Research on User Knowledge Exchange based on Virtual Academic Community : Taking Zhihu for Example

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Abstract. The virtual academic community is currently one of the crucial platforms for communications between domestic and foreign scholars. Besides, it is also significant for academic exchange activities. The essence of virtual academic community is that users can share knowledge, which is also the essence of academic community. The purpose of this paper is to take Zhihu academic community as the research object, in order to clearly elaborate the types and definitions of virtual academic communities and their impact on the efficiency of knowledge exchange between worldwide users.

Keywords: Virtual Academic Community; Knowledge Exchange; Knowledge Sharing.

1. Introduction

With the development of web 2.0, the traditional forms of information exchange including newspapers and TV can no longer satisfy the need of information users growing up in the network environment. Relying on the Internet, groups with the same interests communicate with each other virtually without the constraints of time and space. Therefore, virtual communities emerged to serve this purpose. Virtual academic community has the characteristics of virtuality, openness and interactions, and is an important platform for scholars to exchange scientific ideas and share knowledge. User participation in commenting and sharing information is the fundamental basis for the healthy operation of virtual academic communities, that is, the viscosity and activity of users determine the competitive advantage and influence of the community. Attracting new users and maintaining the continuous participation of existing users are crucial to the long-term development of virtual academic communities. Therefore, it is necessary to explore the knowledge sharing willingness and efficiency of users in virtual academic communities [1].

2. Definition and Characteristics of Virtual Academic Community

A community is a large group of interrelated life formed by several social groups or organizations gathered in a certain field. Based on Cheng Juan's research on the evolution of the concept of community, a community is defined as several social groups or organizations gathered in a real three-dimensional or virtual two-dimensional space on the Internet. The group is formed by certain needs and purposes, each member of which has a certain degree of communication and association with each other[2]. Zhang Meng et al. defined a virtual community as a cyberspace group that uses computers and the Internet as the medium for information exchange and knowledge exchange [3]. Xu Meifeng summarized Markus's classification method of virtual community from the relationship positioning of community members, and divided virtual community into three categories: social community, professional community and business community [4].

Based on the above classification method of virtual community, this paper classifies academic virtual community as professional community. The academic virtual community is defined as a professional community that takes specific academic topics as the main communication content and conducts information exchange activities for academic and related derivative projects.

3. Research Methods and Research Object

3.1. Research Methods

At present, the knowledge exchange of virtual academic community has been studied from different angles domestically and abroad. Based on the analysis of user types and interaction types in academic virtual communities, Ding Jingda et al. analyzed the mode of knowledge exchange in academic communities from three dimensions: conversation, link and citation relationship [5]. By building a model, NRoberts et al. used hierarchical regression techniques to study the relationship between virtual customer groups' absorptive capacity for knowledge exchange and organizational innovation. Zong Ganjin and others conducted an empirical study on the static knowledge exchange effect of eight disciplines using DEA based on the blog data of Science Network [6]. Wan Li also uses the DEA method to evaluate the efficiency of knowledge exchange in different virtual academic communities [7]. It can be seen that there are few studies on the evaluation of knowledge exchange efficiency in virtual academic communities, especially quantitative research on it. [8].

3.2. Research Object

This paper mainly selects the sub-communities of the academic topic "Zhihu" as the research object because it is a typical knowledge sharing community in a ubiquitous learning environment. The sample size of this sub-community is large, which can better describe the overall characteristics. According to Zhihu and iResearch's "Zhihu User Portrait and Media Value Research Report", Zhihu currently has hundreds of millions of registered users, 26 million daily active users, and 11.2 minutes average single usage duration. The usage time is 35.8 minutes, surpassing other similar platforms in terms of usage stickiness, and user satisfaction is higher [9].

The knowledge exchange operations in Zhihu mainly include asking and answering questions, writing articles and commenting. In this article, asking questions is regarded as a way to actively acquire knowledge, while answering questions is regarded as passive sharing of knowledge. Besides, writing the articles is considered as active sharing of knowledge and commenting is regarded as a passive way to acquire knowledge. These operations reflect the attitudes of the participants in the knowledge exchange to a certain extent. The acquired data is more specific, and it is easier to form a new model according to the attitudes of the participants. The conclusions can also be more in line with the research direction of this paper.

4. Model Construction and Empirical Analysis

4.1. Knowledge Exchange Model

According to relevant theories, the knowledge exchange and dissemination of academic virtual community can be divided into three stages.

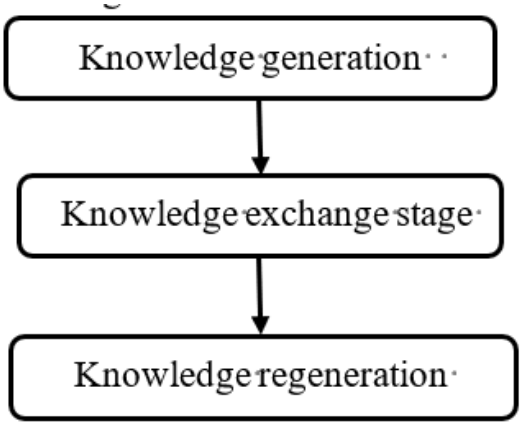

Fig. 1 Three stages of knowledge exchange model

The first stage (knowledge generation stage): According to different dissemination purposes, through different media of the Internet, knowledge demands are put forward in the academic virtual community, and they are viewed and followed by other same knowledge seekers through questioning. The second stage (knowledge exchange stage): Knowledge is shared through the answers of the knowledge owners. Other users participate in the discussion by bookmarking the answers and expressing their own attitudes towards the comments. In this way, knowledge is generated and continuously exchanged [9].

The third stage (knowledge regeneration stage): After sharing by the knowledge disseminators, the knowledge is spread to a new platform, browsed and obtained by other knowledge seekers. In this process, the knowledge is reused, produced, and further spread.

4.2. Model Object

Based on the research on knowledge exchange efficiency evaluation of academic virtual community, we select the topic square of "Zhihu" as the research object. Zhihu divides different categories of topics based on the contents of the questions. Questions are divided into parent categories, subcategories, and further narrow subcategory topics. The content of the latter layer is always derived from the content of the previous layer. As the number of levels increases, Zhihu can cover all aspects of content from the overall layout. Considering this aspect, we select different sub-categories of the same parent category for comparison of knowledge exchange efficiency: Internet - Android development && Internet - web design. Considering that the indicators of the third stage—knowledge regeneration stage are not easy to collect, this paper only selects first two stages, knowledge generation and knowledge exchange for research.

4.3. Method Selection

The method used in this paper is Data Envelopment Analysis (DEA) method. DEA method is a systematic analysis method for evaluating the relative efficiency and effectiveness of multi-input and multi-output departments of the same type [10]. In recent years, DEA method has been widely used in various fields such as technological and productivity progress, technological innovation, resource allocation, financial investment, etc., to carry out effectiveness analysis, so as to make evaluation decisions [11].

Combined with the knowledge exchange model of virtual academic community, we adopt the input-oriented variable return-to-scale VRS model in DEA, that is, for *n* decision-making units with *i* input indicators and *r* output indicators, the improved model is as follows:

$$\max \sum_{i=1}^{m} s_i^- + \sum_{i}^{p} s_i^+$$

$$s.t \begin{cases} \sum_{j=1}^{n} X_j \lambda_j + S^- = X_{j0} \\ \sum_{j=1}^{n} Y_j \lambda_j + S^+ = Y_{j0} \\ \lambda_j \geq 0,\ j = 1, 2, ..., n \\ s_i^- \geq 0, i = 1, 2, ..., m \\ s_i^+ \geq 0, i = 1, 2, ..., p \end{cases} \tag{1}$$

$$(D)=\begin{cases}\min\theta-\varepsilon(\sum_{i=1}^{m}S_i^{-}+\sum_{r=1}^{s}S_r^{+})\\ S.T.\\ \sum_{J=1}^{n}X_{ij}\lambda_j+S_i^{-}=\theta\chi_{io}\\ \sum_{J=1}^{n}y_{ij}\lambda_j+S_r^{+}=y_{ro}\\ \lambda_j\geq 0\end{cases} \tag{2}$$

Among them, θ is the efficiency value of the decision variable, S_i^- and S_r^+ are the allowable residual values of the input index and output index respectively, if and only when the optimal solution $\theta^0=1$ and S_i^{-0}, S_r^{+0}, λ^0 are all 0, the decision variable DEA is valid [12].

4.4. Data Acquisition and Indicator Establishment

4.4.1 Data Acquisition

Taking Zhihu as the data source of this research, the Android development topics and web design topics in the Zhihu topic square in July 2022 are selected. The collected data are shown in the following table:

Table 1. First stage data

Number	DMU	Questions	Questions Answered
1	Android Development	146	251
2	Web Design	70	139

Table 2. Second stage data

Number	DMU	Questions Answered	Attention	Pageviews	Comment	Likes
1	Android Development	251	672	39714	99	151
2	Web Design	139	238	17089	33	35

4.4.2 Input-output Index System in the Initial Stage of Knowledge Generation

4.4.2.1 Input Indicators

The input indicator is mainly the number of questions, as shown in Table 4-3. Zhihu users can obtain knowledge and information by asking questions and requesting answers or opinions from other users.

4.4.2.2 Output Indicators

The output indicator is mainly the number of answers. Other Zhihu users express their opinions by further answering questions on the basis of browsing questions.

Table 3. First stage indicators

Knowledge Initial Generation Indicators	
Indicator Type	Indicator Content
Input Indicator	Number of Questions (X11)
Output Indicator	Number of Questions Answered (Y11)

4.4.3 Input-output Index System in the Stage of Knowledge Exchange

4.4.3.1 Input Indicators

Input indicators mainly refer to the number of titles, the number of views and the number of followers, as shown in Table 4-4. As the output indicators represents knowledge production, the number of answers and the number of followers are also input indicators for knowledge exchange.

4.4.3.2 Output Indicators

The output indicators are mainly the number of comments and the number of approvals. As shown in Table 4-4, questions and answers are browsed by more Zhihu users, and other users will also have opinions based on their own knowledge and express them through approvals and comments. Therefore, knowledge exchange and sharing quickly spread among users who browse the problem.

Table 4. Second stage indicators

Knowledge Exchange Indicators	
Indicator Type	Indicator Content
Input Indicator	Number of Questions Answered (X21)
	Number of Attention Times (X22)
	Number of Pageviews (X23)
Output Indicator	Number of Comments (Y21)
	Number of Likes (Y22)

4.5. Efficiency Analysis of Knowledge Exchange in Academic Virtual Community

Select Technical Efficiency, Pure Technical Efficiency, Scale Efficiency as the analysis indicators of knowledge exchange efficiency in Zhihu topic square. Among them, Technical Efficiency is the ability to achieve the optimal output under the input index in the given knowledge exchange stage of Zhihu Internet topics; Pure Technical Efficiency is the ability to achieve the maximum input-output ratio during the knowledge exchange stage of Zhihu Internet topics; Scale Efficiency corresponds to Pure Technical Efficiency, which refers to the change in efficiency brought about by the proportional increase of all input indicators on the premise of keeping technical factors unchanged. With Deap2.1 software, the VRS model is used to analyze the knowledge exchange efficiency of Zhihu, as shown in Table 4-5:

Table 5. First stage efficiency analysis

DMU	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	Returns to Scale
Android Development	0.866	1	0.866	drs
Web Design	1	1	1	-
Mean Value	0.933	1	0.933	

According to Table 4-5, the knowledge generation in this stage of knowledge exchange is relatively optimized and reasonably allocated. In the topic of Android development, the technical efficiency is effective and the returns to scale are diminishing, indicating that the knowledge exchange efficiency in this topic is weak DEA effective. People have more questions about the topic of Android development, but there are not many answers and solutions. Therefore, the efficiency of this topic in the initial stage of knowledge generation is lower than that of web design knowledge generation.

Table 6. Second stage efficiency analysis

DMU	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	Returns to Scale
Android Development	1	1	1	-
Web Design	0.941	1	0.941	irs
Mean Value	0.971	1	0.971	

According to Table 4-6, the comprehensive efficiency of knowledge exchange, pure technical efficiency and scale efficiency of Android development topics are all 1, indicating that the knowledge exchange in this process is relatively optimized and reasonably configured. In the topic of web design, technical efficiency is effective and the returns to scale are increasing, indicating that the non-DEA effectiveness of knowledge exchange efficiency in this topic is not due to the ineffectiveness of pure technical efficiency but from the ineffectiveness of scale efficiency. Moreover, the scale returns are increasing, indicating that the number of comments and likes is relatively insufficient at this stage. The opinions of others have not been well utilized, and the efficiency of knowledge exchange is lower than that of Android development topics.

5. Virtual Academic Community Trends

The virtual academic community is developed under the Internet information technology and is one of the open innovation modes, but the development of the domestic virtual academic community platform is not yet fully mature. This paper puts forward the following development trends and suggestions for virtual academic communities from the perspective of community managers. First of all, it is necessary to establish a reasonable incentive mechanism, which can fully stimulate the willingness of knowledge subjects to participate in the virtual academic community. In addition, community managers should not only link the degree of user knowledge exchange with material rewards, but also give certain spiritual encouragement. Last but not least, it is also necessary to continuously improve the functions of the platform and broaden the medium of knowledge dissemination, so as to create a good atmosphere for knowledge exchange among users.

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