A system dynamics analysis of motivation factors of knowledge collaboration in vcop

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Abstract

With the development of Virtual Community of Practice (VCoP), a lot of research was done on the mechanism and structure of virtual community, while little research was about the motivation of users behaviors. Based on achievement motivation theories and community theories, the motivation factors of users to participate knowledge collaboration are elaborated from individual and group environment perspectives. For further explanation, we developed a dynamic model to simulate the motivation factors of users in VCoP, which was compared with the historical data from Wikipedia,. Finally, based on the simulation and analysis results we propose the strategy to improve the virtual community development and the future study.

Key words: Virtual Community of Practice, System Dynamics, Motivation Factors, Achievement Motivation, Sense of Community, simulation model

1. Introduction

In recent years, the exponential growth of telecommunication technologies has led the interpersonal communication into a new era[1]. A special environment -virtual community was generated from peoples communication with each other through the Internet. Howard Rheingold(1993) first argues that virtual community is a social aggregate which is developed when a sufficient number of people have been in an open discussion long enough in cyberspace (with sufficient emotions), as to form a web site to set up personal relationship. This kind of community is also named as online community and computer mediated community. Virtual community is designed with current internet technique, and VCoP is a task-oriented community generated via the ways their participants use[2].

Techniques and topics vary with different virtual communities, but the information exchange and mutual support always takes priority in virtual community[3]. Rheingold argued that compared to other online organization, virtual

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community is particularly important owing to its self-maintenance and convenience for participants to connect each other. Therefore, cognitive theories in sociology and psychology theories can be adopted when we intend to describe and solve social problems in virtual community. With the development of virtual community, there is an increasing number of people who are focus on the motivation factors affecting users in virtual community. For example, TeoLim and Lai(1999) divided the motivation of consumption community users as external and internal motivation[4]Shang et al. (2005)divided the motivation of online shopping as external and internal motivation[5]Rheingold argued that compared to other online organization, virtual community is particularly important owing to its self-maintenance and convenience for participants to connect each other. Therefore, cognitive theories in sociology and psychology theories can be adopted when we intend to describe and solve social problems in virtual community.

The motivation of users in virtual community is a systematic problem involving personal influence factors, group influence factors and the relationship between different factors, and its practical results are decided by interaction of those factors. The fundamental of system dynamic modeling is its systems view and the unique process of recognizing and the solving problems from unity to part and from outside to inside with manifold loops. Consequently, it is natural to choose system dynamics to research the motivation factors from personal requirement and organization environment perspectives. The next section discusses the background and literature review. The following three sections present Finally, the contributions and limitations of this study, and implications for future research are discussed.

2. Background and literature review

According to Houston, motivation is the dynamic factor formed by individuals collaborating the internal requirements(such as instinct, need and drive) and external cause of behavior(such as goals, reward and punishment), which can inspire and maintain the behaviors. Based on the most popular motivation theories, which are presented by Sigmoid Freud, Abraham Maslow and Frederick Herzberg respectively, scholars divide motivation as physiological motivation, psychological motivation and social motivation. physiological motivation means various consumption motivation to maintain, prolong and develop the life, which is caused by inherent and physiological factors. This motivation, generated in real world, rarely exists in virtual world. Psychological motivation develops with the psychological process such as personal recognition, emotion and will; Social motivation is caused by the socialized need of social interaction, sense of belonging, achievement, respect, self realization, affected by natural condition, life circumstances and various social factors such as politics, laws, customs, education, economy and classes. Motivation driving users to participate virtual community of practice is mostly psychological and social motivation, therefore, this study focuses on personal achievement motivation and motivation on the group level.

Achievement Motivation Theory was proposed by the American psychologist David McClelland in the 1940s, which was defined as the internal motivation factors affecting the desire for success while accomplishing the tasks. In McClellands theory there are three important motivations or needs, including need for achievement, need for affiliation and need for power. Need for achievement is the one to succeed and perform the best; Need for power is the one to affect or control other without being controlled; Need for affiliation is the one to establish intimate and friendly interpersonal relationship. Those people with high achievement motivation tend to be active and enthusiastic in work and studies.

In communities, individuals will contribute their knowledge and thereby influence ideas of other people. Individuals with high achievement motivation will make their effort to solve questions asked by other community members, so that they will feel satisfied after completing difficult tasks. In virtual community, the motivation factors are the inner driving force which inspires individuals to perform best in the tasks perceived valuable and important.

Sense of community belongs to social psychology. [6]. Burroughs and Eby argues that sense of community appears in community because its ability to generate satisfaction and the loyalty to community. Moreover, it is closely related to community activity and expected to solve the problems[7]. Sarason(1986) is the first scholar to define the affection between community members and the community itself as the fundamental cause of a successful community[8]. McMillanChavis(1986) defined it as the sense of belonging, the perception of important relationships and the significance of community, and the common belief that needs of community members should be met by group obligations[9]. They also developed community theory with describing it as feelings of membership, identity, belonging and attachment with the group. This theory has been widely accepted, based on which scholars made a large quantity of theoretical and empirical study[9].

With the advent of virtual community, scholars began to study the community cognition in virtual community. After studying the internet chatroom with sense of community theory, Roberts find the sense of virtual community existing in online community users[10]. Obst, Zinkiewicz and Smith contrasted the virtual community for novels and the neighbor relationship only to find some weaker virtual community relationship[11]. Koh and Kim contrasted the research done by Obst, Zinkiewicz and Smith with their own study, where the relationship between V.I.P members and their influence are defined as factors, finding that sense of community can by no means exist in virtual community as a whole[12]. Blanchard and Markus(2004) studied the sense of virtual community of a newsgroup and draws the similar conclusions as McMillan and Chavis, including feelings of Membership, integration of needs, and shared emotional connections[13].

Through internet, the virtual community provides places and service for community members in order to meet their needs. In the co-creating process of virtual community members, the value and emotion identification is established among members. Also, the establishment is closely related to the motivation to prompt participation, the behaviors in the community and their personalities,

simultaneously affecting the members self-evaluation and performance in the community. Since virtual community is endowed with the same traits as the real community, this paper will adopt the community theory to study the motivation factors for participation of community members.

System dynamics attaches great importance on the complicated requirements in decision making process and the cognition process generated naturally or by the education. Recently, an increasing number of scholars have accepted system dynamics as the tool in virtual community research. For example, Diker [14] developed a membership growth model in an open online system. Yan Mao et al. built a system dynamics model of an online collaborative system and studied its motivation mechanism[15]. Werner W. Wittmannl and Keith Hattrup adopted system dynamic to create a feedback model for information overload[17]. Tina and Stavredes presented a system dynamics model of the evaluation system of educational techniques.

Similar with the studies mentioned, we viewed wiki community as a system and developed a system dynamics model to simulate the motivation factors, where the individual psychological factors and the group influence psychological factors are mainly studied. In this model, the cause and effect relationship and the influence factors need to be verified and modified constantly, and this can be realized by computer technology and simulation software, which also helps to identify the complicated relationship between the system factors and the system structure. In this study, we developed a system dynamic model of motivation factors of wiki users to participate the practical activity with Vensim PLE[19].

3. Motivation factors analysis of knowledge collaboration in virtual community of practice

3.1. The classification of uses

Because of individuals different personalities, motivations, behaviors and qualifications, various levels of activeness, characteristics, ability of expression, knowledge, and roles in community interaction, users in the same virtual community will be differentiated in the sense of community and grouped spontaneously.

Amsrtnog and Hgael(1997)argue that, individuals are attracted by topics they are interested in before they devote themselves to the related community in the complex internet. Inclined to join the community as they are, whether they can be converted from simple browsers to community users who will enter the community repeatedly, interact with others and contribute knowledge, depends on the amount of their interest and satisfaction. Amsrtnog and Hgael divided virtual community members as four types according to their level of participation and value: browser, lurker, contributor and shopper. Adler and Christopher(1998) presented the four types of users as passive member, positive member, inductor and manager[20]. After a long time of observation of game-programming MUD virtual community, Bartle(1990classified the users as killers, achievers, socializes and explorers according to their motivation and related behaviors. Kozinest(1999) , when studying the consumer virtual communities,

divided the members as tourist, mingler, devotee and insiders based on the relationship between users and consuming activities and relationship between users and virtual communities. According to Kozinest, the final identification depends on two related factors: the degree of the relationship between individuals and certain consuming behaviors, and the social relation between individuals and other members in the community. According to the two factors, community members can be divided as four types shown in figure 1.

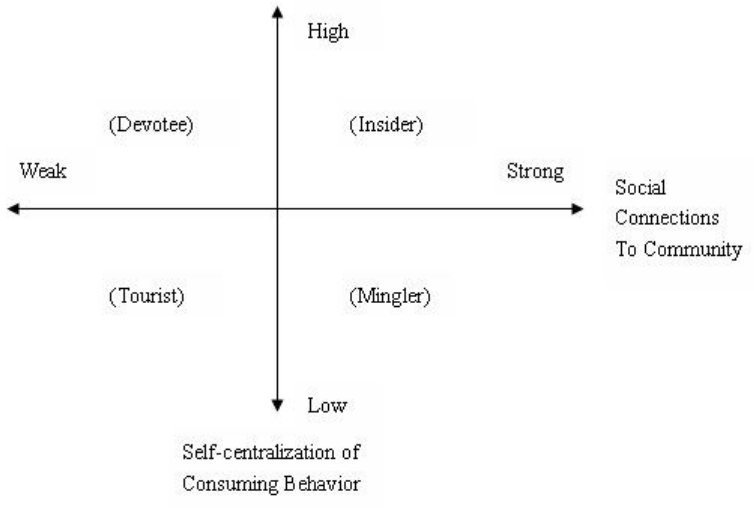


Figure 1: Classification of members in Vcop

1. Browser: lack of intense social relationship with groups; having temporary or little interest in consuming behavior.
2. Mingler: intense relationship with groups; but little interest in core consuming behavior.
3. Devotee: enthusiastic with consuming behavior,; weak relationship with groups.
4. Insider: intense relationship with consuming behaviors and groups.

80/20 principle in management science indicates that 80% of the total value comes from 20% of all factors, and the other 20% of the value comes from the 80% of all factors. About 80% of products and service are consumed by 20%of the consumers. Some preliminary studies indicates that for virtual community, the core market covers devotees and insiders. The loyal consumers will form or join the consumers communities once they can approach the internet. At the

same time, virtual communities could increase the loyal users through cultural and socialized consumption. In this way, tourists and minglers will be converted to devotees and insiders(Kozinest1999)[22]. Virtual community of practice is similar to consume virtual community except that users gather to complete a task or acquire some certain knowledge. Therefore, 80/20 principle is also applicable in this condition, that is, 80% of the valuable practice results are acquired by 80%of the practitioners while the remaining 20% are generated by the 80% of all practitioners. Based on characteristics of virtual community of practice, this study divides its users as two types according to the extent of their participation and interaction in the community.

(1) Experienced members: Experienced members are opinion leaders with highest influence. They are most familiar with the related information and knowledge, also they are willing to interact with others and provide their assistance. Generally, they are the most passionate and active members in the community, not only contributing their original product but also organizing or participating in discussions or activities as much as possible.

(2) ordinary members: ordinary members are members who just participate in the community and those browsers. The former, lack of strong social relationship with others, usually browse casually and contribute little to the community. Moreover, they are inclined to dive in the community, and obtain the knowledge they need without much contribution. The browsers mean tourists who browse and learn in the community with little contribution to it.

3.2. Collaborative behavior analysis in virtual community of practice

Members in virtual community of practice will organize themselves to work and learn together in a certain field, and achieve some goal by communication and knowledge sharing. Essentially, it is a process of knowledge collaboration and knowledge-based task performance.

Knowledge collaboration, which is the knowledge exchange through communication and interaction, happens only when there are requirements for some certain knowledge and there are members who will provide the corresponding knowledge. In this condition, communication and exchange is generated. Similarly, knowledge exchange will never happen if there are few members who is willing to share and contribute their knowledge[23]. So communication in knowledge communication is a bidirectional process in knowledge collaboration. Hendriks points out that knowledge sharing and exchange involves two objects[24], including:

1. knowledge providers: Those who are knowledgeable and willing to provide their knowledge by presentation, works and behaviors. They either provide the related knowledge to solve the problems presented by other members, or post messages in the community to introduce their experience and techniques. In the collaboration process, knowledge providers contribute their own knowledge to the community.
2. knowledge requestors: knowledge receivers. Those who learn and understand knowledge by imitation, listening and reading. Knowledge requestors acquire the knowledge they need in the collaboration process,.

In virtual community, knowledge providers help others by publishing articles or upload the codes, and knowledge requestors can acquire the knowledge by browsing the page or download the document. The two identities will be mutually converted constantly. For instance, if user A helps user B with problem 1, B can be the knowledge provider on problem 2 with A being conversely the requestor. Based on the previous studies, the four types of behaviors are defined as follows:

(1) Browsing: Acquiring knowledge from others passively by browsing the publications of other community members. (2) Collaboration: Participating in the activities or discussions initiated by others, and then offering his advice and methods. Problems could be solved by the collaboration between members. (3) Communication: The act of initiating some discussions or activities which are not related to the tasks, such as some chat or greeting expected to establish emotional relations. (4) Management: A mediating role between community members and community operators, in charge of everyday concerns.

3.3. The analysis of motivation factors to collaboration in the virtual community

Dholkaai et al. (2004)divides the users motivation to participation as two sorts: One is the motivation on the individual level, including achieving goals, maintaining social relationship, social reinforcement and entertainment; The other is the motivation on the group level, including internalization and recognition. It refers to the social influence factors affecting the members participation in the virtual community. Therefore, we study the motivation factors affecting the members participation in the virtual community from two aspects: on the individual level and group level.

3.3.1. Individual level

Based on Theory of Reasoned Action presented by Fishbein and Ajzen, Davis(1989) presented Technology Acceptance Model, which indicates that the perception of computer system will affect the users attitude which will further affect the intention, consequently they will start the using behavior[25]. Teo, Lim and Lai(1999) studied the users motivation to use the internet with TAM model. The motivations can be categorized as extrinsic motivation and intrinsic motivation[4]. Extrinsic motivation is generated by objective factors other than individuals themselves. It focuses on the efficacy of the activities, which are regarded as a tool to achieve the goal. Besides, extrinsic motivation can be observed and felt and it is acquired by the exchange of material, energy and information. Intrinsic motivation stems from individuals themselves and involving in the activities without any effect of external force. It focuses on the process of activities instead of the efficacy, including sense of responsibility, sense of achievement and need for achievement, and so on.

Dholakia2004also classified the factors affecting members participation in the virtual community as individual factors and group factors. He studied some of the individual factors, finding that the informational and instrumental value is the vital factor[26]. Davenport points out that it is like Utopia to think that

knowledge will naturally distribute without economic incentives, because people are not likely to contribute valuable knowledge without any returns[27]. .ZhuGe Hai summarized the motivation factors of knowledge sharing in an organization. Except altruism, the factors include: the hope for material reward, praise from other members, honorary recognition, the environment of reciprocity, and the accessibility of knowledge from others when there is some need[28]. According to the analysis of the above and other scholars, we define the extrinsic motivation on the individual level as:

information value: Information value is not only the result of virtual community of practice but also the primary factor of members to participate in the community. Individuals will not be interested in other factors of the virtual community unless they could obtain the related information to meet their needs for knowledge. Flanagin and Metzger argues that information value contains acquiring information, learning to handle affairs, providing information and contributing all the knowledge to a pool of information.

Instrumental value: Participants will complete a certain task through online interaction, such as solving a problem, providing an original view, affecting others, and evaluating a decision. These tasks are all instrumental, which is often defined as the easiness to achieve the specific goals. Flnagani and Metgze argue that instrumental value(instrumental need) means view generation, negotiation, problem solution, finding others for assistance and decision making.

extrinsic rewards: Generally, in virtual communities the rewards are not presented in material. But larger personal spaces and more privilege for functions have become the extrinsic motivation factors for users to participate in the community practice.

reciprocity: Since everyone is limited in his abilities, the completion rate will be increased by exchanging knowledge with others. Usually, reciprocity is not realized simultaneously, but the efficiency could be improved by interaction and mutual assistance.

A large quantity of empirical studies have proved the important role of extrinsic motivation. However, it is hard to determine which factor takes the priority, Furthermore, virtual communities, like wiki, all developed with the enthusiasm of users instead of extrinsic rewards. Therefore, intrinsic motivation is as important as extrinsic motivation. Intrinsic motivation is generated from the altruism of individuals and the satisfaction of the psychological needs, or from the pursuit of some certain moral principles. Intrinsic motivation is mostly the satisfaction of some certain psychological needs. Nicholls1982discovers the intrinsic dynamic for people to strive for success when they are performing a task, that is, the inner drive for people to do those tasks perceived to be important and valuable. It is defined as achievement motivation. ClarkVaradarajan and Pride also take achievement motivation as the competition for excellence or the hope for realizing ones goals[32]. According to Elliot and Andrew J, the achievement motivation is the competition-based emotion, cognition, activation and orientation of behaviors. In the achievement needs theory brought by DavidCMcClelland, personal achievement motivation includes achievement needs, power needs, and affiliation needs. Within personal achievement, self-

efficacy is a vital category which is defined as Individuals perception or belief of their ability to control the life [34] He discovers that the act of individuals not only depends on their willpower but also on their self-assurance of the effective use of power, which can be realized by self-efficacy. As a latent important factor affecting knowledge collaboration, self-efficacy is the belief of the organization and execution ability needed for the expected condition. According to the above analysis, the intrinsic motivation factors on the individual level can be defined as the follows:

(1) Need for achievement: It means the individuals requirements for success and best performance. DavidCMcClelland argues that people with strong need for achievement aspire to do things in a perfect way, improve working efficiency and become more successful. They are concerned with the joy in overcoming difficulties, solving problems and the sense of achievement after success, but material award is not their concern. The sense of achievement is closely related with the standard of economics, culture, society and government, as well as the social moralities. The sense of achievement of individuals is satisfied in the practice, which inversely encourages the individuals to participate in the virtual community.

(2) Need for power: It is the requirement of affecting or controlling others without being controlled. Also, it refers to the drive to control and influence others. The extent of aspire for power varies. Those who are endowed with a strong aspire for power are interested in controlling, ordering, and claiming for power. Correspondingly, they are typically argumentative, talkative, straight, and clear-minded; they are born instructors and lecturers. They pursue excellence and competitive environment not for the sense of achievement as those with strong need for achievement, but for acquiring power and status or maintaining the present power. One kind of participants, called community leaders in virtual community, whose advice can influence other members to a great degree, will make lectures and instruct others when there is a debate, and later they will obtain higher status and power in the community.

3) Need for affiliation It is the need to establish intimate social relationship, and a desire to seek for being loved and accepted. People with strong need for affiliation are fond of associating with others, which brings joy to them. Sensitive to interpersonal relationship, they prefer cooperative to competitive working atmosphere, and need more communication and mutual understanding. Sometimes, this kind of need is presented as the fear to lose intimate relationships and the withdraw in front of interpersonal conflict. In virtual communities, the need for affiliation is important to keep social association and harmonious interpersonal relationships.

(4) Self-efficacy: It is an significant intrinsic motivation which helps to initiate knowledge collaboration between community members. In the context of achievement, self-efficacy is an intuitive or personal judgment made by an individual on whether he is competent for the task before undertaking it. It is both self-perception of competence and an emotional private experience. After studying the motivation factors for workers to contribute knowledge to enterprise knowledge base, Kankanhalli believes that the motivation will be weakened

if the workers think their knowledge has no effect to the enterprise. Hsu gets the similar conclusion after studying the motivation factors of knowledge sharing in virtual community: Self-efficacy is an important motivation of knowledge sharing.

3.3.2. group level

Virtual community is a social group formed by the aggregation of online users Since the sociality is a typical feature of virtual community, social factors are crucial in motivating members to participate in virtual community. The sense of community, which is a combination of the sense of belonging, sense of identity, emotional connection and the feeling of stability, reflects the need for others and the interaction with others of each individual. Furthermore, there will be active impact of the sense of community. Mcmillan and Charvis presents the most influential and typical definition of the sense of community, that is, the sense of belonging, the perception of important relationships and community significance, and the common belief that the group is obliged to meet the members needs. Although there is no face-to-face interaction and regional association in the computer-based virtual community, the sense of community will be generated from it. The anonymity (the real identity will not be exposed) and selectivity (people can enter or leave the community at any time) enables people to explore themselves and build identity more freely, thus brings a more interactive and open society. Therefore, virtual communities could meet the needs of sense of community that can not be satisfied in real communities. In this study, we define community identity, community attachment, community cohesion, and community satisfaction as four fundamentals of the sense of community in virtual communities.

(1) community identity involves the semiotic significance and social value for people, that is, the process and extent of the community becoming the self-identity of individuals, which seems like the sense of membership. Sense of identity is the extent individuals feel themselves as part of the group. Roland Warron indicates that, the extent of the sense of identity varies with different individuals or groups[37], and the sense can be analyzed in cognitive, afflictive and evaluative aspects. Dholkaia argues that the sense of identity includes cognition, affiliation and evaluation. From the view of cognition, identity is a process of classification, which means the extent of individuals recognition of themselves as a member in the virtual community.(similar with the members and different from non-members) ; From the view of affiliation, identity means the emotional state of belonging to a virtual community; Evaluation is what users evaluating themselves in the virtual community.

(2) Community attachment is the emotional engagement in the community which is similar with mutual emotional relationship. The individuals participate in virtual communities to escape from loneliness and communicate with people of the same thoughts, obtaining friendship and social support. The members will tend to participate owning to their sense of the membership. Postmes argues that the attractiveness of virtual communities comes from the sense of cluster,

which is a positive experience of members gathering together to communicate with each other in the virtual community.

(3) community cohesion emphasizes on the group interaction and the unity between individual goals and group goals, which seems like influence and the integration and realization of needs. There is an phenomena named internalization in community cohesion. The internalization means making decisions based on the overlap between ones sense of worth and others. Eagly and Chaiken indicates that the sense of worth cover a large quantity of concepts, such as belief, attitude and other moral belief [39]. For members in the virtual community, internalization happens when they share the same sense of worth with others. In the virtual community of practice, an expertise in java may meet others who like java as he does, or a fan of archaeology will meet with other fans who are posting their comments on the relate topics. In every condition, there is some apparent overlap of the sense of worth. Owning to the casualness of selection, that is, community members could select the virtual group that share the same sense of worth with themselves, Bagozzie and Dholakia(2002) view internalization as an important influential factor of community members. Internalization develops in the information exchange among community members and keep growing when the information means a lot to the participants.

Table 1: the classification of motivation factors for the virtual community members to participate in knowledge collaboration

Individual level	extrinsic motivation	Information value Instrumental value Extrinsic rewards Reciprocity
	Intrinsic motivation	Need for achievement Need for power Need for affiliation Self-efficacy
Group level	Community identity Community attachment Community cohesion Community satisfaction	

(4) Community satisfaction is an emotional state of community evaluation. It is also close to community cohesion, referring to the subjective evaluation of the objective condition in the community. The research on community satisfaction made by Malans and Jess(1975) is the most prominent one. They find that the features of the objective condition where an individual lives are not equal to his feelings in that condition. Most people, even those living in a lower standard are satisfied with their community. In most circumstances, satisfaction is highly related with the affiliation to the family and the friends living in the community [41]. John Buckner, the psychologist, presents a research of studying community (cohesion) sense on the group level, and presents three dimensional

indexes measuring the neighborhood cohesion: the sense of community of residents in the neighborhood, the livings of residents and the level of residents attractiveness to other neighbors, and the level of interaction with neighbors.

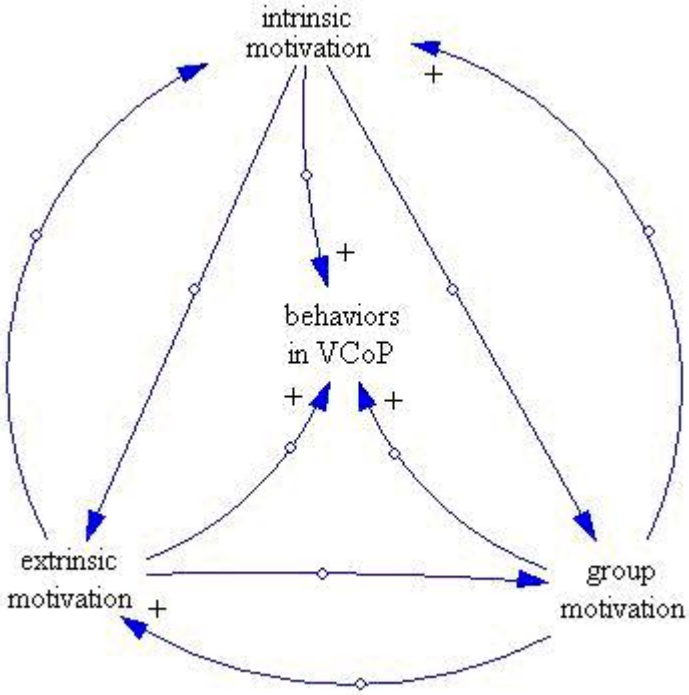
4. the modeling process

There is a mutual supportive or restrictive relationship between the intrinsic and extrinsic motivation on individual level, and the same relationship exists between the individual level and group level. Dholakia discovers that the target value of t=individuals will strengthen their sense of identity, which brings the common sense of members resulting in the community cohesion. David Mcmillan and David Chaves argue that the common experience and interaction embodies important psychological rules. Association hypothesis : The more people interact with each other, the more intimate they will be. The quality of interaction: The more active the experience and relationship is, the more close the relations will be; Achievements promote cohesion. Behavior prevention: Uncertain interactions and the non-completion of community tasks will prevent the community cohesion. The hypothesis of equivalent events: the greater events people have experienced together, the closer connections will be. (For example, people will get closer connection if they have experienced a catastrophe together); Devotion: The devotion determines the importance of the history and current situation to community members(For example, the one who devotes more to the community will feel the impact of community events more easily; Also he will have more affection on the community); The influence of the honor and humiliation on community members: The honor and humiliation is very influential on the members attitude on the community. Spiritual connections: connections generated or strengthened by common spirit(such as the religion and racism)[43]. Bagozzi and Dholakia(2002) finds out the sense of identity will increase the individuals desire, which is reflected as various psychological requirements, when they are moderating the MGB model. Moreover, active emotion expectations will increase the individuals psychological desire[40]. Based on the analysis, we conclude the basic cause-and-effect relationship between motivation factors in virtual communities of practice shown as figure 2.

4.1. The motivation factor model of experienced members

Experienced members in virtual community of practice mainly participate in the collaboration and discussion, but rarely browse or manage in the community. Therefore, in this model the behavior dimension includes two horizontal variables: collaboration and communication.

On the individual level, experienced members will focus on the instrumental value of the community and the extrinsic rewards will have effect on some of them. Reciprocity is also meaningful for the experienced members. Because they join the collaboration mainly for solving problems instead of acquiring information, the information value of the community is not very distinct. In general, experienced members have stronger need for achievement, and some


intrinsic
motivation
+
+
behaviors
in VCoP
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+
extrinsic
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motivation

Figure 2:

of them have stronger need for power or need for affiliation. They would like to undertake the responsibility and complete the task with some achievement, so their self-efficacy is higher and has positive impact on themselves. On the group level, experienced members have become regular members in the community, with their sense of identity, belonging, cohesion, and satisfaction at a higher level. Those psychological factors will correspondingly prompt them to participate in the collaboration more frequently. Consequently, the motivation factor dimension includes 11 horizontal variables: instrumental value, extrinsic rewards, reciprocity, need for achievement, need for power, need for affiliation, self-efficacy, community identity, community attachment, community cohesion, and community satisfaction. The motivation factor model of experienced members is shown as figure 3.

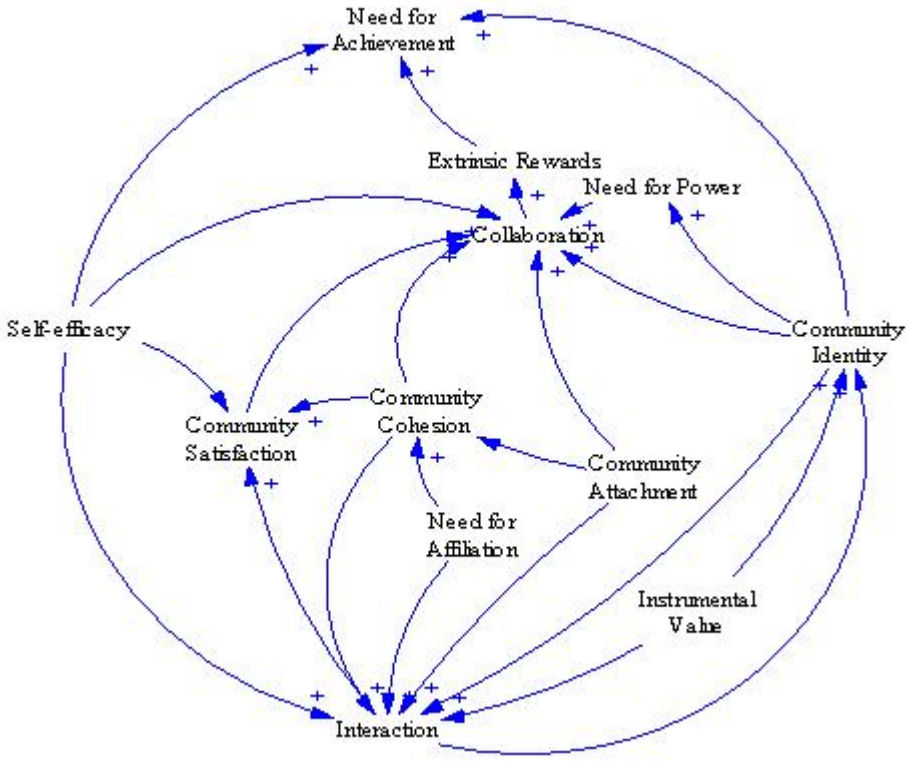

Figure 3:

4.2. motivation factor model of common members

Common members in virtual communities take no activity except browsing, which is the only horizontal variable in the behavior dimension in this motivation factor model of common members.

On the individual level, common members often lay great emphasis on the information value and instrumental value of the community in practice. Without undertaking any tasks, there is rarely any extrinsic rewards and reciprocity between members. Although there are only a few common members who contribute little to the community, there is some latent need for achievement and need for affiliation. And there is little need for power among them. Because their behavior is mainly browsing that is seldom affected by self-efficacy, the horizontal variables do not involve self-efficacy in this model. On the group level, the common members sense of identity, belonging, cohesion and satisfaction is weaker compared to the experienced members, but these psychological factors will spur them to participate in the collaboration. Therefore, the motivation dimension includes 8 horizontal variables: information value, instrumental value, need for achievement, need for affiliation, community identity, community attachment, community cohesion, and community satisfaction. The motivation factor model of common members is shown as figure 4.

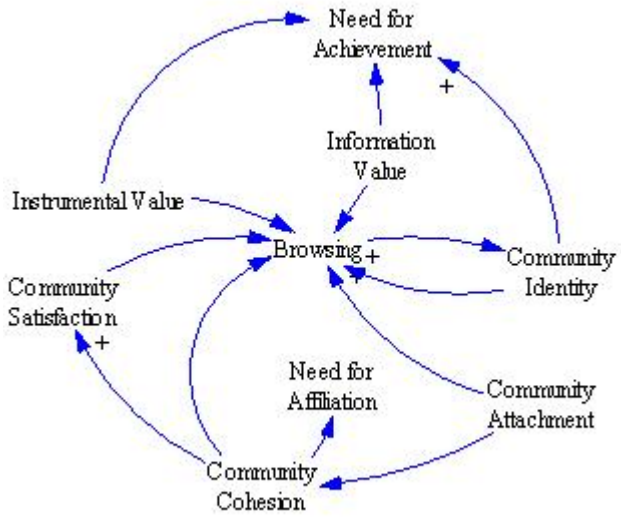

Figure 4:

5. Simulation research

Based on the basic model, we moderate the model according to Wikipedia, and make a system simulation research. A contrastive analysis is made between the simulation results and the real data.

5.1. The background of simulation research: wikipedia

Wiki is an open hypertext system subject to collaborative creation, which is developed in 1995 by Ward Cunningham, the father of Wiki. Ward Cunningham defines Wiki as a social computing system which allows a cluster of users to create and connect web pages with simple markup language[44]. In wiki, there is a system that enables users to make and moderate simple HTML web pages, and a system recording and arranging all the alternations. Social group-oriented collaborative writing is supported by Wiki system, which provides necessary assistance to the writing process. The writers of Wiki naturally form a social group and their simple communicating tools are provided by Wiki. As a open community, wiki helps users to share knowledge of one field in a social group and collaborating with others. Therefore, we choose wiki in our case study, and make simulation analysis of the motivation factors for users to participate in knowledge collaboration.

A system is an functional aggregation with distinct and interactive parts connected together. We should first define the boundary of system and make primary feedback analysis before the system dynamics model could be built. Users edit entries through the behavior of edit, and communicate with each other through the behavior of Talk. This study describes virtual community of practice in two perspectives: a) the result of users practice; b) the psychological factors prompting the generation of practice results, including factors on the individual level and group level. In wiki, users collaborate with each other by editing entries and they can talk with each other about entries and texts of questions. Individuals complete editing entries voluntarily without any extrinsic rewards, which indicates that users in wiki are endowed with the similar and strong self-efficacy. The basic concept model includes Edit, Talk, need for achievement and the sense of community. The constant participation behavior of users influenced by individual and environmental factors is featured by positive feedback and the tendency of self-reinforcement. The moderated model is explained by the cause-and-effect graph shown in figure 5.

5.2. The definition of factors in the Wiki system simulation model

In wiki, users collaborate with each other on a question and they can talk with each other about questions and texts of other topics. In this study, we adopt need for achievement and the theory of sense of community to explain the psychological factors driving community members to collaborate and communicate with each other. Based on the basic cause-and-effect graph, we make further feedback analysis on the motivation factors for community users to participate in knowledge collaboration, and define the horizontal variables of the system dynamic model of motivation factors in wiki as Level 1 Edit: The way

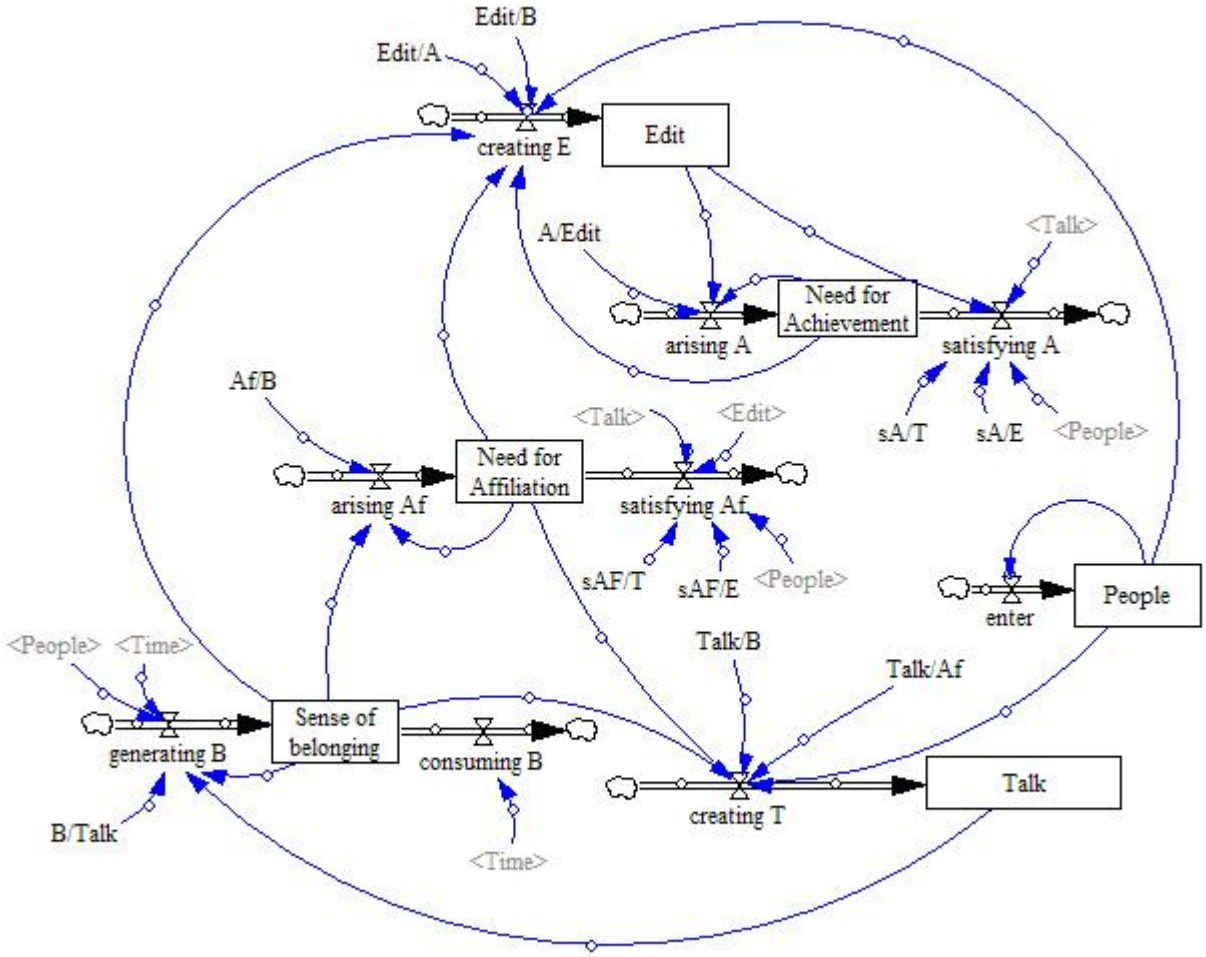
Edit/B
Edit/A
creating E
Edit
A/Edit
<Talk>
arising A
Need for Achievement
satisfying A
sA/T
sA/E
<People>
Af/B
<Talk>
<Edit>
arising Af
Need for Affiliation
satisfying Af
sAF/T
sAF/E
<People>
enter
People
<People>
<Time>
Talk/B
Talk/Af
generating B
Sense of belonging
consuming B
B/Talk
<Time>
creating T
Talk

Figure 5: sds

in which users participate in practice. As an open community, the virtual community of practice allows users to collaborate with each other by creating and moderating entries. In editing, which is an equal collaboration, each member has the identical power and responsibility. The knowledge collaboration is completed by the edit of entries or categories, thus edit is treated as a horizontal variable of this study. Level 2 Talk: The way in which users communicate with each other. The communication through text among members in virtual communities reflects the coordination and affiliation between the members. Because users could discuss and exchange ideas on entries and categories through Talk pages, Talk is included as the horizontal variable indicating the communication between members. Level 3 Need for achievement: Meclelland believes that people with strong need for achievement aspire to work more efficiently and struggle for greater success. They are not concerned with material rewards. This sense will increase with personal achievement and decrease for some other reasons, such as the attribution and comparison, so the need for achievement is defined as a variable in this study. Level 4 Need for affiliation: The need for affiliation and the shared emotional connections in the sense of community indicates that members can reduce the personal distance between them by communication and establishing intimate social relationships. With the increasing level of intimacy between individuals, the community cohesion will be strengthened, and it will also be weakened owning to the community policy. Consequently, we define the need for affiliation as the horizontal variable. Level 5 Sense of belonging: The sense of membership includes 5 factors: Boundary, sense of security, sense of belonging and identity, personal investment, and the common semiotic system. In the virtual community, there are open boundaries, the sense of security with little impact on the open community, the personal investment which could be reflected by knowledge collaboration and the common semiotic system defined by the system itself. Therefore, only the sense of belonging can be defined as the horizontal variable reflecting the membership in the community. Level 6 People: The individual is an important factor of the community constitution, and it is defined as the horizontal variable in this study. Collaboration in Wiki emphasizes on the equality and coordination of the relationship between numbers. Consequently, there is no community leaders whose power transcend other individuals, thus, there is no need for power and no desire for leadership in the community. Though McMillan and Chavis take influential power as the most important factor in the sense of community, Anita L. Blanchard discovers strong relationship between members and weaker individual impact, and furthermore, the exchange and support between members is significant for the community development [45]. Some other scholars also prove that the influence in the sense of virtual community is not as important as SOC. As a result, we do not include influential power as a factor.

5.3. Wikipedia

McMillan and Chavis argue that the common experience and interaction of community members reflect important psychological activity rules. Moreover,

they find that more interaction will bring higher intimacy, and more active relationship promotes closer connection. Cohesion is strengthened by achievement, while investment determines the significance of the community to members. The sense of community becomes stronger with larger investment. Influenced by individual and environmental factors, users participate in the practice constantly, so the 5 horizontal variables are mutually promotive and featured by the self-reinforcement of positive feedback. Figure 6 describes the moderated motivation factor model of users to participate in knowledge collaboration according to real data from wiki.

Table 2: the variables and input/output parameters in system dynamic model

horizontal variable	input stream params			
the name of variables	name	parameter significance	name	
Need for Achievement	A/Edit	the incremental n need for achievement of users per Edit	sA/E	the
			sA/T	the
Need for Affiliation	Af/Talk	the incremental need for affiliation of users per Talk	sAF/T	t
	Af/B	the need for affiliation generated per affiliation		
Sense of Belonging	B/Talk	the incremental sense of belonging per Talk	/	
Edit	Edit/A	Edit generated per unit of need for achievement	/	
	Edit/B	Edit generated per unit of sense of belonging	/	
Talk	Talk/B	Talk generated per unit of sense of belonging	/	
	T/Af	Talk generated per unit of need fro affiliation	/	

Based on the previous analysis of the effect of intrinsic motivation on behavior, the users knowledge will accumulate in practice, at the same time, their need for achievement and affiliation will grow until it becomes stable. The input stream that influences the need for achievement and the need for affiliation is defined: Arising A and Arising Af; The motivation itself will also not grow infinitely, so two output streams are designed for need achievement and need for affiliation: Satisfacting xiahuaxian A, Satisfacting Af. As time goes on, members sense of community will grow with the increase of knowledge collaborators, so the input stream of sense of belonging is defined: generating B. According to psychology principles, the human feelings will decay as time goes on, and the output stream of sense of belonging is defined as: consuming B. The details of variables and parameters are shown as table 2.

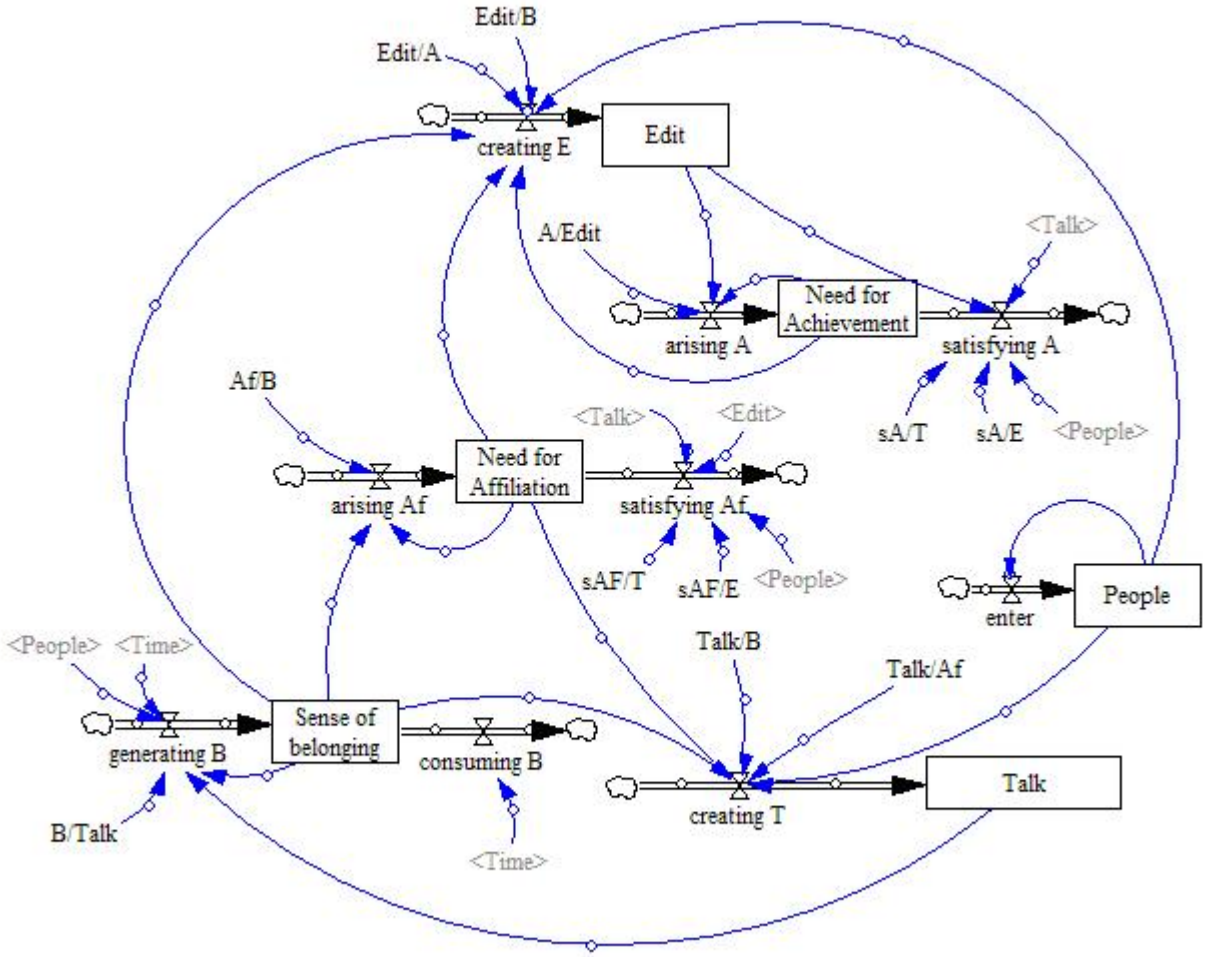
Edit/B
Edit/A
creating E
Edit
A/Edit
<Talk>
arising A
Need for Achievement
satisfying A
sA/T
sA/E
<People>
Af/B
<Talk>
<Edit>
arising Af
Need for Affiliation
satisfying Af
sAF/T
sAF/E
<People>
enter
People
<People>
<Time>
Talk/B
Talk/Af
generating B
Sense of belonging
consuming B
B/Talk
<Time>
creating T
Talk

Figure 6: sfd