

Influencing Factors of User Knowledge Adoption Behavior in Developer Communities from a Configurational Perspective: An fsQCA Analysis of 96 CSDN Cases

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Abstract

Purpose/Significance Developer communities have become crucial platforms for individuals to acquire fragmented IT knowledge in the era of ubiquitous learning. Knowledge adoption constitutes the primary behavior of community users, and uncovering the configurational patterns of factors influencing knowledge adoption behavior can enhance the knowledge ecology of sharing communities and foster their sustainable development.

Method/Process Grounded in information adoption theory and uses and gratifications theory, this study constructs a research framework encompassing five dimensions: knowledge quality, knowledge source reliability, recipient characteristics, supply-demand matching, and information cost. Employing 96 cases from CSDN as the research sample, the influence pathways of user knowledge adoption behavior were analyzed using fuzzy-set Qualitative Comparative Analysis (fsQCA).

Results/Conclusion The findings reveal three driving pathways for knowledge adoption, anchored respectively in content quality, reputation status, and professional recognition, with supply-demand matching serving as a core condition across all pathways. The research outcomes not only facilitate the enhancement of knowledge management performance in developer communities but also offer implications for the design of future ubiquitous learning environments.

Full Text

Research on Factors Influencing Knowledge Adoption Behavior of Users in Developer Community from the Perspective of Configuration—fsQCA Analysis Based on 96 Cases of CSDN

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Abstract

[Purpose/significance] The developer community has become an important place for people to obtain fragmented IT knowledge in the era of pervasive learning. Knowledge adoption is one of the main behaviors of community users. Revealing the configuration of factors influencing knowledge adoption behavior is beneficial to improving the knowledge ecology of the sharing community and promoting its sustainable development. **[Method/process]** Based on Information Adoption Theory and Uses and Gratifications Theory, a research framework was constructed from five dimensions: knowledge quality, knowledge source reliability, receiver characteristics, supply-demand matching, and information cost. Using 96 cases from CSDN as research objects, the fsQCA method was employed to analyze the influence paths of users' knowledge adoption behavior. **[Result/conclusion]** The study found three driving paths for knowledge adoption, respectively relying on content quality, reputation status, and professional recognition, with supply-demand matching serving as the core condition in all paths. The research results not only help promote the improvement of knowledge management performance in developer communities but also provide implications for the design of future ubiquitous learning spaces.

Keywords: developer community; Information Adoption Theory; Uses and Gratifications Theory; influencing factors; fsQCA

Classification number: G252

Developer communities constitute a knowledge-sharing ecosystem composed of knowledge providers, knowledge consumers, and knowledge platforms. As virtual social organizations aimed at knowledge exchange, their novel informal communication models break traditional spatiotemporal constraints, providing convenience and enhancing the efficiency of knowledge exchange [?]. As specialized communities, developer communities—unlike comprehensive platforms such as Zhihu—gather numerous technology enthusiasts and professional developers, making their knowledge interaction content more specialized. Simultaneously, communication methods are more standardized, with users often demonstrating and solving problems through specific programming code. Furthermore, community communication functions are more diversified [?], extending beyond com-

mon Q&A and discussions to allow users to publish their own articles, videos, and resources, meeting the needs of different types of developers. Currently, mature foreign developer communities include Stack Overflow and GitHub, while domestic platforms are primarily represented by CSDN and Gitee.

With the gradual maturation of emerging technologies such as artificial intelligence and cloud computing, IT technology has been widely applied across various production domains. Technological achievements in smart agriculture, smart factories, and smart logistics have led people to profoundly recognize the importance of IT knowledge in modern society, triggering a surge in IT knowledge learning that has attracted students and experts from humanities and social sciences. However, in the information age, knowledge in the IT field iterates faster than in other domains, with new programming languages, frameworks, tools, and technologies constantly being introduced and updated. People need to continuously learn to adapt to new knowledge, making ubiquitous learning the mainstream learning model in pervasive computing environments [?]. Traditional book-based and classroom learning methods can no longer meet people's needs for learning anytime and anywhere. In such a knowledge ecology, developer communities play an increasingly important role, serving as a crucial supplement to systematic learning through books and other formal channels.

Meanwhile, developer communities have become a key research focus for scholars. Some studies have examined the Stack Overflow platform to analyze development trends in Q&A topics [?] and the impact of cultural characteristics on developer behavior [?], while others have investigated the psychological motivations behind users' knowledge contribution, including reputation motives, altruistic motives, and self-actualization, noting that users' knowledge contribution behavior is also influenced by environmental factors [?]. However, research on knowledge adoption behavior and its influencing factors among developer community users remains relatively scarce. Knowledge adoption is one of the primary behaviors of users in sharing communities [?], holding significant importance for the development of online communities, social interaction within communities, and information sharing.

Users' knowledge adoption behavior in communities represents recognition and encouragement for knowledge providers, motivating them to continuously provide high-quality knowledge. This helps alleviate the severe problem of mixed quality in knowledge management systems caused by low dissemination costs [?], enhancing community knowledge management performance and improving the knowledge ecology. Through a case study of CSDN, this paper explores the combination of factors influencing knowledge adoption behavior in developer communities, providing theoretical foundations for management strategy formulation and helping communities better fulfill their roles to adapt to the characteristics of the current ubiquitous learning era.

2 Literature Review

This paper analyzes the connotation, influencing factors, and research methods of knowledge adoption behavior of users in online communities from relevant literature, systematically reviewing recent studies.

2.1 Connotation of Knowledge Adoption

Existing research has not yet provided a clear definition of knowledge adoption; the concept primarily derives from information adoption. As early as 2010, Song Xueyan et al. [?] proposed the connotation of information adoption, viewing it as a process that connects information seeking, selection, retrieval, and utilization. This process involves the purposeful selection, evaluation, acceptance, and utilization of information by the subject, ultimately influencing subsequent behaviors. In recent years, research on information adoption has gradually deepened and found applications in various subfields. In the medical domain, Zhu Qinghua et al. [?] explained health information adoption as the sum of all stage behaviors from health information acquisition and acceptance to utilization. In the government new media domain, Zhang Xiangxian et al. [?] defined information adoption as the process by which government new media users purposefully search, screen, absorb, and apply government information to meet the needs of completing government activities and personal requirements. In the knowledge management domain, Li Juanjuan et al. [?] defined knowledge adoption in social Q&A communities as the process where users purposefully accept valuable knowledge, experiences, and viewpoints provided by other users, apply them to solve their own problems, and innovate on the knowledge when possible.

2.2 Influencing Factors of Knowledge Adoption Behavior

Zhang W and Watts were the first to propose that the decisive factors influencing knowledge adoption among online community users are information quality and information source reliability [?]. Since then, scholars have primarily focused on two dimensions: information subject characteristics and information sources, discussing key factors influencing online users' knowledge adoption behavior in conjunction with different platform features. Yang Xuejie et al., using the Elaboration Likelihood Model as their research framework, found that knowledge timeliness, relevance, and originality all influence knowledge adoption behavior among chronic disease users in online health communities, with knowledge relevance having a particularly significant impact [?]. Huo C et al. integrated sensory theory, fear appeal theory, social influence theory, and information richness theory to examine the mediating effect of trust on knowledge adoption in the spinal disease domain [?]. Rahaman et al. applied technology acceptance theory to explore the impact of word-of-mouth information on social media users' adoption behavior [?]. Chen Yini et al. comprehensively applied social influence theory, planned behavior theory, and the information adoption model, empirically finding that knowledge sharers' popularity and reputation status

have significant positive direct effects on users' knowledge adoption intention [?]. Jin Xin, based on the Unified Theory of Acceptance and Use of Technology, uses and gratifications theory, and perceived risk theory, proposed that whether users possess necessary knowledge and skills strongly influences their paid adoption [?].

Additionally, some scholars have analyzed the impact of information environmental factors on users' knowledge adoption behavior. For instance, Tang Xuli et al., from the perspective of health literacy and trust, found that users' trust in community platforms positively influences information adoption intention [?]. Tang Liqiang et al., using social capital theory as their research framework, demonstrated that social capital also has a significant positive effect on users' adoption behavior [?].

2.3 Research Methods for Knowledge Adoption Behavior

Existing literature on knowledge adoption behavior of online community users involves both quantitative and qualitative methods. Qualitative research methods are primarily grounded theory [?], while quantitative research methods mainly include regression analysis and structural equation modeling. For example, Yang Haijuan used questionnaire surveys and structural equation modeling to explore influencing factors of user adoption intention on comprehensive Q&A websites [?]. Among studies using regression methods, distinctions in model construction can be further categorized into hierarchical linear regression [?], sample selection regression [?], and multiple linear regression [?]. Some studies have improved upon traditional single methods by adopting combined quantitative and qualitative approaches. For instance, Mo Min et al. first constructed an influencing factor model of users' consultation information adoption intention through data collection and three-level coding, then employed structural equation modeling for path analysis [?].

In summary, current domestic and international research on users' online knowledge adoption behavior primarily focuses on two types of platforms: social Q&A communities and health forums, leaving a research gap regarding knowledge adoption in virtual knowledge communities such as developer communities. Scholars have achieved fruitful results in studying knowledge adoption influencing factors from the dimensions of quality and source. In the knowledge adoption process, knowledge receivers serve as the main subjects, and their characteristics also exert certain influences on adoption outcomes, warranting inclusion as antecedent variables in knowledge adoption research. At the methodological level, most studies employ quantitative methods, with a minority using qualitative methods represented by grounded theory. Quantitative analysis techniques such as regression analysis and structural equation modeling exclude the uniqueness of research cases and ignore outliers. Essentially, they adopt a "net effects" thinking, focusing on analyzing and comparing the relative importance of independent variables on outcomes, with evaluation results dependent on model specifications. As competing variables increase, net effects may diminish to zero.

However, users' knowledge adoption behavior results from complex multi-factor interactions. As a branch of social science, knowledge adoption involves many highly correlated independent variables that do not constitute true competitive relationships. Therefore, using traditional quantitative analysis methods may generate unnecessary theoretical inferences and fail to discover matching relationships among factors. To address these research gaps, this paper adopts Qualitative Comparative Analysis (QCA), selecting appropriate large-sample cases to analyze the interactive effects of knowledge adoption influencing factors from a configuration perspective, revealing the complex causal relationship structure among variables. Simultaneously, the paper improves and innovates indicator design by incorporating variables such as receiver characteristics and supply-demand matching into the knowledge adoption influencing factor system.

3 Research Design and Model Construction

Information primarily serves as a basis for decision-making, while learning itself is a process of seeking and acquiring knowledge. Developer communities serve as a powerful supplement to systematic learning methods, with information circulating in the community manifested as fragmented knowledge. Therefore, this paper defines knowledge adoption as: the process by which users search for and obtain relevant IT knowledge in developer communities, measure the influence of knowledge on themselves through autonomous judgment and evaluation, and only trust and incorporate it into their own knowledge system when the knowledge is sufficiently persuasive.

3.1 Theoretical Foundation

Information Adoption Theory

Information Adoption Theory (IAT), proposed by Sussman S W and Siegal W S in 2003 [?], integrates the perceived usefulness variable from the Technology Acceptance Model (TAM) with theoretical concepts from the Elaboration Likelihood Model (ELM). The IAM model posits that information quality and information source reliability are key factors that indirectly influence information adoption outcomes. In developer communities, information manifests as knowledge. Currently, models of the information adoption process have been extended to the knowledge management domain to study various knowledge participation behaviors of users in virtual communities, such as knowledge adoption [?], knowledge payment [?], etc. This paper also examines knowledge adoption behavior of users in developer communities based on Information Adoption Theory.

However, Information Adoption Theory only studies the impact of information and information sources on adoption behavior, neglecting the roles of information receivers and the information environment. In real-life scenarios, people's adoption behavior is influenced by perceived ease of use. Fred Davis defined perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort." From the perspective of perceived ease

of use, information cost profoundly impacts user experience and adoption behavior; higher information costs imply lower ease of use. Information cost refers to various costs required to obtain and utilize information, including costs of acquiring target information and transacting target information. Since none of the 96 blog posts in this study belong to paid columns, this research does not consider information transaction costs, focusing only on information acquisition costs. In summary, this paper introduces knowledge receiver characteristics and information cost to extend Information Adoption Theory.

Uses and Gratifications Theory

Uses and Gratifications Theory is a theory in media effects research. Its main proposition is that during media usage, users have certain needs, purposes, and motivations, and they choose to use media to satisfy these needs. If usage brings expected effects and users feel satisfied, they will subsequently adopt and continue using the medium [?]. Therefore, Uses and Gratifications Theory can serve as a reference theory for studying supply-demand matching issues, helping enterprises and organizations better understand user needs and behaviors to formulate appropriate product or service strategies and enhance user satisfaction.

As an important medium for IT knowledge sharing, whether the knowledge content provided by developer communities meets users' own needs is crucial. Supply-demand matching reflects the adaptability and usefulness of products or services. Inspired by Uses and Gratifications Theory, this paper posits that higher supply-demand matching makes it easier for users to adopt and use products/services, and facilitates knowledge transfer and absorption, thereby positively promoting users' knowledge adoption. Consequently, this paper introduces the indicator of supply-demand matching degree to establish a connection between knowledge and knowledge adoption subjects, reflecting the interactive process between knowledge and receivers.

3.2 Research Method—QCA

Qualitative Comparative Analysis (QCA) was proposed by American sociologist Charles C. Ragin. This research method is case-centered, conducting investigations based on condition combinations as the unit of analysis.

The influencing factors of knowledge adoption behavior among developer community users are extremely complex, affected by multiple elements that are interdependent. QCA follows "set theory" thinking, combining the advantages of quantitative and qualitative approaches. Through case combinations, it can balance and supplement the limitations of traditional quantitative research methods. Moreover, from a configuration perspective, it can avoid negative impacts from autocorrelation and multicollinearity of independent variables [?]. Additionally, compared with grounded theory methods that emphasize historical differences and positivism, QCA is more meso-level and context-sensitive, developing new concepts of causal relationships—namely, the ability to explore mul-

multiple concurrent causal relationships among antecedents. Currently, academia has recognized the superiority of QCA in handling large samples and analyzing complex configuration problems [?], employing it as an important tool for solving complex causal relationship issues in management, library and information science, information communication, and other fields. QCA is applicable to this research topic. Furthermore, QCA is not only suitable for small and medium-sample studies with fewer than 50 cases but also applicable to large-sample case studies [?], analyzing and summarizing generalizable configurations and paths. This paper will explore condition combinations influencing user knowledge adoption behavior in developer communities, with a moderate sample size. Therefore, the most applicable QCA variant—fuzzy-set Qualitative Comparative Analysis (fsQCA)—is selected, along with multi-value QCA (mvQCA) and temporal QCA (tsQCA). Considering the continuous variable data types in this study, such as knowledge density, provider reputation status, and supply-demand matching degree, and given that fsQCA has the advantage of calibrating sample values into set membership degrees while considering degree changes, this paper adopts fsQCA to analyze the influence paths of user knowledge adoption behavior in developer communities.

3.3 Research Model and Measurement Design

Based on the comprehensive analysis above, this paper innovates upon existing research according to the knowledge exchange patterns of the developer community CSDN and data availability. Grounded in Information Adoption Theory and Uses and Gratifications Theory, the paper explores the interactive effects among influencing factors of user knowledge adoption in developer communities from five dimensions: knowledge quality, knowledge source reliability, receiver characteristics, supply-demand matching, and information cost. Figure 1 [Figure 1: see original paper] presents the research model.

Figure 1 Research Model of Influencing Factors on User Knowledge Adoption in Developer Communities

Variable Selection and Measurement

The basis for variable selection and measurement methods in this study are as follows:

(1) Outcome Variable—Knowledge Adoption

The outcome variable in this study is the knowledge adoption degree of individual blog posts. Scholars such as Huang Chengsong [?] and Yang Xuejie [?] have used likes and views as measurement methods for knowledge adoption. Considering the characteristics of developer communities, likes or views alone cannot fully and authentically reflect users' adoption behavior, and the positive impact of publication duration on likes and collections cannot be ignored. Therefore, this paper adopts a measurement method to calculate the knowledge adoption degree of individual blog posts.

(2) Knowledge Quality

Knowledge quality in developer communities refers to the quality level of knowledge information circulating within the community [?]. Information quality has been proven to have a decisive impact on knowledge adoption, with scholars conducting in-depth explorations from multiple perspectives. Zhu Z et al. [?] divided answer quality in social Q&A sites into 13 dimensions including objectivity, novelty, and usefulness. Nelson et al. [?] proposed that information quality can be measured from four aspects: standardization, correctness, comprehensiveness, and timeliness. Additionally, relevance, understandability, universality, and reliability have also been mentioned in some studies [?, ?]. Professor Wang Huanchen proposed the definition of knowledge density as the proportion of necessary knowledge content within knowledge materials. Higher knowledge density indicates more exclusive knowledge [?]. Knowledge adoption by users in virtual communities is essentially a knowledge transfer process. Knowledge density is a characteristic of knowledge, and Wang Jian et al. included knowledge density as an antecedent condition for knowledge transfer efficiency [?]. Therefore, this study attempts to incorporate knowledge density as a characteristic of knowledge subjects into the antecedent variables of knowledge adoption.

In summary, this paper selects timeliness, universality, standardization, and knowledge density as indicators to measure knowledge quality. Timeliness is calculated by collecting the most recent update time of blog posts and computing the number of days from the data collection date (January 8, 2023), taking the reciprocal of the result. Universality is measured using the number of tags on blog posts. Standardization is obtained by scoring research cases using the version 4 CSDN rating system.

For knowledge density measurement, this study adopts the Tsinghua University Open IT Lexicon [?] as a professional dictionary. This dictionary and a stopword list are used to segment the 96 blog posts. All cases constitute a corpus, and the TF-IDF algorithm is employed to calculate the TF-IDF values of words in each blog post, with the calculation method shown in Equation (4).

In Equation (4), $f_{w,d}$ refers to the frequency of word in document ; N_d refers to the total number of words in document ; N refers to the total number of documents in the corpus; and N_w refers to the number of documents in the corpus containing word .

Referencing parameter settings from Yuan Yongxu et al. [?] and combining them with experimental results from this study, words with TF-IDF values greater than 0.1 are extracted as keywords for each blog post. The ratio of the total number of keywords to the total number of words in a blog post constitutes its knowledge density, with the measurement method shown in Equation (5).

In Equation (5), KD_i represents the knowledge density of the i th blog post, K_i represents the total number of keywords in the i th blog post, and W_i represents the total number of words in the i th blog post.

(3) Knowledge Source Reliability

In developer communities, knowledge providers are the knowledge sources. Based on existing research conclusions, this paper selects provider identity

[?], provider capability, and provider reputation status as characteristics of knowledge providers. Provider capability includes two aspects: blogger blog level [?] and number of original articles [?]. Provider reputation status includes average exposure [?] and number of followers [?]. Provider identity is measured by collecting the number of knowledge provider certification badges. Provider capability and reputation status are both obtained through entropy weighting method to weight subordinate indicators. In this study, average exposure refers to the ratio of total blog views to total number of articles, i.e., views per article.

(4) Receiver Characteristics

Wang Huidong et al. [?], when studying employees' external knowledge receiving behavior, selected employees' professional skills and participation degree to examine the moderating effects of individual characteristics on knowledge receiving behavior. Soroya et al. believe that lower user cognitive levels lead to more negative trends in information adoption [?]. Based on developer community characteristics, this paper identifies two research directions: receiver learning ability and receiver activity level, measured by users' blog levels and achievement badge counts, respectively. Simultaneously, considering that the length of platform usage time affects users' trust in the platform and consequently influences their knowledge adoption behavior, this study adds the variable of receiver learning duration, converting users' "code age" into uniform numerical values in years.

(5) Supply-Demand Matching

As a professional community in the IT domain, CSDN allows users to select different fields for learning and communication based on their interests. Simultaneously, as CSDN bloggers, users must select appropriate tags when publishing blog posts to help readers more accurately find content of interest. Moreover, the range of tag fields selected by CSDN users and bloggers is consistent, ensuring tag validity and facilitating communication and knowledge transfer between users and bloggers. Combining the case selection and data source section described earlier, this paper uses the matching degree between users' interest fields and blog post tags—that is, supply-demand matching degree—as the factor under the supply-demand matching dimension. When blog post tags involve content in the receiver's interest field, the variable is recorded as 1; otherwise, it is recorded as 0.

(6) Information Cost

The concept of knowledge stickiness evolved from information stickiness. Von Hippel E. first proposed that information has stickiness, which represents the cost in information transfer processes [?]. Knowledge stickiness refers to knowledge being somewhat attached to knowledge providers, creating obstacles for knowledge sharing that can be understood as costs in information dissemination. Wu Dan et al. found that knowledge stickiness hinders effective knowledge transfer [?], thereby affecting users' knowledge adoption behavior. Therefore, this paper attempts to introduce knowledge stickiness as information cost into the model to verify its impact on adoption behavior in developer communities.

In the knowledge exchange process of developer communities, poorer blog post readability leads to higher knowledge stickiness. Thus, this paper draws on the research methods of Yan Qiang et al. [?] to explain knowledge stickiness from the perspective of readability. The reciprocal of readability represents knowledge stickiness; higher knowledge stickiness indicates poorer readability and higher information costs for readers' knowledge adoption.

The calculation method for readability is shown in Equation (5). In Equation (6), represents the knowledge stickiness of the i th blog post, represents the readability of that blog post, represents the number of punctuation marks in that blog post, and represents the total word count of that blog post.

In summary, the indicator system settings for this study are shown in Table 1 .

Table 1 Indicator System of Influencing Factors on User Knowledge Adoption Behavior in Developer Communities

Dimension	Factor	Indicator	Measurement Method
Knowledge Quality	Knowledge Density (KD)	Number of blog post keywords / Total words in blog post	TF-IDF algorithm
	Timeliness (TS)	Reciprocal of days from last update to data collection date	Days from Jan 8, 2023
	Universality (GL)	Number of blog post tags	Tag count
	Standardization (SF)	GSDN quality score v4	Rating system
Knowledge Source Reliability	Provider Identity (IV)	Number of provider certifications	Certification count
	Provider Capability (CA)	Weighted blog level + original articles	Entropy weighting
	Provider Reputation Status (RS)	Weighted followers + avg exposure	Entropy weighting
	Receiver Learning Ability (LA)	Average blog level of receivers	Mean value
Receiver Characteristics	Receiver Activity Level (SM)	Average achievement badges	Mean value

Dimension	Factor	Indicator	Measurement Method
Supply-Demand Matching Information Cost	Receiver Learning Duration (LS)	Average “code age” in years	Mean value
	Matching Degree (DM)	Match between user interests and blog tags	Binary (0/1)
	Knowledge Stickiness (KS)	Reciprocal of readability	Punctuation/word count

Note: Secondary variables for receiver characteristics take the average values of all knowledge receivers’ indicators for each blog post.

4.1 Case Selection and Data Sources

This study examines China’s largest developer community—CSDN. Founded in 1999, CSDN is an integrated comprehensive platform for information and knowledge dissemination and sharing services, providing technical developers with full lifecycle services including technical exchange, resource sharing, and online learning. Currently, CSDN has over 35 million registered users, with daily traffic reaching 36 million and more than 300,000 user original articles and 480,000 comments monthly [?]. The platform encompasses dynamic content such as user personal information and feedback information, providing a foundation for this study’s investigation of knowledge adoption behavior in developer communities.

This study selected 100 blog posts from CSDN’s site-wide ranking list as cases. This list belongs to the content hotlist, which comprehensively considers factors such as click-through rates, interaction rates, and time decay to rank eligible original articles, covering both expert bloggers and newcomers across various fields—conforming to the maximum heterogeneity criterion for QCA case selection [?]. This study used descendant collector tools to gather indicator data, excluding 4 cases with severe data missingness. The final valid sample comprised 96 cases, with data collection completed on January 8, 2023. Origin software was used to plot a frequency histogram of knowledge adoption degrees for all cases, revealing good differentiation among cases.

Knowledge Adoption Degree

Figure 2 [Figure 2: see original paper] Frequency Distribution Histogram of Knowledge Adoption Degree

This study includes 96 cases, constituting large-sample research. Referencing the experimental settings of Wang Fengbin et al. [?] (104 cases, 11 antecedent

variables), this paper determines that 12 condition variables meet the requirements.

4.2 Descriptive Statistics and Calibration

This study uses the direct method for data calibration, employing three important qualitative anchors—full membership threshold, full non-membership threshold, and crossover point—for structured calibration, performed using fsQCA 3.0 software. Referencing Ragin' s condition presentation method [?], this paper calibrates 12 independent variables and the dependent variable, setting the corresponding full membership threshold, full non-membership threshold, and crossover point at the 95th, 50th, and 5th percentiles of the sample, respectively. Descriptive statistics and calibration anchors for condition and outcome variables are shown in Table 2 .

Conditions and Outcome Variables

Table 2 Descriptive Statistics and Calibration Anchors for Variables

Variable	Descriptive Analysis	Fuzzy-Set Calibration
	Max	Min
Blog Knowledge Density		
Blog Timeliness		
Blog Universality		
CSDN Quality Score		
Provider Identity		
Provider Capability		
Provider Reputation Status	193.95	
Receiver Learning Ability	22258.29	
Receiver Activity Level		
Receiver Learning Duration		
Demand Matching Degree		
Knowledge Adoption Rate		

From the descriptive analysis results, the standard deviations of blog post knowledge density and universality, knowledge receivers' learning activity, learning duration, supply-demand matching degree, knowledge stickiness, and blog post knowledge adoption degree are relatively small, indicating uniform distribution. In contrast, knowledge providers' reputation status and provider learning ability show large standard deviations and high dispersion. Overall, the knowledge adoption degree distribution is uniform across cases, involving diverse blog post types and various knowledge provider and receiver characteristics, meeting this study' s research needs.

Regarding the issue in fsQCA where cases with exactly 0.5 membership degree are excluded [?], Fiss proposed a solution of adding a constant of 0.001 to an-

tecedent conditions with membership below 1 [?]. Some studies suggest that modifying membership values of 0.5 to 0.499 can also effectively solve the problem [?]. This paper chooses to change calibrated membership values of 0.5 to 0.499 to maximize case utilization.

5.1 Single Variable Necessity Analysis

After completing data calibration, it is necessary to analyze the necessary conditions for user knowledge adoption, using consistency indicators to determine whether necessity and sufficiency relationships exist between variables. The results of single variable necessity analysis are shown in Table 3 .

Table 3 Consistency Data for Single Variable Necessity Analysis

Condition	Consistency for Knowledge Adoption	Consistency for Non-Knowledge Adoption
Knowledge		
Density		
~Knowledge		
Density		
Provider		
Identity		
~Provider		
Identity		
Provider		
Capabil-		
ity		
~Provider		
Capabil-		
ity		
Provider		
Reputa-		
tion		
Status		
~Provider		
Reputa-		
tion		
Status		
Receiver		
Learning		
Ability		
~Receiver		
Learning		
Ability		

Condition	Consistency for Knowledge Adoption	Consistency for Non-Knowledge Adoption
Receiver		
Activity		
Level		
~Receiver		
Activity		
Level		
Receiver		
Learning		
Duration		
~Receiver		
Learning		
Duration		
Supply-		
Demand		
Match-		
ing		
~Supply-		
Demand		
Match-		
ing		
Knowledge		
Sticki-		
ness		
~Knowledge		
Sticki-		
ness		

As shown in the table above, the consistency of all single variables is below 0.9, indicating that none are sufficient to individually constitute necessary conditions for knowledge adoption among developer community users. Therefore, further sufficiency analysis of condition configurations is required.

Note: ~ denotes logical NOT

5.2 Configuration Analysis

When conducting configuration analysis using fsQCA 3.0 software, relevant parameters need to be set according to specific research requirements. Referencing Fiss' s research conclusions, for sample sizes greater than 150, the frequency threshold can be set to 3 or higher; for smaller sample sizes, the frequency threshold can be set to 2 [?]. Fiss also proposed that PRI values below 0.5 indicate substantial inconsistency [?]. This paper' s parameter settings reference Fiss [?] and Du Yunzhou [?], setting the raw consistency threshold at 0.8 and

the PRI consistency threshold at 0.5. Since this study's case number > 50, constituting a large-sample case study, the case frequency threshold is set to 2. The sufficiency analysis results for condition configurations are shown in Table 4.

Table 4 Sufficiency Analysis of Condition Configurations

Configuration	Provider	Provider	Provider	Receiver	Receiver	Receiver	Supply-	Raw	Unique
	Identity	Capability	Reputation	Learning	Activity	Durability	Demand Match	Coverage	Coverage

A total of 4 configurations were generated, with characteristics shown in Table 5. Observation reveals that high supply-demand matching serves as a core condition in all configurations, indicating that supply-demand matching has a crucial impact on knowledge adoption. When knowledge content falls within the interest domain of knowledge receivers, receivers show higher tendencies to adopt such knowledge. indicates core conditions, presence indicates condition existence, indicates condition absence, and indicates auxiliary conditions.

The overall consistency of these 4 configurations is 0.907, indicating that these four configurations are sufficient conditions for knowledge adoption. Meanwhile, the solution coverage is 0.314. Referencing the research results of Gupta et al. [?] (122 samples, coverage 0.31) and Mellewigt et al. [?] (137 samples, coverage 0.21), this meets the coverage standards for large-sample QCA. To better compare the differential impacts of various configurations on knowledge adoption, the configuration characteristics of knowledge adoption are summarized into the following three driving paths:

Table 5 Characteristics of Various Configurations

Path	Knowledge Quality	Source Reliability	Receiver Characteristics	Supply-Demand	Information Cost
Path 1: Potential Rookiestandard format	High density, recent update, few tags, non-standard format	Ordinary blogger, non-prominent features	High learning ability, active, new user	High match	Low stickiness

Path	Knowledge Quality	Source Reliability	Receiver Characteristics	Supply-Demand	Information Cost
Path 2: Traffic Guidance	Low density, non-recent update, few tags, high standardization	High followers/exposure, but low capability/identity	Low ability/activity, long-term user	High match	High stickiness
Path 3&4: Mutual Learning	Low density, recent/non-recent update, few/many tags	Expert blogger, high capability/identity/reputation	High ability, active, long-term user	High match	High stickiness

(1) Potential Rookie Blog Posts Grounded in Content Quality—Configuration 1

In Configuration 1, supply-demand matching serves as the core condition, with high blog post knowledge density, high timeliness, and high receiver learning ability and activity as auxiliary conditions, achieving higher knowledge adoption degrees. Such blog posts can be explained as follows: although the blogger's capability and status on the platform are not prominent, their blog content is novel with high knowledge content—i.e., high content quality. Capable and active new users have relatively tolerant requirements for knowledge presentation formats. Therefore, even when blog posts lack format standardization, such users will adopt them when they discover the posts' merits and find them matching their supply-demand needs.

(2) Traffic Guidance Blog Posts Grounded in Reputation Status—Configuration 2

Configuration 2 uses supply-demand matching as the core condition, with high blog post standardization, high provider reputation status, non-high receiver learning ability and activity, long learning duration, and high knowledge stickiness as auxiliary conditions to achieve higher knowledge adoption degrees. Contrary to Configuration 1's receiver characteristics, these long-term platform users have been exposed to more fragmented knowledge than novice users and have already established bloggers they follow. For bloggers with certain follower bases and exposure, compared to Configuration 1 bloggers, they have more polished formatting and publish personal note series and portfolio index blog posts with good traffic attraction effects—i.e., they have formed their own knowledge brand. Typical cases include “Wangdao Operating System Study Notes Complete Directory + Mind Maps.” Based on the significantly differentiating condition of provider reputation status, this paper summarizes such characteristic configu-

rations as traffic guidance blog posts grounded in reputation status. Although these posts have low knowledge density and readability, they feature the blogger's personal series style with few but refined tags and standardized writing. After publication, resident users represented by fan groups will adopt them when they find high supply-demand matching.

(3) Mutual Learning Blog Posts Grounded in Professional Recognition—Configurations 3 & 4

Beyond supply-demand matching as the core condition, Configurations 3 and 4 share the common characteristic that knowledge providers and receivers both have high indicators and high knowledge stickiness. From the knowledge provider perspective, high identity, capability, and reputation status point to typical blog experts, highlighting provider professionalism and high recognition compared to the first two paths. From the knowledge receiver perspective, user group characteristics show high learning ability, active community veterans—i.e., experts within user circles. This suggests that the academic capabilities and other features of both knowledge adoption parties can compensate for the negative impacts of non-high blog post knowledge density and knowledge stickiness on adoption, triggering adoption behavior when supply-demand matching occurs. Since in these two configurations, both blog post standardization and blogger professionalism receive platform recognition, and receiver characteristics also indicate higher-level recognition of blog posts, they can be summarized as mutual learning blog posts grounded in professional recognition.

The difference between the two configurations lies in the knowledge quality dimension, mainly manifested in timeliness, universality, and standardization. Configuration 3 blog posts are experts' latest self-experience summaries, using popularized language to describe technical skills in certain industry domains. These posts do not emphasize formatting, involve complex industry terminology, and thus exhibit characteristics of high timeliness but non-high universality and standardization, requiring receivers to possess corresponding technical accumulation and similar industry experience to resonate and communicate with knowledge providers. Typical cases include “Four Years of Outsourcing Was Too Poor, Suddenly Realized I Need to Job Hop” and “This Year, I Only Earned a Little.” Configuration 4 blog posts aim at basic teaching, written by experts, mostly serialized as collections and technical summaries with illustrations and standardized formats. Therefore, such posts exhibit characteristics of non-high timeliness but high universality and standardization, with high professional recognition. Typical cases include “Hand-in-Hand Teaching You to Create Data Visualization Projects (Part 7)” and “Everything About Git in One Article.”

5.3 Robustness Test

There are four common robustness testing methods for QCA: adjusting calibration anchors, minimum case frequency, consistency threshold, and adding/deleting cases. Any one method can be selected for robustness testing.

This paper references the robustness testing method of Duan Zhongxian et al. [?], conducting robustness tests by raising the consistency level from 0.5 to 0.55. After adjustment, the overall solution consistency increases to 0.935, while coverage slightly decreases to 0.293. The solutions before and after parameter adjustment are shown in Table 6 .

Table 6 Comparison of Solutions Before and After Robustness Test

Configuration	Raw Coverage	Unique Coverage
Original Solution		
$KDTS_{GL_{SF-IV}CA}RSLASM^*_{LSDM}K$		
$KD_{TS_{GL_{SFIV}CARS-LA}}SMLSDM^*KS$		
$KD_{TS_{GL\sim SFIVCARS}LASMLSDM^*KS}$		
$\sim KD\sim TS_{GL_{SFIVCARS}LASMLSDM^*KS}$		
Adjusted Solution (Consistency=0.55)		
$KDTS_{GL_{SF-IV}CA}RSLASM^*_{LSDM}K$		
$KD_{TS_{GL_{SFIV}CARS-LA}}SMLSDM^*KS$		
$\sim KD\sim TS_{GL_{SFIVCARS}LASMLSDM^*KS}$		

Comparative observation of the two solutions reveals that the three configurations in the new solution correspond to combinations , , and of the original solution. The unique coverage of original configurations 1 and 4 increases, while other parameters remain unchanged. Analysis shows that original configuration 3 merged into the above two configurations, primarily categorized into the fourth configuration, which is consistent with the three-path results constructed in the previous section. Therefore, it can be inferred that the solution after adjusting the consistency level is a subset of the original solution. Although one configuration is reduced, it does not change the original explanatory mechanism. Referencing Rutten' s robustness experimental conclusions [?], this paper' s analysis results demonstrate good robustness.

6.1 Research Conclusions

This paper is the first to employ fsQCA methods to conduct condition combination analysis on 96 cases from CSDN' s comprehensive hotlist, exploring the driving paths of 12 factors across five dimensions—knowledge quality, knowledge source reliability, receiver characteristics, supply-demand matching, and information cost—on user knowledge adoption behavior in developer communities, revealing the core conditions and complex interactive nature influencing user knowledge adoption. The main research conclusions are as follows:

Overall, none of the factors across the five dimensions of knowledge quality, knowledge source reliability, receiver characteristics, supply-demand matching, and information cost are sufficient to individually constitute necessary conditions for user knowledge adoption. This proves that knowledge adoption in

developer communities is essentially a complex process influenced by multiple factors. There exist 4 configurations of user knowledge adoption behavior in developer communities, which can be categorized into 3 matching paths based on differences: potential rookie blog posts grounded in content quality, traffic guidance blog posts grounded in reputation status, and mutual learning blog posts grounded in professional recognition.

All driving paths for knowledge adoption share a common feature: supply-demand matching serves as the core condition in all paths, indicating that in the process of user knowledge adoption, the “social identity principle” ¹ does not play a decisive role. Instead, users tend to choose knowledge that best suits them and matches their own needs.

Knowledge stickiness, as an information cost in the knowledge adoption process, substantially hinders adoption behavior among specific knowledge receiver groups, which is consistent with existing literature on information adoption [?]. The positive characteristics of both knowledge providers and receivers can compensate to some extent for the negative impacts of knowledge stickiness on adoption behavior. When facing knowledge content with high stickiness and non-high knowledge density, long-term platform users are more willing to engage in such knowledge exchange activities. However, the prerequisite for driving user knowledge adoption behavior is that bloggers need to possess certain reputation status.

6.2 Theoretical Contributions

Compared with related research on knowledge adoption behavior in other virtual communities, this paper’s main theoretical contributions are as follows:

First, this is the first study to examine the interactive effects among influencing factors of online user knowledge adoption behavior from a configuration perspective, enriching the application scope of QCA methods and laying a foundation for the formation of knowledge management decision theory in developer communities. To date, existing relevant research has been limited to studying the impact of single variables on knowledge adoption, predominantly employing quantitative research methods such as structural equation modeling and linear regression, which cannot explain the complex interactive effects of variables on knowledge adoption. This paper introduces fsQCA methods, combining the advantages of quantitative and qualitative approaches to provide a holistic perspective for knowledge adoption behavior research. The study demonstrates that single variables are insufficient to constitute necessary conditions for user knowledge adoption, verifying that user knowledge adoption behavior is a complex process of multi-factor interaction. Through further condition combination analysis, this paper uncovers three driving paths for user knowledge adoption in developer communities.

Second, this paper extends Information Adoption Theory by innovatively selecting variables from the dimensions of receiver characteristics, supply-demand

matching, and information cost, combined with knowledge quality and knowledge source reliability, to explore complex antecedents influencing user knowledge adoption behavior in developer communities. Grounded in Information Adoption Theory, this paper comprehensively considers the impacts of knowledge, both parties in knowledge adoption, and knowledge adoption costs on user knowledge adoption behavior. The study finds that knowledge receiver characteristics can compensate to some extent for deficiencies in knowledge quality, thereby facilitating user knowledge adoption, which corroborates the validity and typicality of this paper's variable selection. For example, users with longer platform usage times are more receptive to blog posts with low knowledge density, while new users prefer blog posts with higher knowledge density.

Third, the supply-demand matching degree variable selected in this paper reflects the interactive process between knowledge and receivers. As an outcome variable, knowledge adoption degree only describes the direct behavioral results of receivers toward knowledge. This paper establishes a relationship between the two by comparing users' interest field content with blog post tags, obtaining insights from social psychology. The research results demonstrate that high supply-demand matching serves as a core condition guiding user knowledge adoption in any configuration path.

6.3 Management Implications

This study's conclusions provide four recommendations for platform operation and management of developer communities:

First, referencing the important conclusion that supply-demand matching serves as a core condition in configurations, developer communities should continuously optimize SEO search engine mechanisms to recommend blog posts with prioritized supply-demand matching for users. Scholars Li Shengli et al. [?] found that the international developer community Stack Overflow leads CSDN in overall community content quality. Domestic developer communities can, on one hand, emulate its strict review mechanisms to ensure resource quality; on the other hand, platforms can promote a signal incentive mechanism [?], such as a programmer employment encouragement strategy—where bloggers whose articles receive more knowledge adoption in developer communities demonstrate higher technical levels, helping them gain more potential employment opportunities—thereby motivating bloggers to create high-quality content.

Second, based on the interactive effects of knowledge source reliability and receiver characteristics on knowledge adoption, developer communities should optimize user reputation rating systems. This can not only promote users' knowledge adoption behavior but also serve as an incentive for knowledge providers, driving them to make continuous knowledge contributions, thereby forming a virtuous cycle of knowledge adoption and creating a good community learning atmosphere. Regarding knowledge transfer mechanisms, communities can reference and learn from GitHub's project team work model [?], where a project

team can consist of multiple contributors. Continuous supplementation and improvement of knowledge among contributors help enhance overall community knowledge quality, with specific identifiers given to knowledge contributors. From the knowledge provider perspective, this provides a good communication environment for knowledge exchange among contributors, while joining project teams through review also helps improve their reputation.

Third, considering that the first configuration of knowledge adoption exists in a large base within the community and this configuration has high timeliness requirements, when new bloggers publish works that receive high-quality ratings after scoring system and manual review, platforms should actively provide traffic support to discover and cultivate more potential high-quality content creators. Simultaneously, communities can attempt to develop personalized learning paths for knowledge receivers based on their interest field content, cultivating more receivers into knowledge providers to achieve sustainable community development.

Fourth, among the four configuration results obtained, the latter three configurations all have low blog post knowledge density, which is not a positive phenomenon. As a type of virtual knowledge community, developer communities are characterized by academic, integrative [?], innovative, and valuable features [?] that distinguish them from other social Q&A communities. Therefore, platforms should encourage high knowledge density creation to improve community knowledge professionalism and academic quality. Meanwhile, having programmers and developers from various locations also means the community can produce more diversified and innovative knowledge to some extent [?]. Communities can increase promotional efforts to attract more developers to join.

Based on Information Adoption Theory and Uses and Gratifications Theory, this paper constructs a research model of influencing factors on user knowledge adoption in developer communities and employs fuzzy-set qualitative comparative analysis methods for relevant empirical exploration. The study ultimately identifies three configuration-driven paths leading to high knowledge adoption of blog posts and proposes several management recommendations based on configuration characteristics, providing effective references for promoting the sustainable development of knowledge platforms such as developer communities.

This study still has some limitations that can serve as directions for future research. First, generalizability of conclusions. This paper examines China's largest developer community—CSDN—and does not investigate knowledge adoption behavior in other communities. Whether the research conclusions are equally applicable to other virtual knowledge communities remains to be verified. Second, among knowledge receivers, there are some lurkers who do not actively like, collect, or comment when browsing relevant blog posts, making it impossible for this paper to collect characteristic data for this portion of receivers. Future research can combine interviews, sampling surveys, and other methods to improve case data.

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Du Yanxuan: Data collection and analysis, experimental design, paper writing and revision.

¹ Social identity principle: Refers to the tendency of people to imitate each other when free to act. In the context of knowledge adoption, it can be understood as people tending to adopt knowledge that other users have adopted. It should be emphasized that this paper does not deny the influence of social identity on user adoption behavior, but rather highlights the key impact of supply-demand matching.

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

Source: ChinaXiv –Machine translation. Verify with original.