Finding a Needle in a Haystack: Homophily, Communication Structure, and Information Search in an Online User Community

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A B S T R A C T

A growing body of research explores how users of online communities navigate through large-scale platforms to find the information they seek. This study builds on the theories of homophily, structural embeddedness, and social exchange to investigate how interest homophily and existing communication structures serve as mechanisms driving information searches and the subsequent formation of communication networks in these communities. Specifically, we analyze comment-on-post tie formation using network data from "Today's House," the largest online user community specializing in interior design in Korea. Employing the LR-QAP method, a permutation-based hypothesis testing algorithm for social network data, our research identifies that network tie formation is driven by both homophilous information searches based on instrumental and hedonic interests, as well as by structurally induced searches such as preferential attachment, reciprocity, and transitivity. In addition, we investigate the contingent effects of communication structure on homophilous tie formation. Our findings suggest that while network-wide structural characteristics enhance homophilous tie formation based on instrumental interests, local network processes leverage homophily based on hedonic interests. We conclude by discussing the theoretical implications of the differential influence of participation motivations on information search patterns and the practical implications for the design of online communities.

Keywords: Online Community, Information Search, Interest Homophily, Communication Structure, Social Network Analysis

Ⅰ. Introduction

As the loci of business and social life shift from offline to online spaces, firm-hosted online user communities are rapidly growing. The success of these communities, functioning as multi-sided platforms,

hinges on their ability to attract a large number of users, facilitate interactions among them, and consequently enhance member satisfaction (Gawer, 2009; Ma and Agarwal, 2007). individuals frequently participate in online user communities to fulfill their psychosocial or hedonic needs, seeking emotional and experiential benefits such as social belonging, self-identification, enjoyment, and escapism through interaction with like-minded individuals and consumption of online content (Arnold and Reynolds, 2003; Babin et al., 1994; Liu and Guo, 2015; Ray et al., 2014). Another key motivation for participating in these communities is to acquire helpful and often readily available information from individuals with similar interests. For an online community to be sustainable, it is essential that participants, regardless of their motivations, must actively engage in searching for valuable information, be it practical or hedonic in nature (Xia et al., 2012).

However, given that online user communities are typically large-scale and characterized by electronically mediated interactions among users with unclear membership boundaries, users may face a substantial challenge in navigating through the "ocean of information" to identify content that deserves closer attention (Mesch and Talmud, 2006). Moreover, because online communication is rarely constrained by time and space, it presents a paradox: although high-quality information is likely to be abundantly available within the community due to its accumulation over an extended period and across diverse regions, the broad scope of information searches can significantly increase the time and energy devoted to sifting through a multitude of information to find credible and useful content. Participants must grapple with remarkable cognitive burden and high uncertainty to "find a needle in a haystack" (Greenwood et al., 2019; Hoetker and Agarwal, 2007; March and Simon, 1993). In response, many online platforms offer various devices designed to assist users in navigating their websites, such as search boxes, filtering systems, and electronic records of member activities. The central question then becomes how users effectively find the information they are seeking, presumably by utilizing these devices, and what forms of communication networks emerge in this process.

This study focuses on two underlying mechanisms through which information is searched in online user communities. The first is homophily. Existing literature suggests that individuals with similar attributes are not only more easily detectable and accessible but are also considered more trustworthy than those with different attributes, as people tend to form emotional and psychological attachments to those who share the same group identities (Currarini and Mengel, 2016). Furthermore, individuals sharing common interests are more likely to understand each other's perspectives, and thus can provide a more informative knowledge stock (Barone and Coscia, 2018). In face-to-face settings, sociodemographic characteristics such as gender, age, nationality, education, and social class are reported to be essential dimensions in forming homophilic ties (Lazarsfeld and Merton, 1954; Mark, 2003; McPherson et al., 2001). Yet, these characteristics are usually unobservable in online settings, making it challenging to use these tangible markers as signals to evaluate similarity. Instead, many social media platforms include search tools like menu categories or navigation tabs specifically designed to help users discover others with similar interests. This raises the question of whether homophilous search mechanisms still operate in online user communities and, if so, what dimensions of user attributes are crucial in creating an information exchange network. Building on prior research on online communities (Groenewegen and

Moser, 2014; Kane et al., 2014; McPherson et al., 2001), this study argues that both instrumental and hedonic interests, associated respectively with the practicality of information and cultural preferences, play a crucial role in shaping homophilous information search networks (Cheng, 2018).

The second mechanism involves pre-existing communication structures that may serve as critical avenues for information search. Sociologists have long asserted that the structural properties of social systems act as both the medium and outcome of social actions within the complex web of social relationships (Fligstein, 1987; Giddens, 1984; Granovetter, 1985). Therefore, the network structure not only mirrors patterns of social interactions but also reinforces specific behavioral patterns, continually shaping and reshaping the social landscape. Numerous studies have indicated that network configurations, in which social actors are embedded, afford them opportunities to connect with others beyond their immediate circle of acquaintances (Gimeno, 2004; Gulati, 1995; Kim et al., 2016). Consequently, the network is not merely a pipe through which information and resources flow, but rather "a lens or prism through which the qualities of actors are inferred by potential exchange partners" (Podolny, 2001, p. 58; Stuart et al., 1999). In online communities, users' activities are recorded permanently in the form of "digital footprints" (posts, comments, clicks, and replies), and such information is publicly available for other members to act upon. This study investigates how these existing comment-on-post network structures can provide users with opportunities to seek new information or information holders by following the trail of digital footprints. Specifically, we focus on various forms of structurally induced information search mechanisms, such as preferential attachment, reciprocity, transitivity, and cyclicity.

In addition, we adopt a contingent approach to examine how homophilous information search is influenced by the structural configurations of the existing communication network. Social network research suggests that homophilous tie formation is deeply embedded within network structures, delimiting opportunities for social interaction (Kleinbaum et al., 2013; McPherson et al., 1992; McPherson et al., 2001). We depart from this line of research, proposing that different types of homophily (instrumental versus hedonic interests) may interact with different structural configurations. For example, a user motivated by instrumental interest is likely to seek reliable information from popular users endorsed by many people. However, hedonic interests, which are rooted in personal pleasure or aesthetic appreciation, rely heavily on nuanced understanding and shared experiences. Therefore, homophilous information searches guided by these interests are more readily found among users who are either directly or indirectly connected, rather than among those who are unconnected.

Although extant research offers valuable insights into how users seek information in online user communities (Faraj and Johnson, 2011; Johnson et al., 2014; Surma, 2016), we still have a limited understanding of the relative importance of homophily versus communication structures and the patterns of their interactions. This study aims to address these gaps, examining the conditions under which each mechanism has a stronger effect on information searches in online user communities, and the ways in which these two mechanisms complement each other. To empirically investigate how interest homophily, communication structure, and their interplay shape behavioral patterns of information search, this study analyzed the comment-on-post network data extracted from "Today's House," the largest online

user community specializing in interior design in Korea. We applied the LR-QAP method, a permutation-based algorithm predicting the presence of network tie between dyadic pairs in a social system. We believe that comment-on-post data are a good reflection of the patterns of information search in online communities, where it is a common norm for information seekers to show their recognition by leaving comments on posts that they find useful (Chen et al., 2017; Jin et al., 2015).

Ⅱ. Theoretical Perspectives on Network Tie Formation in Online Communities

2.1. Interest Homophily

Research on social networks has consistently demonstrated that individuals within a network tend to connect with others who share similar traits (McPherson et al., 2001; Ren et al., 2007). Interacting with similar individuals fosters a feeling of comfort and security, leading to emotional attachments and an enhanced sense of social belonging. Moreover, interpersonal similarity establishes mutual trust, thereby reducing uncertainty involved in various types of social and economic exchanges (Collet and Phillippe, 2014; Putnam, 1994; Trapido, 2013). While previous studies have primarily underscored the sociopsychological aspects of homophily, we suggest that a tendency towards homophilous communication patterns may also arise, at least partly, from the motivation to acquire helpful information with reduced search costs. First, individuals sharing similar attributes are likely to have common interests and, consequently, possess rich information and considerable expertise that are mutually beneficial (Hwang et al.,

2015). Thus, establishing connections with similar others could be a shortcut to obtaining desired information. Second, having common interests facilitates the exchange of tacit knowledge, as individuals with similar traits are "more likely to have a shared language and skills, and an understanding of what others know" (Hwang et al., 2015, p. 1596; Levin and Cross, 2004).

Drawing on Lazarsfeld and Merton (1954)'s seminal work, we differentiate between two types of homophily: status and interest. Status homophily involves a preference for others who share similar socioeconomic statuses, such as education level, social class, and occupation, whereas interest homophily pertains to an association with those who share similar values, beliefs, attitudes, and interests. Status homophily is more relevant in offline communities, as sociodemographic status is easily observed in face-to-face settings (Groenewegen and Moser, 2014). In online environments, however, sociodemographic characteristics are usually unobservable and unreliable even when observed (Brown et al., 2007). The absence of such sociodemographic cues is compensated by the enhanced salience of interests and values typically expressed in online documents. According to previous studies, online community participants leverage such information as personal statements, self-declared user categories, and uploaded content, to make inferences about similarities of interests (Groenewegen and Moser 2014; Han et al., 2015; Kane et al., 2014). As most community websites provide filtering devices like keyword search and preference categories, users can quickly search through websites and easily find content that aligns with their needs and interests, enhancing the likelihood of tie formation between users with similar interests.

User interests in online communities can be cate-

gorized into two types: instrumental and hedonic. Instrumental interests center around an individual's goals, aspirations, and practical needs, such as learning new skills, solving problems, and acquiring methodological knowledge. Empirical research shows that individuals often participate in online communities to obtain information useful for specific purposes, like making purchase decisions or completing organizational tasks (Haas et al., 2015; Hwang et al., 2015; Wang et al., 2017). For instance, in an online interior design community, users considering a complete interior overhaul might seek information from those who have undertaken or are considering a similar construction project. In contrast, hedonic interests involve the pursuit of sensory, emotional, and aesthetic pleasure, often tied to personal preferences, values, and attitudes. Online user communities, particularly those focused on cultural goods, serve as platforms for users to exchange information that satisfies their cultural tastes, aesthetic values, and hedonic needs. (Huang and Benyoucef, 2013; Hu et al., 2021).

To the best of our knowledge, there has been limited empirical investigation into which type of interest homophily (instrumental vs. hedonic) is more prominent in online user communities. As Hwang et al. (2015, p.1954) note, previous studies on interest homophily have yielded mixed results regarding their effects on communication tie formation in online communities, indicating that different types of similarities may have different effects.[1]

Therefore, it is essential to distinguish between these two types of interest homophily and examine whether they exert distinct effects on information search patterns in online user communities. Given the lack of current knowledge concerning the relative importance of these two types, we hypothesize the following:

H1: Interest homophily (similarity both in instrumental and hedonic interests) will increase the likelihood of the comment-on-post tie formation in an online user community.

2.2. Communication Structure as a Source of Information Search

Studies of social networks have revealed that the likelihood of two actors engaging in social interactions depends on their structural positions within the network (Baum and Dutton, 1996; Burt, 1992; Granovetter, 1985). Network theorists argue that a social network, as a pattern of individual ties, affords individuals opportunities and constraints in pursuing their interests (Lin, 2017). This premise is supported by various empirical studies demonstrating that individuals occupying structurally advantageous network positions tend to enjoy greater access to resources and information (Burt et al., 1998; Gulati, 1995). Similarly, individuals can leverage their structural positions to build favorable reputations by attracting the attention of other network participants

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1) Hwang et al. (2015, p.1954) suggest that shared interests can be indicative of future interactions on online knowledge collaboration sites, yet conflicting findings indicate that interest homophily may have only a limited or even negative impact on forming connections in specific online communities. Similarly, the role of demographic homophily in predicting friendship ties on social networking sites is inconclusive, with some studies supporting the idea while others find no significant effect

in certain online communities. Additionally, the impact of belonging to the same category on knowledge sharing is contingent on factors such as online community type and participant experience. Finally, expertise homophily, particularly in technical domains, can enhance mutual understanding and learning, with its influence on knowledge sharing potentially increasing as participants gain more experience in the system.

(Gnyawali and Madhavan, 2001). Thus, the network structure is not merely a pipe through which information and resources flow but also a lens through which to search for opportunities to obtain valuable information and resources, otherwise unattainable (Podolny, 2001). In consequence, we argue that the network embeddedness argument offers insights into the underlying information search processes and mechanisms in online communities.

The importance of information searches through existing networks can be particularly pronounced in online environments. In online communities, social cues related to personal attributes are often absent or significantly reduced, leading participants to attend to other cues available, including the structural positions occupied by potential exchange partners. These structural features are more salient in online than offline communities, given that members' activities are digitally recorded and publicly available to the community as a whole. These electronic archives serve as reliable clues for assessing the trustworthiness of users and the quality of information they provide, thereby facilitating connections among otherwise disconnected members (Burt, 1992; Coleman, 1988; Hansen, 1999; Hass et al., 2015; Uzzi, 1997). In addition, in the absence of face-to-face contact, electronically recorded patterns of interaction offer a fruitful avenue for gaining access to useful content. For instance, users may visit the page of someone who has commented on their post and discover unexpectedly valuable information. Moreover, they can find helpful posts by tracing the chain or thread of comment-on-post communication links.

This study considers three broad categories of structural configurations that may have significant influence on information search patterns in online user communities: preferential attachment, reciprocal search, and localized search. First, preferential

attachment, which refers to the tendency to build connections with a few extremely popular network members, has been recognized as an important source of network tie formation (Barabási and Albert, 1999; Merton, 1968). Preferential attachment is akin to the "Matthew effect," where positive feedback mechanisms lead to the rich getting richer and the poor getting poorer, resulting in a power-law distribution of in-degree centrality <Figure 1(a)>. This inclination towards popular individuals is also observed in the neo-institutional account of mimetic isomorphism, which posits that popularity itself may signal social status, reputation, desirability, and information richness (DiMaggio and Powell, 1983).

Several studies have explored the role of preferential attachment in online settings (Barabási, 2012; Johnson et al., 2014; Liao, 2022; Lu et al., 2013). Utilizing agent-based modeling and real data analysis, Johnson et al. (2014) demonstrated that preferential attachment contributes to the emergence of power-law distributions, although a full-fledged explanation requires consideration of other structural mechanisms. However, Faraj and Johnson (2011) found a disinclination towards preferential attachment after controlling for direct and indirect reciprocity. Although the authors attributed this unexpected finding to the egalitarian orientation frequently observed in online communities (i.e., a norm of welcoming behavior towards new participants), we believe that this explanation may not apply to online user communities where the primary purpose of participation is to acquire useful information, not to make new acquaintances and socialize. We contend that participants seeking valuable information are likely to pay attention to popular individuals and connect with them by leaving comments or asking questions (Kuk, 2006). Therefore, we hypothesized the following:

H2-1: The likelihood of the comment-on-post tie formation in an online user community will be positively affected by preferential attachment.

Reciprocity may represent another mechanism driving network search. Social exchange theory proposes that reciprocity is a common norm in social relations, viewed as an obligation to return favors to those who provide a benefit (Blau, 1964; Cook and Rice, 2001; Wasserman and Faust, 1994; Wu and Korfiatis, 2013). This concept is particularly relevant in community settings, where the norm of egalitarianism prevails and "quid pro quo" acts as a behavioral standard. Mutual exchanges foster trust among community members, encourage active participation, and maintain a shared identity, thereby enhancing the sustainability of the community itself (Coleman, 1990; Constant et al., 1996; Fulk et al., 1996; Kollock, 1999). Various studies have offered empirical evidence supporting reciprocal tie formation in online settings (Faraj and Johnson, 2011; Johnson et al., 2014; Pai and Tsai, 2016). We argue that reciprocation is not solely a moral obligation but also a significant avenue for acquiring valuable information. In online user communities, where navigating through an abundance of information can be challenging, an efficient strategy to save time and energy is to visit the page of the member who has left a comment on one's own page, checking for any useful information <Figure 1(b)>. Furthermore, we argue that reciprocating is expected to serves as a viable search strategy to increase the likelihood of discovering helpful information. Users who left comments on one's posts are highly likely to share similar interests, suggesting that their posts may contain the very information one is seeking. Consequently, we hypothesized the following:

H2-2: The likelihood of the comment- on-post tie formation in an online user community will be positively affected by reciprocity.

Third, network tie formation may be influenced by localized information searches, where individuals pay greater attention to others located nearby in the communication network than to those farther away (Haas et al., 2015; Watts, 1999). Social exchange theories often differentiate between direct and indirect reciprocity, suggesting that the latter involves the tendency to contribute to the group as a whole, rather than returning a favor to a specific individual. Previous studies have identified the presence of indirect reciprocity in online communities, where altruistic norms and social commitment to the community motivate members to contribute to the benefits of other community members, even those without prior contacts (Johnson and Faraj, 2014; Rheingold, 2000; Sproull and Arriaga, 2007; Wasko and Faraj 2000). Nonetheless, we argue that indirectly reciprocated exchanges are more likely directed towards network neighbors than distant members, because proximity tends to enhance social visibility and presumably increases the likelihood of sharing similar interests (Johnson and Faraj, 2014).

This idea aligns with the bounded rationality thesis, which posits that decision-makers cannot process all alternatives simultaneously and, as a result, restrict their attention to a few alternatives located near the problem area (Belenzon et al., 2019; Hansen and Haas, 2001; Piezunka and Dahlander, 2015). Actors, embedded in local neighborhood networks, have their range of alternatives severely constrained by the surrounding network structure. However, actors are not only constrained by a local network but likely to leverage it to expand the scope of their search (Burt, 1992, 2000). Network theorists argue that the network

| (a) Preferential Attachment | (b) Reciprocity | (c) Transitivity | (d) Cyclicity |
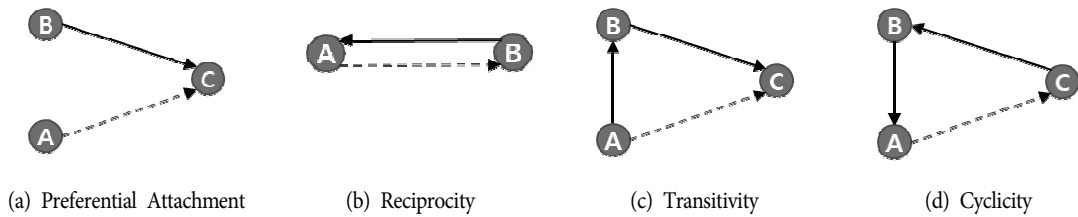
<Figure 1> Structural Configurations

Note: solid arrows : Links that occurred firstly / dotted arrows : Trailing links that are likely to happen

is not only a conduit for information flow but also a lens for identifying potential exchange partners and assessing their trustworthiness and information quality (Podolny, 2001). Therefore, local network configurations may significantly impact information search through the network.

Given that indirect reciprocity is the tendency of network ties towards a third party beyond the ego-alter[2] dyad, it is crucial to identify who this third party is and how it is connected to the ego and its alters. Transitivity, a well-studied concept of local network configuration, is considered an important mechanism conducive to tie formation across various networks (Holland and Leinhardt, 1970, 1971). Transitivity refers to the structural configuration where, if an ego's alter has a directional tie to a third party, the ego also forms a directional tie to that third party <Figure 1(c)>. For instance, in online user communities, if A commented on B's post and B commented on C's post, then A is expected to comment on C's post. This type of local information transmission is likely to occur frequently in online user communities, as information such as "who likes whom" or "who follows whom" is publicly available on each user's personal page.

Cyclicity is another local network configuration associated with the formation of network ties. Cyclicity exists when there is a tendency to complete a circular form of interaction through a third party, creating an information flow within a narrow circle consisting of a small number of nodes <Figure 1(d)>. It embodies a form of locally constrained generalized exchange, where an ego does not directly reciprocate to its alter but instead indirectly reciprocates by extending a favor to the third party who favors that alter. However, cyclicity is not just a social mechanism; it also functions as an information search mechanism (Fan et al., 2021). For example, users may visit their followers' posts and unearth valuable information. Although previous research has paid little attention to the possibility of this reverse information search in online user communities, it is reasonable to assume that the cyclicity mechanism operates because someone who follows an ego's follower seems to share similar interests with the ego. Based on the discussion on localized information searches, we propose the following two hypotheses:

H2-3: *The likelihood of the comment-on-post tie formation in an online user community will be positively affected by transitivity.*

H2-4: *The likelihood of the comment-on-post tie formation in an online user community will be positively affected by cyclicity.*

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2) In the social network analyasis, an ego-alter dyad refers to a pair of nodes consisting of 'ego,' the focal node being studied, and its 'alter,' another node that has a direct tie to the ego.

2.3. Communication Structure as a Source of Homophilous Tie Formation

Although acknowledging that homophilous tie formation in online communities frequently occurs through keyword searches or filtering systems, it is also worth noting that ties between users with similar traits could also stem from information searches through communication networks established via digital footprints. This argument is consistent with prior research proposing that, because the range of social contacts and subsequent information searches is constrained by existing network structures, homophilous tie formation is strongly embedded in ongoing social relations (Granovetter, 1985; Kleinbaum et al., 2013; McPherson et al., 1992; McPherson et al., 2001). For instance, Kleinbaum et al. (2013) found that organizational structures limit opportunities for social interaction, resulting in a higher proportion of homophilous interactions within business units, job functions, and offices. This pattern is also observable in online communities. Thus, we argue that structural configurations arising from existing communication networks provide a pathway for discovering like-minded others and act as a nontrivial mechanism for ehnancing the likelihood of homophilous tie formation.

Drawing on the recent work of Fuhse and Gondal (2022), which highlighted that tie formation mechanisms vary depending on the meanings and purposes attached to relationships, we expect that different types of homophily (instrumental versus hedonic) will interplay with distinct structural configurations. Information search based on instrumental interests entails active and proactive engagement in search activities because it is primarily driven by the concern for immediate (often urgent) problem-solving. For example, users of a home interior community inter-ested in full remodeling will seek those who can provide a wealth of reliable information on this type of interior construction. A useful strategy to reduce the time and energy in searching through a huge pile of information is to initially select a handful of well-recognized popular users and then sort through them to find those who share similar interests. Users might initially choose the remodeling category to find users with similar interests, out of whom then select a few popular users. Either way, when looking for practical information to solve an immediate problem, users are likely to select others who are both popular and have a shared interest, asking them detailed questions about costs, methods, contractors, etc. Therefore, we predict that the structural configuration of preferential attachment will strengthen the tendency for homophilous patterns of information search based on instrumental interests.

H3-1: Preferential attachment will increase the tendency for homophilous tie formation based on instrumental interests.

In contrast, homophilous searches based on hedonic interests, such as a preferred design style, are likely to be influenced more by local communication structures than by preferential attachment. Previous studies demonstrate that design elements that are culturally localized and aesthetically pleasing can foster hedonic interests such as user preferences and a sense of connection (Artuger, 2020; Abdullah et al., 2023; Kirillova and Chan, 2018). Individuals' hedonic interests are difficult to define objectively, and their boundaries are fuzzy and nuanced (Podolny and Hill-Popper, 2004), making popularity (i.e., being liked by many people) less relevant when seeking information regarding hedonic interests. Instead, he-

donic values become meaningful insofar as they are shared and recognized by those who interact directly or indirectly. Accordingly, information search and resulting network tie formation based on hedonic interests are more likely to occur within a narrow range of localized communication networks than across entire networks (Fuhse and Gondal, 2022). For instance, two users who selected "modern" as their preferred design style may find each other's post less suitable to their own tastes, presumably due to categorical fuzziness of cultural preferences. Instead, sympathy and empathy may flow between directly (or indirectly) connected users because people with similar tastes down to the detail are likely to cluster nearby in the comment-on-post network. Therefore, we predict that users can gain useful information about the shared design style by visiting their commenter's personal page, reciprocating recognition by returning sympathetic comments to that commenter.

H3-2: Reciprocity will strengthen the tendency for homophilous tie formation based on hedonic interests.

Ⅲ. Data and Methods

We collected a dataset of comment-post dyads from the "Online Housewarming" tab of Today's House,[3] publicly accessible and open for academic research. Today's House is Korea's largest online e-commerce platform specializing in interior design, and it also runs a community for its members to share information. According to IGAWorks, a Korean mobile marketing company, Today's House is the top interior community in Korea with over 5 million users as of 2022.[4] The company is also expanding internationally, with its services set to launch in Japan and the United States in 2023. Online Housewarming section of Today's House is a community space where people post photos and descriptions of their homes, discuss design concepts, and share information like costs, contractors, and construction periods. We believe Today's House provides an ideal setting for our study, as it possesses an ample amount of data including electronic records of user activities and various kinds of user attributes.

Among the various residence types, we concentrated solely on the apartment category, the most common residence type in South Korea, comprising 62.9% of the total (Statistics Korea, 2020). The data cover the period from the community's launch in November 2014 to October 2022. To analyze how users seek information in this online community, we focused on the formation of comment-on-post ties, because these ties are the most reliable traces of information seeking activities in online spaces. As previous studies have shown (Ameri et al., 2023; Leskovec et al., 2010), commenting on a post in an online community signifies a strong expression of empathy and satisfaction with information on the post. We created a list of dyadic relationships between the user who created the post (alter) and the user who commented on that post (ego), yielding 177,686 comment-on-post dyads with 75,332 users. Our initial analysis revealed that there were a significant number of users with very low activity; for example, those who were active only upon registration and then remained inactive. To filter out transient and virtually inactive members, we included only those

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3) https://contents.ohou.se/projects

who received or wrote at least two comments. We also excluded users with missing data for any of the three key attribute variables (family type, construction type, and preferred design style). The final network dataset included 3,015 comment-on-post dyads among 1,165 users.

We also assembled user-attribute data containing information about each user's interest concerning family type, construction type, and preferred design style. Family type categories include "newlyweds" (56%), "families with babies" (21%), "families with school-aged children" (11%), "single" (5%), "families with parents" (4%), and "other" (3%). Construction type of interest has three categories, out of which "remodeling" accounted for more than half (52%), whereas "home-styling" and "partial work" accounted for 38% and 10%, respectively. Preferred design style has ten categories such as "natural" (39%), "modern" (34%), "minimal and simple" (14%), "vintage and retro" (3%), "nordic" (2%), "unique and mix-match" (2%), and a few other design styles including "lovely and romantic," "classic and antique," "french and provence," and "industrial."

To empirically examine the effects of structural configurations, we construct independent matrices where each cell represents structural features for a corresponding ego-alter dyad. The matrix for preferential attachment records the number of inward connections to the ego's alter from other nodes in the network; that is, the indegree centrality of node C in <Figure 1(a)>. In the reciprocity matrix, each cell is assigned a value of 1 if there is a tie from the corresponding alter to the ego, and 0 otherwise. Transitivity is quantified by the number of two-path ties from the ego to the alter, whereas cyclicity is measured by the number of two-path ties from the alter back to the ego; thereby indicating indirect connections through intermediary nodes like B in

<Figure 1(c) and <Figure 1(d)>.

<Figure 2> depicts the comment-on-post communication network of the Today's House online community, where a tie between two nodes indicates that a user left a comment on the other user's post. The network is divided into a core consisting of densely connected users, a semi-periphery surrounding the core, and a periphery occupied by relatively inactive users. However, a number of users in the core area are connected to a single user (pseudonymized as N383) with an exceptionally high out-degree value of 253 (for comparison, the average out-degree is 2.65). Removing this node reveals a relatively even distribution of ties across the network. Interestingly, 98% of ties have the tie strength of 1, with only 71 dyads connecting twice or more, indicating that community users prefer to "shop" around different users to obtain a variety of information, rather than focusing on a few users for deeper information. Therefore, we dichotomize the network data, assigning a value of 1 for at least one tie, and 0 otherwise.

To test our hypotheses concerning patterns of information search and subsequent network tie formation, we employed a Quadratic Assignment Procedure (QAP) logistic regression model that analyzes the likelihood of the presence of a tie for each dyad. In general, parametric statistical techniques assume that observations are independent of each other; however, this assumption does not hold in social network analysis, where the primary purpose is to examine patterns of interdependent relationships among nodes. To address this problem, we used the QAP because it is a non-parametric permutation-based technique that does not require the in-

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5) A dot represents the user (node), and a line indicates a directional comment-on-post link.
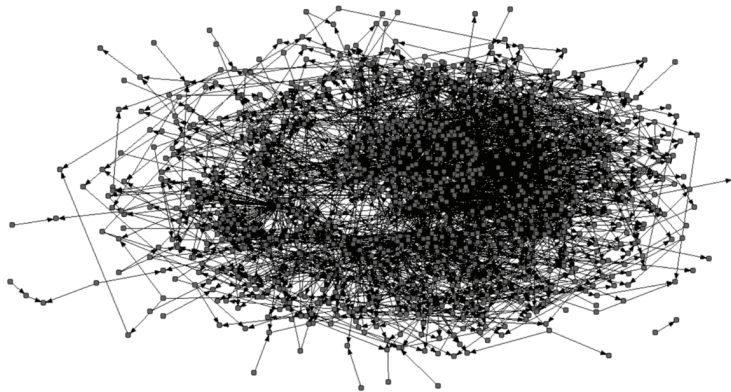
<Figure 2> Comment-on-post Network in Today's House Online Platform[5]

dependence assumption (Oloritun et al., 2013). As Krackhardt (1988, pp. 362-363) put it, "by generating all correlations that result from permutating the rows and columns of one of the structural matrices, one can determine the distribution of all possible correlations given the structures of the two matrices." A test statistic of interest is derived from a large number of permutations, wherein nodes in the network are randomly assigned to other nodal positions of the network and then compared with the observed statistic. The p-value is computed as the proportion of permutations that yield statistics that are more extreme than the observed statistics.[6] Since we had binary network data with a value of 1 for the presence of ties and 0 otherwise, we used the LR-QAP technique, a logistic regression version of the QAP. Thus, a significantly low p-value indicates that the observed

relationship between the matrices is so strong that it is unlikely to occur by chance. The dependent matrix represents whether a comment-on-post link exists between each pair of users. Several independent matrices were included in the analysis to examine the influence of interest homophily and existing communication structure.

Ⅳ. Results

We applied LR-QAP models with 1,000 permutations to investigate the effects of interest homophily and structural configurations on patterns of information search and resulting network tie formation within the Today's House online community. The results are presented in <Table 1>.[7] Model 1 examines homophilous tie formation. We found that user attributes related to instrumental interests (family and construction types) are conducive to homophilous tie formation. However, interior design style,

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6) The QAP model goes through several steps to obtain test statistics and associated significance levels. First, Pearson's correlation coefficient between the corresponding cells in independent and dependent matrices are drawn. Second, a large number of random networks are constructed by iterative permutation, and, for each random network, Pearson's correlations are calculated. Third, test statistics are derived by comparing the random and observed results: the proportion of times that the result of the first step is smaller or equal than the random result is derived to identify the level of relation between the matrices.

7) In all models reported in this paper, we included N383, the node with the highest out-degree centrality. In separate analyses, we excluded N383 to avoid the potential distortion by this single outlier, finding no fundamental change in regression results (available upon request).

\<Table 1\> LR-QAP Regression Analysis Predicting Network Tie Formation

Variables	Model 1 (Odds Ratio)	Model 2 (Odds Ratio)	Model 3 (Odds Ratio)	Model 4 (Odds Ratio)	Model 5 (Odds Ratio)
Homophily					
Family Type	1.293 *** (0.001)	1.239 ** (0.014)	1.241 ** (0.020)	1.238 *** (0.010)	1.240 ** (0.024)
Interior Construction	1.183 *** (0.008)	1.209 *** (0.006)	1.118 * (0.100)	1.209 *** (0.010)	1.116 (0.167)
Design Style	0.996 (0.885)	0.989 (0.851)	0.989 (0.290)	0.951 (0.710)	0.951 (0.543)
Structural Configuration					
Preferential Attachment		1.155*** (0.001)	1.146 *** (0.010)	1.155 *** (0.010)	1.146 *** (0.001)
Reciprocity		50.938 *** (0.001)	51.073 *** (0.001)	45.022 *** (0.001)	45.100 *** (0.001)
Transitivity		6.931*** (0.001)	6.924 *** (0.001)	6.931*** (0.001)	6.924 *** (0.001)
Cyclicity		1.003 (0.961)	1.006 (0.410)	1.014 (0.900)	1.017 (0.817)
Interactions					
Interior Construction× Preferential Attachment			1.109 ** (0.030)		1.019 * (0.064)
Design Style×Reciprocity				1.461** (0.040)	1.465 ** (0.012)
Log-Likelihood	-21394.389	-18806.697	-18804.91	-18802.805	-18800.957
R-Square	0.002	0.122	0.122	0.123	0.123

Note: Odds ratios are reported and p-values are in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

indicative of hedonic interests, shows no significant effect. It appears that users of the same family type are 29% more likely to form ties compared to those from different family types. Similarly, the likelihood of tie formation between users interested in the same construction type is 18% higher than that between users with different construction interests. Overall, the hypotheses regarding homophilious tie formation are partially supported: homophilous information exchanges are more prevalent among users interested in practical information rather than among those pursuing hedonic interests.

To examine the patterns of homophilous tie formation in greater detail, we calculated the Krackhardt's E-I index for each of the three user attributes. The E-I index, computed as the number of out-group ties minus the number of in-group ties divided by the total number of ties, ranges from -1.0 indicating the perfect homophily, to +1.0, indicating perfect heterophily (Krackhardt and Stern, 1988).

$$E - I\ Index =$$
$$\frac{The\ number\ of\ external\ links\ -\ The\ number\ of\ internal\ links}{The\ number\ of\ external\ links\ +\ The\ number\ of\ internal\ links}$$

<Table 2> E-I Index for Each User Attribute

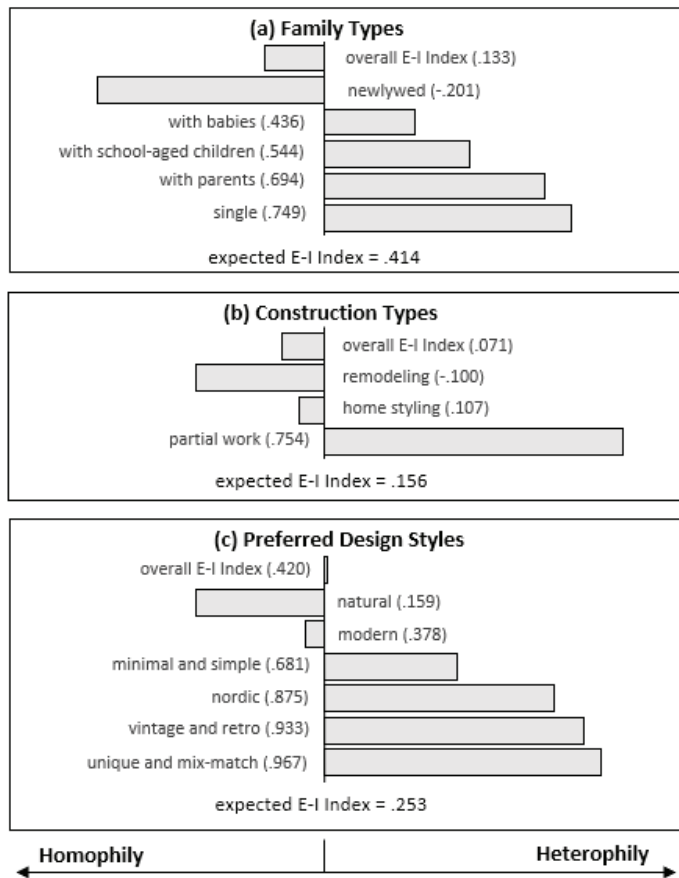| User Attribute	E-I Index	Expected E-I Index
Family Type	0.133 ***	0.253
Interior Construction Type	0.071 ***	0.156
Design Style	0.420	0.414

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

To assess how homophilous or heterophilous the network is, we must look at how much and in what direction the observed value of the E-I index deviates from its expected value. <Table 2> presents the E-I indices for each of the three user attributes. We found that the family type shows homophily with the E-I index score significantly lower than the expected score ($p < 0.001$). The newlywed family type has a particularly strong homophilous pattern of information exchange, as indicated by its category-specific E-I index of -0.201 (See <Figure 3(a)>). This pattern likely arises because newlyweds, commonly beginning their couple life in a new home, tend to have rather homogeneous interests in decorating and remodeling their new homes, without concerns about other residential issues, such as caring for elderly parents and raising children. Consequently, newlyweds seem more inclined to seek information from other newlyweds, asking where to buy furniture and home appliances. For example, a comment from one newlywed to another read, "can you give some information about your sofa?"

There is a marked tendency for homophily in terms of interior construction type. The E-I index for interior construction types is 0.071, which is significantly lower than the expected score of 0.156 ($p < 0.001$). This result substantiates that comment-on-post ties tend to form among users sharing an interest in the same construction type. As depicted in the <Figure 3(b)>, the E-I index for the remodeling

category is particularly low (-0.100), indicating that users interested in remodeling-type construction were inclined to seek information from each other.[8] The highly homophilous patterns in information search within the remodeling category might be attributable to the fact that remodeling often requires a comprehensive overhaul, which is not only expensive and time-consuming but also challenging to modify once completed. To access rich and in-depth information, it appears that users with an interest in remodeling actively communicated with others who shared similar interests. We noticed numerous inquiries seeking practical information about contractors, price, duration, and methods: "Where did you get your cost estimate from?"

In relation to interior design styles, we found no homophilous patterns. This is surprising, as it is often said that one of the primary motivations for participation in online user communities, particularly those with a strong cultural flavor, is to satisfy cultural passions by associating with others who share similar cultural preferences. A possible explanation for this absence of homophily could be that individuals usually have multiple or only vaguely defined cultural preferences. Although practical needs, such as improving residential conditions, can be relatively clearly defined, aesthetic and cultural preferences may

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8) The observed E-I index (0.107) for home-styling is also lower than the expected E-I index of 0.156, meaning that users interested in home-styling tend to associate with each other.

(a) Family Types
overall E-I Index (.133)
newlywed (-.201)
with babies (.436)
with school-aged children (.544)
with parents (.694)
single (.749)
expected E-I Index = .414

(b) Construction Types
overall E-I Index (.071)
remodeling (-.100)
home styling (.107)
partial work (.754)
expected E-I Index = .156

(c) Preferred Design Styles
overall E-I Index (.420)
natural (.159)
modern (.378)
minimal and simple (.681)
nordic (.875)
vintage and retro (.933)
unique and mix-match (.967)
expected E-I Index = .253

Homophily   Heterophily

<Figure 3> The E-I Index for Family Type, Construction Type, and
Preferred Design Styles (by Categories)

be more challenging to categorize into a single type. Accordingly, we interpret that network ties based on preferred design style seem to be less about information sharing, but more about admiration and appreciation, as exemplified by a comment like "I love your furniture's color."[9]

9) Removing N383 from the dataset makes homophilous patterns more pronounced: The E-I index scores for interior construction type, family type, and design style become somewhat lower from 0.071 to 0.047, 0.107 to 0.073, and 0.420 to 0.370, respectively. This suggests that N383 with the out-degree value of 253 is a "omnivorous" information seeker, causing some degree of distortion in the structuration of communication network.

Model 2 in <Table 1> incorporates four structural configurations: preferential attachment, reciprocity, transitivity, and cyclicity. Overall, we found strong structural effects without significant alterations in the patterns of homophily observed in Model 1. With the exception of cyclicity, all structural configurations appear to significantly enhance the likelihood of comment-on-post tie formation. The odds ratio for preferential attachment is 1.16, indicating that a one-unit increase in in-degree centrality raises the likelihood of an additional tie by 16%. This implies that information search is concentrated towards a small number of popular users. The odds that users recip-

<Table 3> Summary of Hypothesis Testing

Hypotheses	Results
H1a: Instrumental Interest Homophily	Supported
H1b: Hedonic Interest Homophily	Not Supported
H2-1: Preferential Attachment	Supported
H2-2: Reciprocity	Supported
H2-3: Transitivity	Supported
H2-4: Cyclicity	Not Supported
H3-1: Instrumental Interest Homophily x Preferential Attachment	Supported
H3-2: Hedonic Interest Homophily x Reciprocity	Supported

rocate a tie is more than 50 times higher than the odds of a tie being formed at random. Transitivity has the odds ratio of 6.931, suggesting that a network tie is highly likely to form between two users indirectly connected through the same third party. The presence of transitivity as well as reciprocity implies that users are likely to expand their search scope through direct connected alters. Surprisingly, we did not observe a significant effect of cyclicity, indicating that backward information search (giving attention to my follower's follower) is not common in the Today's House online community.

Model 3 to Model 5 analyzed how different types of interest homophily interact with different structural configurations of the communication network. Model 3 yielded support for H3-1, indicating a positive interaction effect between construction type and preferential attachment. This suggests that users seeking practical information are inclined to value the opinions of a few popular users, as those with more in-degree connections are perceived to possess more useful and reliable information suitable for practical purposes. Model 4 introduces the interaction between homophily based on preferred design style and reciprocity to test H3-2. We found that reciprocity significantly increases the likelihood of homophilous tie formation based on the preferred design style.

We propose that because hedonic interests, involving cultural tastes, are subjective and intersubjective at best, users with similar hedonic interests are rather easily found in localized clusters formed through direct or indirect links. <Table 3> summarizes the results of hypothesis testing, demonstrating that all hypotheses, except on for cyclicity, were supported.

Ⅴ. Discussion and Conclusion

Building on the theories and methods of social network analysis, homophily, structural embeddedness, and social exchange, this study delved into how online community users navigate through the ocean of information to find valuable information. We developed the research model regarding the impact of interest homophily and existing communication structures on users' information search behaviors and subsequent formation of communication network. Additionally, we examined the contingent effect of communication structures on homophilous information search, claiming that different forms of communication structures facilitate distinct types of interest homophily. To empirically investigate our theoretical propositions, we analyzed comment-on-post data drawn from Korea's largest in-

terior design online user community.

The results revealed a marked tendency for communication ties to form among users with similar instrumental interests, in contrast to the limited tie formation among users with similar hedonic interests. Preferential attachment, reciprocity, and transitivity have also been found to be crucial mechanisms in forming network ties, highlighting that community users frequently leverage existing communication networks to identify relevant information and its providers (Podolny, 2001). Furthermore, we observed the presence of interactions between structural configurations and interest homophily, indicating that a homophilous pattern of information search based on instrumental interests is reinforced by network-wide structural characteristics such as preferential attachment. In contrast, homophily based on hedonic interests appears to be influenced by local network processes, such as reciprocity.

This study makes several contributions to our understanding of information searches in online user communities. First, our findings illuminate behavioral patterns of information search that vary depending on users' motivations for participation and the types of information they seek. Despite longstanding arguments regarding the differential patterns of homophilous associations based on actor motivations and interests (Lazarsfeld and Merton, 1954), there have been few empirical studies that explored these differential patterns in online user communities. The scarcity of research in this area is surprising, given the diverse motivations driving participation in online communities, which likely result in varied information search behaviors. Our findings underscore that users with instrumental interests are inclined to acquire information by interacting with popular users who also share similar practical interests within the community. This implies that participants seeking

practical, problem-solving information are more likely to connect with users who have previously experienced the similar issues or are deemed to have high-quality information in their areas of interest (Fuhse and Gondal, 2022). These behavioral patterns of information search are likely because interior projects such as remodeling can be costly and difficult to undo once finished; hence, obtaining accurate and highly recognized information is crucial.

In contrast, we found no empirical evidence of homophily driven by hedonic interests, indicating that individuals motivated by aesthetic appreciation or forming connections with like-minded individuals tend to exchange information across a broad spectrum of preferences. Interestingly, however, homophily concerning preferred design style does interplay with reciprocity, revealing that information exchange among users with similar hedonic interests predominantly occurs within locally bounded communication networks. This finding is intriguing, suggesting that information searches motivated by practical needs and those by hedonic needs involve distinct search behaviors and mechanisms: the latter involves less proactive and self-directed search behaviors than the former. While users seeking practical information often use categorized search systems or seek information from individuals deemed to have high-quality information, finding people with similar cultural tastes seems more or less serendipitous, often occurring through network links formed around the focal actor.

Second, the communication tie formation based on hedonic interests appears to be driven more by a "quid pro quo" type of obligation than tie formation for practical information (Blau, 1964; Fuhse and Gondal, 2022; Wu and Korfiatis, 2013), because of a strong in-group orientation among users who share similar cultural tastes (Mark, 2003). This is the ex-

tension of research on motivations for participation in online user communities by exploring how people with distinct motivations create, distribute, and exchange information in online spaces.

Third, our study enhances our understanding of the hierarchical nature of information flow in online user communities. Our results highlighted the importance of preferential attachment and transitivity as key mechanisms for information seeking, while cyclicity shows no notable effect. The significant effect of preferential attachment indicates that information tends to flow from more popular to less popular users (Khan et al., 2019). Transitivity, conceptualized as "I like a person if that person is liked by someone whom I like," serves as another structural configuration pointing to the hierarchical nature of the network tie formation (Snijders, 2011). The prevalence of transitive triads suggests unidirectional flow of information along the chain of ties from more liked to less liked.

The absence of a significant effect of cyclicity also implies a hierarchical structure in the information flows within the Today's House user community. Given that cyclicity is typically articulated as "I follow a person if that person follows someone who follows me," its lack of significance implies that users rarely seek information from those lower in the chain of information flow. The prevailing notion views the online space as a flat and open community where there is no noticeable distinction between information producers and consumers, and information is exchanged horizontally rather than vertically (Lindberg et al., 2016). However, our results paint a different picture. There is a distinction in the roles of information producers and consumers, and the information flow is unidirectional rather than bidirectional. This suggests that, similar to offline communities, there might be an uneven distribution of reputation, status, knowledge, and skills among users, and that this uneven distribution, along with the resultant hierarchical network structure, is fostered and reinforced during the information search process (Hwang et al., 2015; Johnson et al., 2014).

In addition, our work carries practical implications for designing a firm-hosted user community to facilitate its members to easily "find a needle in a haystack." Many online communities offer categorized filtering systems or keyword search functions to aid users in obtaining useful information, yet these systems may work only for users who already have a clear idea of what they are looking for. As evidenced by the strong effects of network configurations, however, the various kinds of "digital footprints" (comments, clicks, reviews, replies, etc.) also serve as cues to often serendipitously discover useful information. Research on social networks has repeatedly demonstrated that people with similar interests and tastes, even with differing pronounced interests, tend to cluster locally through direct or indirect connections (Mark, 2003). Goodreads which is an American social cataloging website owned by Amazon serves as a compelling example of how information searches through a chain of connections works. This website makes extensive use of digital footprints tailored to individual users, such as reviews, interests, reading activities, and interaction histories. By adding friends to their profiles, users can embark on a journey through their network of connections and thereby facilitate serendipitous discoveries of books that might not have been directly searched for. This can lead to the discovery of valuable information and diverse perspectives within the community. Therefore, we recommend that online community providers enhance the visibility of various types of digital footprints and furnish comprehensive information about commenters and reviewers (e.g.,

their interaction history and a list of connected third parties), thereby increasing the chances of members finding valuable information through localized information searches.

Furthermore, our study offers insights into improving the recommender systems commonly used in e-commerce businesses. A promising approach is to fine-tune recommendation algorithms to reflect the communication network structure formed surrounding the focal user. For instance, given that like-minded users are likely to be closer to each other in a communication network, one may design a recommendation algorithm that assigns more weight to shorter distances. Collaborative filtering techniques incorporate the influence of the user's network by giving more weight to the preferences of users who are directly or indirectly connected. Signals from users with closer connections carry more weight in influencing recommendations, reflecting the inherent influence of like-minded individuals. This way, the system suggests items that have gained popularity or positive feedback within the user's social networks, enhancing the chances of aligning with the user's preferences.

Nevertheless, this study is subject to a few limitations that should be addressed in future studies. Firstly, our network data were derived solely from users who left comments on other users' posts; therefore, users who read posts but did not contribute were systematically excluded from the data. While leaving a comment is presumed to indicate high level of satisfaction with the post, we acknowledge that our study suffers from the potential sampling bias in our data. Future studies could obtain more comprehensive network data by capturing all electronic records, including each user's viewing duration and frequency. Secondly, although our study focused on the occurrence of comments from one user on anoth-

er user's post, we did not analyze the actual content of these comments. While our selective reading suggested that most comments expressed strong positive emotions or deep interests, future work could employ text and image analytics to more thoroughly understand communication networks in online user communities. Thirdly, the empirical findings presented in this study may be influenced by country-specific and domain-specific contexts, raising questions about the generalizability of our findings to various online communities operating in different cultural settings. Future research should investigate the applicability of our findings to different cultural backgrounds and types of online communities. Lastly, for a comprehensive understanding of the behavioral patterns of information search and the resulting network tie formation, an evolutionary approach to network formation should be considered. Future research can use network evolution models to explore how information spreads in online spaces.

In conclusion, our study significantly contributes to a nuanced understanding of information search patterns and the emergence of network structures in online communities, by applying theories of interest homophily, structural embeddedness, and other theoretical resources advanced in social network analysis. With the locus of information search transitioning from offline to online, the volume of information to be explored has increased dramatically. In response, online community users and providers have adapted their behavioral patterns and technological systems to alleviate the time and cognitive burden associated with navigating massive amounts of information. While these adjustments are nontrivial, our study highlights that interest homophily and existing network structures continue to be pivotal mechanisms in information search within online spaces. This prompts the question of how to design

online environments to effectively leverage these mechanisms for efficient information retrieval. By integrating theories of social networks and online communities, we believe this study paves the way for future research in this area.

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