnaire comprised two parts: (1) Basic personal information—61% female respondents, primarily aged 20-30, with 22.9% undergraduates, 54.4% master's students, and 22.8% doctoral students. Approximately 84% were Zhihu users, followed by Xiaomuchong, Renmin University Economic Forum, Kaoyan Forum, and ScienceNet. Most were ordinary members with community tenure of 6 months to 1 year. (2) Variable items—43 qualified items remained after removing those with factor loadings below 0.6 (see Table 1).

5.2 Measurement Model Testing

This study uses SmartPLS 2.0 to test both measurement and structural models. PLS uses regression methods to optimize model relationships, minimizing residuals and being particularly suitable for complex models. Testing includes reliability and validity assessment. Reliability reflects questionnaire reliability, stability, and consistency. Cronbach's Alpha (CA) and Composite Reliability (CR) are key reliability indicators. All latent variables' CA and CR exceed 0.8, indicating high reliability. Average Variance Extracted (AVE) values exceed 0.6, demonstrating good convergent validity (see Table 2).

Validity reflects measurement effectiveness and accuracy. All items were directly extracted or adapted from domestic and international research literature, ensuring high content validity. This study uses the square root of each variable's AVE to assess discriminant validity. The square root values of AVE (bolded in Table 3) exceed inter-variable correlations, confirming significant differences between variables and good discriminant validity.

The data analysis results in Tables 3-5 demonstrate good model quality, with confirmatory factors and variables meeting validity standards.

5.3 Structural Model Testing

This study uses SmartPLS 2.0 and SPSS 22.0 for structural equation modeling. Survey data were input into the structural equation model, with path testing results shown in Figure 2 [Figure 2: see original paper].

Regarding significant relationships: only immersion in virtual community perception shows no significant relationship with self-interested knowledge innovation willingness; knowledge self-efficacy significantly correlates only with self-interested knowledge innovation willingness; subjective norms and group norms both significantly correlate with altruistic knowledge innovation willingness; both self-interested and altruistic knowledge innovation willingness significantly correlate with knowledge source innovation and new problem/idea development; virtual community interactive environment significantly moderates the relationships between altruistic knowledge innovation willingness and both knowledge source innovation and new problem/idea development. Specific results appear in Table 4 .

This study uses hierarchical multiple regression to test moderating effects. Based on hypotheses, self-interested/altruistic knowledge innovation willingness and virtual community interactive environment serve as independent and moderating variables, with interaction terms constructed. To reduce multicollinearity, variables were centered [43]. If regression coefficient c is significant, moderation is significant, with effect size indicated by ΔR^2. Results show virtual community interactive environment does not significantly moderate relationships between self-interested knowledge innovation willingness and innovation behaviors (sig=0.543, sig=0.334), with no significant R^2 increase, thus H7a and H7b are not supported. Virtual community interactive environment significantly moderates relationships between altruistic knowledge innovation willingness and knowledge source innovation (sig=0.032) and new problem/idea development (sig=0.001), with significant R^2 increases (ΔR^2=0.253 and 0.244 respectively), indicating notable moderation effects.

Given significant moderation, simple slope analysis was conducted using Aiken and West's method [44]. By creating high and low values of the moderator (mean ± SD) and examining interaction effects, results show: for altruistic knowledge innovation willingness and knowledge source innovation, simple slopes range from [0.127, 0.364] and are significantly non-zero. At high interactive environment levels, the relationship is significantly positive (B=4.65, t=3.55, p<.001); at low levels, the relationship is also significantly positive but weaker (B=3.15, t=3.9, p<.001) (see Figure 3 [Figure 3: see original paper]). For altruistic knowledge innovation willingness and new problem/idea development, simple slopes range from [0.05, 0.417] and are significantly non-zero. At high interactive environment levels, the relationship is significantly positive (B=0.61, t=4.6, p<.001); at low levels, the relationship is positive but weaker (B=0.84, t=0.631, p<.001) (see Figure 4 [Figure 4: see original paper]). Thus, H7c and H7d are supported.

6. Results Discussion and Research Summary

6.1 Results Discussion

Analysis using SmartPLS 2.0 and SPSS 22.0 demonstrates the theoretical framework and measurement model are reasonable, yielding several conclusions:

(1) **Endogenous motivation effects**: H1 and H2 are supported—membership and influence positively affect self-interested knowledge innovation willingness. Membership creates belongingness; stronger membership fosters loyalty and responsibility, generating positive attitudes toward knowledge innovation. When users receive recognition, their sense of achievement strengthens. Perceiving influence enhances importance, and for self-value improvement and challenge, users form internal motivation for self-interested knowledge innovation. This confirms Blanchard's finding that virtual community perception significantly affects user behavior [45]. H3 is not supported, indicating immersion does not significantly affect self-interested knowledge innovation willingness. This suggests time spent in virtual communities does not directly correlate with innovation willingness, as addiction may reflect habit or entertainment rather than complex knowledge innovation behavior.

Only H4a is supported for knowledge self-efficacy, indicating it only affects self-interested knowledge innovation willingness, not altruistic. Self-interested willingness originates from self-actualization emotions, while knowledge self-efficacy represents confidence in one's knowledge abilities. When users believe they possess competence and skills, their task confidence increases, generating self-interested rather than altruistic motivation. Results also show knowledge self-efficacy does not directly affect innovation behavior, confirming that not all perceived behavioral control directly influences behavior.

(2) **Exogenous motivation effects**: H5 is supported—subjective norms positively affect altruistic knowledge innovation willingness. Subjective norms reflect important others' influence on individual decisions and individuals' need for approval. When users anticipate others' expectations for their knowledge innovation, they derive satisfaction from altruistic behavior itself, forming altruistic knowledge innovation willingness. H6 is supported—group norms positively affect altruistic knowledge innovation willingness. Group norms ensure group goal achievement, and stronger group norm awareness leads to greater willingness to help others and improve information exchange efficiency. When members identify with group values, they are more willing to serve the virtual community and actively perform behaviors beneficial to community development.

(3) **Innovation willingness effects**: H8a, H8b, H9a, and H9b are supported—both self-interested and altruistic knowledge innovation willingness positively affect knowledge source innovation and new problem/idea development. Behavioral intention represents subjective

probability judgments about behavior implementation. Both types of willingness are purposeful and motivational, thus predicting and incentivizing knowledge innovation. Self-interested willingness shows stronger effects than altruistic willingness, indicating internal motivation primarily drives behavior. However, moderation tests show only H7c and H7d are supported—virtual community interactive environment only moderates relationships between altruistic knowledge innovation willingness and innovation behaviors. As an external motivational factor, interactive environment coordinates external factors to enhance altruistic willingness's effect on behavior, with higher-quality environments showing stronger moderation.

6.2 Research Summary

This study divides knowledge innovation willingness into self-interested and altruistic types corresponding to endogenous and exogenous motivation, integrating TPB, expectancy incentive theory, and virtual community perception factors to examine motivational factors for user knowledge innovation behavior, with interactive environment as a moderator. Theoretical contributions include: (1) integrating expectancy incentive theory and virtual community perception into TPB, deepening TPB's application in knowledge management; (2) combining endogenous and exogenous perspectives to reveal mechanisms between motivational factors and behavior; (3) innovatively introducing virtual community perception as an attitudinal factor; (4) specifying knowledge innovation behavior into knowledge source innovation and new problem/idea development for deeper analysis.

Practically, findings provide guidance for virtual community managers: (1) Strengthen self-interested willingness by enhancing member connections (e.g., regular online group activities), identifying opinion leaders for rewards, and creating star role models; (2) Cultivate subjective norms and improve group norms to clarify reciprocity principles and create harmonious knowledge exchange environments; (3) Optimize platform interface, navigation, and interaction design to improve information transmission quality and create benign interactive environments that enhance altruistic willingness's effect.

Limitations include: (1) Using online questionnaires with academic virtual communities as primary subjects, without comparative analysis across community types; (2) Focusing on motivational factors while lacking analysis of tacit/explicit knowledge transformation during innovation. Future research should apply more comprehensive theoretical frameworks to analyze content and process for more scientific models.

References

[1] Shao Bo, Hu Yuanjiao. Construction and Analysis of Knowledge Innovation and Sharing Based on Social Networks [J]. *Library and Information Knowledge*,

2011(5): 115-121.

[2] Nonaka I, Umemoto K, Takeuchi H. A Theory of Organizational Knowledge Creation [J]. *Organization Science*, 1996, 5(1): 14-37.

[3] Wu Qiong, Deng Shengwei. Empirical Research on Influencing Factors of Knowledge Innovation in Virtual Communities [J]. *Information Studies: Theory & Application*, 2011, 34(6): 829-854.

[4] Qin Min, Qiao Han, Chen Lianghuang. Research on Enterprise Open Innovation Community Online User Contribution Behavior Based on CAS Theory: Taking Domestic Well-Known Enterprise Communities as Examples [J]. *Management Review*, 2015, 27(1): 126-137.

[5] Chou SW. Why Members Contribute Knowledge to Online Communities [J]. *Online Information Review*, 2010, 34(6): 829-854.

[6] Wasko MM, Faraj S. Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice [J]. *MIS Quarterly*, 2005, 29(1): 35-57.

[7] Yli-Renko H, Autio E, Sapienza HJ. Social Capital, Knowledge Acquisition, and Knowledge Exploitation in Young Technology-Based Firms [J]. *Strategic Management Journal*, 2001, 22(6/7): 587-613.

[8] Hsu CL, Lin JCC. Acceptance of Blog Usage: The Roles of Technology Acceptance, Social Influence, and Knowledge Sharing Motivation [J]. *Information & Management*, 2008, 45(1): 65-74.

[9] Al-Debei MM, Al-Lozi E, Papazafeiropoulou A. Why People Keep Coming Back to Facebook: Explaining and Predicting Continuance Participation from an Extended Theory of Planned Behavior Perspective [J]. *Decision Support Systems*, 2013, 55(1): 43-54.

[10] Long Xiaowen, Pang Jiangang. Empirical Research on Knowledge Innovation Behavior Motivation of Academic Community Members Based on Principal Component Analysis [J]. *Journal of Intelligence*, 2016, 35(12): 127-132.

[11] Long Xiaowen. Research on Influencing Factors of Knowledge Innovation Behavior in Academic Network Communities [D]. Mianyang: Southwest University of Science and Technology, 2017.

[12] Liu Qi, Du Rong. Research on Relationships Among Knowledge Sharing Quality, Innovation, and Satisfaction in Network Communities Based on Participation Motivation [J]. *Information Studies: Theory & Application*, 2013, 36(3): 56-61.

[13] Zhang Yongyun, Zhang Shengtai, Peng Hanjun, et al. Knowledge Innovation Behavior in Cyberspace from an Innovation Ecosystem Perspective: A Case Analysis of Six Network Virtual Communities [J]. *Science & Technology Progress and Policy*, 2017, 34(6): 139-146.

[14] Blanchard A, Markus M. Sense of Virtual Community—Maintaining the Experience of Belonging [C]//Hawaii International Conference on System Sciences. Hawaii: IEEE, 2002: 3566-3575.

[15] Blanchard A. Developing a Sense of Virtual Community Measure [J]. *CyberPsychology & Behavior*, 2007, 10(6): 827-830.

[16] Tontéri L, Kosonen M, Ellonen HK, et al. Antecedents of an Experienced Sense of Virtual Community [J]. *Computers in Human Behavior*, 2011, 27(6): 2215-2223.

[17] Sánchez-Franco MJ, Carballar-Falcón J, Velicia F. The Influence of Customer Familiarity and Personal Innovativeness Toward Information Technologies on the Sense of Virtual Community and Participation [C]//IFIP Conference on Human-Computer Interaction. Verlag: Springer, 2011: 265-279.

[18] Ajzen I. The Theory of Planned Behavior [J]. *Organizational Behavior and Human Decision Processes*, 1991, 50(2): 179-211.

[19] Porter LW, Lawler EE. Managerial Attitudes and Performance [J]. *Industrial & Labor Relations Review*, 1969, 23(1): 199-209.

[20] Deci EL. Effects of Externally Mediated Rewards on Intrinsic Motivation [J]. *Journal of Personality and Social Psychology*, 1971, 18(1): 105-115.

[21] Jin Hui, Wu Jie, Yin Jie. Review and Prospect of Organizational Incentive Research from Endogenous and Exogenous Perspectives [J]. *Journal of Jiangsu University of Science and Technology (Social Science Edition)*, 2011, 11(3): 93-101.

[22] Blanchard A, Markus M. The Experienced Sense of a Virtual Community: Characteristics and Processes [J]. *Database for Advances in Information Systems*, 2004, 35(1): 64-79.

[23] Cheng L, Yang SC, Tang SM. Sense of Virtual Community and Knowledge Contribution [J]. *Computers in Human Behavior*, 2013, 29(5): 2100-2106.

[24] Cui Xuan, Chang Yu. Preliminary Exploration of Virtual Community Perception Scale Suitable for Chinese Netizens [J]. *Journal of Intelligence*, 2009, 28(12): 182-185, 130.

[25] Koh JJ, Kim YG. Sense of Virtual Community: A Conceptual Framework and Empirical Validation [J]. *International Journal of Electronic Commerce*, 2003, 8(2): 75-93.

[26] Cheung CMK, Lee MKO. What Drives Members to Continue Sharing Knowledge in a Virtual Professional Community? The Role of Knowledge Self-Efficacy and Satisfaction [C]//Knowledge Science, Engineering and Management, Second International Conference. Melbourne: DBLP, 2007: 472-484.

[27] Zhang Jin, Zheng Quanquan. Development, Improvement, and Application of the Theory of Planned Behavior [J]. *Chinese Journal of Ergonomics*, 2012,

18(1): 77-81.

[28] Wang Chenxing. Research on Influencing Factors of Knowledge Sharing in Social Q&A Websites [D]. Hefei: University of Science and Technology of China, 2017.

[29] Nahapiet J, Ghoshal S. Social Capital, Intellectual Capital, and the Organizational Advantage [J]. *Academy of Management Review*, 1998, 23(2): 242-266.

[30] Nonaka I. A Dynamic Theory of Organizational Knowledge Creation [J]. *Organization Science*, 1994, 5(1): 14-37.

[31] Hagel J III, Armstrong AG. Net Gain: Expanding Markets Through Virtual Communities [J]. *Journal of Interactive Marketing*, 1999, 13(1): 55-65.

[32] Zhang Yi, You Daming. Empirical Research on Influencing Factors of Innovation Willingness of Employees in Technology-Based Enterprises: Based on TPB Perspective [J]. *Nankai Business Review*, 2014, 17(4): 110-119.

[33] Ajzen I, Fishbein M. Understanding Attitudes and Predicting Social Behavior [M]. Englewood Cliffs, NJ: Prentice-Hall, 1980.

[34] Kankanhalli A, Tan B, Wei KK. Contributing Knowledge to Electronic Knowledge Repositories: An Empirical Investigation [J]. *MIS Quarterly*, 2005, 29(1): 113-143.

[35] Zhou Tao, Lu Yaobin. Research on Virtual Community User Knowledge Sharing Behavior Based on Social Influence Theory [J]. *R&D Management*, 2009, 21(4): 78-83.

[36] McMillan DW, Chavis DM. Sense of Community: A Definition and Theory [J]. *Journal of Community Psychology*, 1986, 14(1): 6-23.

[37] Perugini M, Bagozzi RP. The Role of Desires and Anticipated Emotions in Goal-Directed Behaviors: Broadening and Deepening the Theory of Planned Behavior [J]. *British Journal of Social Psychology*, 2001, 40(1): 79-98.

[38] Zhang Min, Tang Guoqing, Zhang Lei. Influencing Factors of User Knowledge Contribution Behavior in Online Social Learning [J]. *Journal of Intelligence*, 2016, 35(10): 146-152, 180.

[39] Yoon C, Wang ZW. The Role of Citizens' Behaviors and Social Capital in Virtual Communities [J]. *Journal of Computer Information Systems*, 2011, 52(1): 106-115.

[40] Zhang Zheng. Research on the Influence of Network Social Capital on Virtual Community Knowledge Sharing and Innovation [D]. Hangzhou: Zhejiang University, 2008.

[41] Yli-Renko H, Autio E, Sapienza HJ. Social Capital, Knowledge Acquisition, and Knowledge Exploitation in Young Technology-Based Firms [J]. *Strategic Management Journal*, 2001, 22(6/7): 587-613.

[42] Nonaka I, Toyama R, Byosière P. Theory of Organizational Knowledge Creation: Understanding the Dynamic Process of Creating Knowledge [M]. Oxford: Oxford University Press, 2001.

[43] Wen Zhonglin, Hou Jietai, Zhang Lei. Comparison and Application of Moderating and Mediating Effects [J]. *Acta Psychologica Sinica*, 2005(2): 268-274.

[44] Aiken LS, West SG. Multiple Regression: Testing and Interpreting Interactions [M]. Newbury Park, CA: Sage, 1991.

[45] Blanchard A. Sense of Virtual Community [J]. *Handbook of Research on Computer-Mediated Communication*, 2008: 182-193.

Author Contributions

Li He: Review, revision, and final approval;
Peng Lihui: Research conceptualization and overall writing;
Hong Chuang: Data collection and organization;
Liu Jincheng: Statistical analysis;
Zhu Linlin: Model construction and analysis.

Keywords

endogenous motivation, exogenous motivation, virtual community, knowledge innovation

Note: Figure translations are in progress. See original paper for figures.