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Published in:
Complexity

Published: 01/01/2021

Document Version:
Final Published version, also known as Publisher's PDF, Publisher's Final version or Version of Record

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Publication record in CityU Scholars:
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Published version (DOI):
[10.1155/2021/6692210](https://doi.org/10.1155/2021/6692210)

Publication details:
Li, N., Huang, Q., Ge, X., He, M., Cui, S., Huang, P., Li, S., & Fung, S.-F. (2021). A Review of the Research Progress of Social Network Structure. *Complexity*, 2021, Article 6692210. <https://doi.org/10.1155/2021/6692210>

Citing this paper

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Review Article

A Review of the Research Progress of Social Network Structure

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Received 29 October 2020; Revised 30 November 2020; Accepted 27 December 2020; Published 8 January 2021

Academic Editor: Fei Xiong

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Social network theory is an important paradigm of social structure research, which has been widely used in various fields of research. This paper reviews the development process and the latest progress of social network theory research and analyzes the research application of social network. In order to reveal the deep social structure, this paper analyzes the structure of social networks from three levels: microlevel, mesolevel, and macrolevel and reveals the origin, development, perfection, and latest achievements of complex network models. The regular graph model, P1 model, P2 model, exponential random graph model, small-world network model, and scale-free network model are introduced. In the end, the research on the social network structure is reviewed, and social support network and social discussion network are introduced, which are two important contents of social network research. At present, the research on social networks has been widely used in coauthor networks, citation networks, mobile social networks, enterprise knowledge management, and individual happiness, but there are few research studies on multilevel structure, dynamic research, complex network research, whole network research, and discussion network research. This provides space for future research on social networks.

1. Introduction

Social network is a form of social organization based on “network” (the interconnection between nodes) rather than “group” (clear boundary and order). It is an analytical perspective emerging from western sociology in the 1960s. Although “social networks” have been proposed for more than 60 years, social networks are still an important research method. Social network refers to the relatively stable relationship system formed between individual members of the society due to interaction. Social network focuses on the interaction and connection between people, and social interaction can affect people's social behavior.

This paper reviews the theoretical and empirical literature on social networks. Firstly, the network structure view, relationship strength theory, social capital theory, and structural hole theory of social network are discussed. Then,

the methods of social network analysis are discussed. Social network analysis is a new social science research paradigm based on social network theory, and it is an important method to study social structure. It is a tool in the theory of social networks to quantify the relationship between actors in social networks. As more and more scholars study social structure and think seriously about the “network structure” of social life, various network concepts (such as centrality, density, structural hole, and clustering coefficient) are crowding in. Then, it reviews the development of network theory: regular network, random network, and complex network. A large number of studies have proved that a complex network is more suitable to the characteristics of the real network. Social support and social discussion networks are the last part of this article; they study social network structure in the perspective of social support and social discussion. Social support network refers to a person

through mutual exchanges to maintain social status and get emotional support and material assistance. And social discussion networks define the network relationship by whether you discuss important issues with him.

2. Social Network Theory

Social network is a perspective of sociological analysis that emerged in the 1960s. At present, the main theories include strong ties and weak ties theory, social capital theory, and structural hole theory. After years of development, the social network theory has been widely used in the fields of computing science, economics, and information dissemination. And it has become an important theory and method for research.

Network refers to the relationship between things, and social network was first put forward by the famous British anthropologist Radcliffe Brown in his attention to structure. It focuses on how culture stipulates the behavior of internal members of a bounded group, while actual interpersonal behavior is much more complex. Barnes believed that the informal connection between individuals is the essence of the meaning of social networks [1]. A more mature definition of a social network is Wellman's idea in 1988 that "a social network is a relatively stable system composed of social relations among individuals," that is, he treats "the network" as a series of social ties or social relations linking actors, whose relatively stable patterns make up the social-structure [2]. With the expansion of application scope, the concept of the social network has exceeded the scope of interpersonal relationship. Network actors are no longer limited to individuals; it can also be collectives, such as families, departments, organizations, institutions, and countries. With the development and improvement of social network theory, social network, which is originated from sociology began to be applied in pedagogy, economics, and other fields. More and more scholars construct the concept of "social structure," and social network theory was gradually recognized by scholars [3].

"Social network" is a collection of social actors which is treated as nodes and their relationships [4]. Among them, the actor may be an individual, the organization, or the state. The relationship between actors is the specific content between two actors, including the relationship between actors (friendship and partnership), the interaction between actors (benefit-exchanging and information transmission), and the evaluation of actors (trust and respect) [5]. Some scholars think that people often communicate and form relationships through the network. But social network analysis studies the social phenomenon and social structure from the perspectives of the "relationship." It is a research method to study interpersonal relationships and interpersonal interaction among group members. As a kind of quantitative analysis tool, it has strong analytical and graphical characteristics [6]. Social network analysis is different from traditional research, which starts from the relationship between individuals and analyzes the interaction and influence among network members, while traditional research mainly focuses on the attributes of individuals [7].

The research of social networks began in the 1960s. By the mid-1970s, the social network becomes a new field of sociology. In recent years, the social network research is widely used in computer science, mathematics, education, neuroscience, economics, and other fields with many scholars' contributions. A large number of relevant studies use social network analysis methods to analyze social phenomena and social problems, such as coauthor network and citation network, mobile social network, enterprise knowledge management, career mobility, individual happiness loneliness, group decision making, urban sociology, mental health, and gerontology. There are some representative social network theories: the perspective of network structure, relationship strength theory, social capital theory, and structural holes theory [8].

Network structure view and status structure view are completely two different research paradigms. According to the status structure view, individuals in the society have certain attributes, and we can classify them by the attributes of individual members. Also, their social behaviors are explained according to the categories they belong to. However, the network structure view holds that the link between any subjects (person or organization) and other subjects is an objective social structure, which will have an impact on the subject's behavior [9]. White, Granovetter, and some others are also supporters of the view of network structure. They oppose the idea that individuals are classified by their categorical attributes and using their attributes to explain their actions. Status structure view and network structure view have the following several differences: firstly, the status structure view emphasizes the individual attribute (age, gender, class, and status), and the individual is sorted by their characteristics. But network structure theory emphasizes the link between individual and individual (family and friends); it is classified by individual social networks. Secondly, the status structure view focuses on the individual's identity and sense of ownership, while the network structure view focuses on the individual's social embeddedness. Thirdly, the status structure view emphasizes whether an individual possesses resources or not and how much resources he possesses and attribute it to the status of an individual, while the network structure view holds that the position of an individual in the network and the scale of the network determines the rules of the social network. The two views seem to be opposite, but in fact, they complement each other [10].

The concept of tie power was first proposed by American sociologist Granovetter in his article "The power of Weak tie" published in 1973, and the ties were divided into strong ties and weak ties. He believes that the strength of the ties determines the nature of the available information and the likelihood that an individual will achieve his goal. In terms of the measurement of the strength of the tie, most studies refer to the four dimensions classified by Granovetter: interaction frequency, the emotional strength, the intimacy, and the reciprocal exchange behavior [11]. Strong tie refers to the strong homogeneity of the individual social network (that is, the work that the communicating group is engaged in and the information they grasp is similar), the close relationship

between people, and there is a strong emotional factor maintaining the interpersonal relationship. Weak tie is characterized by a strong heterogeneity of individual social network (i.e., a wide range of contacts, contacts may come from all walks of life, so the information available is also multifaceted), and interpersonal relationship is not that tight, and there is not too much emotional maintenance [12]. Although Granovetter pointed out the theory of strong and weak ties, he focused on elaborating and developing the theory of weak ties accordant to American society. Bian and Zhang, a Chinese scholar, developed the theory of strong tie based on China's actual situation and defined and developed relational social capital. He viewed social phenomena and social problems from the perspective of social relations, not limited to the perspective of the social network [13].

In the 1980s, Bourdieu explained social capital. He believed that social capital is a collection of actual resources or potential resources, which are related to the network of mutual acquaintance and recognition. In other words, it is related to the identity of group members. The amount of social capital is affected by an individual's economic status and social status, and the amount of social capital an individual has is usually related to his or her relationship network, economic status, and cultural quality. The definition of social capital concept by Lin what absorbing the concept of Marx's capital, Schultz's human capital concept, as well as Bourdieu, Coleman, and Putnam was most comprehensive. It emphasizes that the social capital is a kind of source invested in social relations and for acquiring the harvest in the market, embed in social structures, and obtain resources by a purposeful action [14]. When Lin defines social capital, he emphasizes the preexistence of social capital, which exists in a certain social structure, and people must follow the rules in order to obtain the social capital. Meanwhile, the definition also explains the initiative of human action, and people can obtain social capital through purposeful actions. Lin Nan believed that the theoretical model of social capital should include three processes: firstly, investment in social capital; secondly, the involvement and mobilization of social capital; the third is the return of social capital. He divided social action into instrumental action and emotional action. Instrumental action is understood as obtaining resources not owned by the actor, while emotional action is understood as maintaining resources already owned by the actor [14]. Existing literature has conducted in-depth research on social capital theory from the perspectives of basic concepts, measurement methods, and indicators as well as social and economic performance. The development of social capital has been relatively perfect. In recent years, researches have focused on the combination of social network theory and specific problems. For example, Cook and Hole investigated the survival of homeless people in the street from the perspective of Bourdieu's social capital theory [15]. Valente and Pitts analyzed and evaluated the social network theory and applied it to public health problems [16]. Chinese scholars Zhou et al. studied the online participation behavior of health community users based on the social capital theory [17]. Zhang and Wang studied the reading

interest relationship network in public libraries from the perspective of social network theory [18].

In 1992, Ronald Burt proposed the "structural hole theory" in *Structural Holes: Competitive Social Structures*. The "structural hole" refers to the gap in the social network, that is, some individuals in the social network have direct contact with some individuals, but they do not have direct contact with other individuals and there is no direct relationship. So it seems that there is a hole in the network structure from the whole perspective of the network [19]. Burt pointed out that structural holes in social networks not only have greater access to nonrepetitive resources but also can control resource flows between a group of nodes connected by structural holes, thus bringing greater benefits to participants located in the competitive field [20]. Structural hole theory is a new member of the family of interpersonal network theory, which emphasizes that the structural holes existing in the interpersonal network can bring advantages in information and other resources to organizations and individuals in this position. Compared with other theories, it emphasizes the structural analysis and the use of the interpersonal network, which is easier to grasp and operate.

With the development in the past almost 70 years, scholars have made an in-depth analysis of the application of social networks in practical fields. Social network, as a unique perspective, provides the academic research of scholars with a unique perspective. It plays a guiding role to some degree in almost each field of human behavior and has been widely recognized by scholars all over the world. The vitality of social network theory lies in its profound theoretical foundation of relational sociology and its scientific and empirical research. From the perspective of studying Chinese society, ties sociology is a set of theoretical knowledge with the main characteristics of ethics-oriented and relationship-oriented. From the perspective of methodology, relational sociology is a kind of mindset and research methodology used to explore and analyze social behavior patterns, or it can be said that it is a knowledge to study various social types from the perspective of relational theory [21].

Relational sociology is theory-oriented empirical research of observation, measurement, and grasp of human behavior, also the combination of qualitative research and quantitative research. Based on the analysis of individuals and their relationships, social network theory emphasizes the initiative of individuals and pays attention to the social structure formed by social networks and the restriction of social systems on individuals, and the interaction between individuals may change the social structure that restricts individuals [22]. Social network theory also builds a bridge between microbehavior and macrophenomena. Society is made up of a variety of microcosmic individuals, all of whom interact to produce a macroscopic picture. In the process of individual interaction, the behavior of individuals influences the social structure through the relationship, and the social structure in turn influences the decision-making and behavior of individuals. Social networks are the organic integration of individuals and their interrelationships [23].

2.1. Social Network Structure Analysis. Social network analysis is a new paradigm of social science research and methods. It is different from traditional sociology research who conducts the research in the perspective of individual characteristics and is used to measure the extent of the individual accepted by the group and organization. It is a tool to discover the existing relationships between people in a group and reveal the structural characteristics of the organization itself. It is mainly used to evaluate and measure the relationships of interpersonal attraction or interpersonal rejection in a social group, as well as a method to study interpersonal selection, information exchange, and interactive relationships within a group [24]. Some scholars believe that society is a huge network composed of various relationships [25]. The structure of the social network and its influence mode on social behavior are the research objects of social network. The purpose of studying social network is to reveal the deep social structure, that is, the fixed network mode hidden under the complex appearance of the social system.

Since the 1960s, social network research has been developed along with the two directions that differ and connect mutually. One is the egocentric network analysis, the other is the whole network analysis. The former analyzes the relationship between individual/node attributes and individual networks, while the latter mainly studies the network structure, the properties of graph theory, and location attributes [26]. Egocentric network analysis defines social networks from the perspective of individuals. Their concern is how individual behavior reacts under the influence of the interpersonal network and how to form a society through the network [27]. Representatives of this field include Mark Granoveter, Harrison White, Lin Nan, and Ronald Burt. Individual network measure includes scale, type of relationship, network density, pattern of relationship, homogeneity, and heterogeneity of members. Whole network analysis studies the integrated structure of the whole network and the internal relations of a small group. A series of network analysis concepts and indicators, such as network density, group centrality and faction, are generated by using the matrix method to analyze interpersonal interaction and exchange patterns [28]. The representative of this field is Linton Freeman.

The individual network locates the network by regarding the individual as the center. The resources in the individual network affect the behavior of the individual through the network structure. The research on the individual network mainly focuses on the attributes of the individual and the explanation of the network's influence on the individual's concept and behavior. In theory, we regarded individuals as part of the social structure, analyzing the influence of individual network characteristics on individual characteristics changes, and the results of individual ideas and behaviors affected by the network [29].

Whole Network is made up of a group of specific individuals and their mutual relations, and network members have relatively obvious boundaries [30]. The research on the whole network is also based on the theory of social network, taking the individual as a part of the social structure, and

analyzing the influence of the network on the individual. The whole network takes the whole network as the direct research object, rather than the specific individuals. It uses graph theory as tools in combination with other methods and focuses on the group internal relationship. The patterns of interpersonal communication and social interaction are analyzed by network density, group centrality, faction, and other network characteristics. By analyzing the characteristics of the whole network, scholars explore the whole characteristics of individuals in the network after being affected by the network. The whole characteristics explain the individual of the whole network being constantly influenced by other individuals and finally completes the embeddedness of social environment and social structure. Whole network research can have a relatively comprehensive study of the whole network and can reveal the whole network of various structural characteristics. For example, the reciprocity index of the network can be calculated, the tripartite relationship structure of the network and the whole network structure can be revealed, the subdivision distribution in the whole network can be found, and the density of the network can be calculated. Obviously, this kind of analysis has surpassed individual network research [31]. As a matter of fact, the whole network is a research method based on dynamics, which not only studies the influence of individual ideas and behaviors by social network factors but also reflects the influence process of the social network.

By studying network relations, social structure studies combine individual relations, "micro" networks and "macro" structures of large-scale social systems. The microanalysis of the social structure focuses on the most basic social relations-role relations. Mesostructural analysis focuses on the relationship between social components, which is not reflected in individual activities. Macrostructural analysis studies the overall social structure as well as the functions and effects of the overall structure. The microstructure, mesostructure, and macrostructure analysis all study the social structure, but at different levels.

2.1.1. Microstructure. Centrality is one of the microstructure characteristics of social networks, and it is also one of the key points in the analysis of the microstructure of social networks. The measurement index of centrality includes degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality [32]. Degree centrality refers to the sum of the number of direct connections between a point and other points and is the most direct measure to depict node centrality in network analysis. The greater the degree of a node means the higher the degree centrality of the node, and the node in the network is more important [33]. Closeness centrality reflects the closeness between a node and other nodes in a network. The reciprocal of the sum of the shortest path distances of a node to other nodes represents the closeness centrality. That is, for a node, the closer it is to other nodes, the greater its closeness centrality is. Closeness centrality measures an indicator of an actor independent from other actors' control [34]. Betweenness centrality refers to the number of times a node serves as the

shortest bridge between the other two nodes. The more a node acts as a “Betweenness,” the greater its betweenness centrality. If a node has a higher betweenness centrality, it acts as a bridge between other individuals. If the betweenness centrality of a node is zero, it means that the node cannot control any actor and is on the edge of the network. If the middle centrality of a node is one, it can completely control other actors. It is at the core of the network and has great power [35]. Eigenvector centrality, the importance of a node depends both on the number of its neighbor nodes (i.e., their degree) and their importance [36].

“Structural holes” is another measurement index of the microstructure of social networks. Structural hole is a chasm between nonredundant contacts, which is a sparse zone between dense areas. From the whole network, it seems that a cave appears in the network. Burt believes that the position of an individual in the network is more important than the strength of the relationship. Its position in the network determines the information, resources, and power of an individual. Therefore, regardless of the strength of the relationship, if there is a structural hole, a third party that links two actors who have no direct connection has an information advantage and a control advantage. So, individuals or organizations must establish a wide range of contacts, occupy more structural holes, and acquire more information in order to maintain an advantage in the competition [37]. Common measurement index of structural holes are network constraint index, network effective size, network efficiency, centrality, PageRank, and local clustering coefficient. The network constraint index measures the network closure and structural hole. This index describes the compact degree to which a node in the network is directly or indirectly connected with other nodes. The higher the index is, the higher the network closure is and the fewer structural holes are. Network effective size reflects the whole influence of nodes, which can measure the importance of structural hole nodes, to a certain extent [38]. Efficiency index is used to describe the degree of influence nodes bring on other related nodes in the network. That is to say, the efficiency of the nodes in the structure hole is generally at a high level. The degree of the hierarchy can characterize some features of structural hole nodes. If a certain node has a high degree of hierarchy, it indicates that constraints concentrate on the node within its neighborhood. The centrality is used to measure the social status of individuals in society. The higher the centrality is, the higher possibility may the nodes be in the structural hole position. PageRank (PR) algorithm is a famous page ranking algorithm. According to the principle of the PR algorithm, it can be speculated that the node with higher PR score may be the structure hole node. Local cluster coefficient (CC) reflects the tendency of the adjacent nodes of a node to gather into groups, while the location of structural hole nodes in the network is quite special, so only nodes with a small clustering coefficient can become structural hole nodes [39, 40].

The development of human society is the result of the interaction between human and society and maintaining the coordinated development of human and society is the sound basis for the existence and development of society.

Therefore, sociology should take the two-way movement of human and society as the starting point of study [41]. As one of the research paradigms of sociology, social network analysis method is analyzed on the basis of the human being in the social research object, rather than the whole function, structure, and development characteristics of the society composed of human beings. The microstructural perspective of social network analysis method takes the individual in the society as the research object and evaluates the influence, function, and value of a person through various measurement indicators.

2.1.2. Mesostructure. “Birds of a feather flock together” is a universal law of nature and human society. This law is reflected in the structure of social network, that is, a part of individuals have a close relationship, while the other part has a relatively sparse relationship. The mesolevel of the social network structure refers to the relationship structure among individuals in the whole network.

At present, there are two-party relations, three-party relations, and cohesive subgroups analysis in mesolevel social network research. A two-party relationship studies the relationship between two individuals. There are three isomorphic types of directed-two-party relationship: one-way relationship, reciprocal relationship and irrelevant relationship [5]. The ratio of the number of one-way and reciprocal relationships reflects one-way communication and two-way interaction between network members. Therefore, the higher the ratio is, the more the one-way communication and interactive connection individuals have; irrelevant relationship are the opposite: the higher the ratio is, the less connection and interaction individual members have. The tripartite relationship is similar to the two-party relationship, and the research focuses on the relationship between small group members. The relationship between any two individuals in a tripartite relationship is a two-party relationship, so it can be said that the tripartite relationship is composed of the two-party relationship. In a directed-network, there are 64 possible relationship structures of the trio, of which only 16 are isomorphic. The more the two-party relationships in the trio, the stronger the sense of identity and belonging of network members in the group have, the easier their ideas spread within the group or influenced by others [5]. At present, the main theoretical research on the two-party relationship and three-party relationship is *Introduction to Social Network Analysis* written by a scholar, Liu Jun. The applied research includes that Li et al. applied the two-party relationship and three-party relationship theory to study the characteristics of China’s peasant workers’ network [42], and Gu used this theory to study the interaction of enterprises [43].

Cohesive subgroups generally have more than three members, which refers to the subsets of members with relatively strong, direct, close, frequent, or positive relationships [44]. Cohesive subgroups analysis analyzes how many such subgroups exist in the network, the characteristics of the

relations among the members within the subgroups, and the characteristics of the relations between the members of one subgroup and another subgroup. Due to the close relationship among members of cohesive subgroups, cohesive subgroups analysis is also called “clique analysis” [45]. Cohesive subgroups include Cliques, N -cliques, N -clan, K -plex, K -core, and Lambda set. [46–48]. The purpose of cohesive subgroups research is to find the subgroups that can be “dispatched.”

With the development of complex network research, scholars have found that a large number of networks are nonuniform, that is, they are composed of many subnetworks. The relationship between individuals within these subnetworks is relatively close, while the relationship between individuals among the subnetworks is relatively sparse. Community structure is one of the main contents of complex network research and also a new direction of social network analysis [49]. Traditional community structure detection methods include the spectral bisection method and Kernighan–Lin algorithm in computer science and hierarchical clustering and nonhierarchical clustering in social science. The traditional algorithm has obvious shortcomings, which is difficult to meet the needs of community structure analysis. So it promotes the updating of community structure analysis methods. Modern methods mainly include the Newman–Girvan algorithm (NG algorithm) [50], simulated Annealing algorithm, greedy algorithm, hierarchical clustering algorithm, and extremal optimization. These methods generally take the modularity index as the evaluation basis of community structure division. And to some extent, it overcomes the defect of traditional methods that cannot determine the number of communities. Although modern methods have overcome some shortcomings of traditional methods to some extent, they still need to be revised, such as the indeterminacy of the number of communities and the evaluation index of community structure with high time complexity is single. The research of the community mainly focuses on the development and optimization of community structure detection methods and algorithms. For example, Dao et al. studied the comparative evaluation of community detection methods [51]. Zarei and Meybodi research on detecting the community structure in complex networks based on genetic algorithm [52]. Domestic scholars research less on the community structure. Zhang and Du Haifeng redefined the community structure of the weighted network based on the relationship between the individual attribute. At the same time, inspired by the detection methods of linked communities and overlapping communities, they proposed a probability model for weighted network community structure detection and the corresponding optimization calculation [53]. Du et al. proposed a Community Structure detection algorithm for dynamic networks in their research, and the algorithm can detect the changes of dynamic networks’ community structure [54].

2.1.3. Macrostructure. Whole network analysis is a kind of relationship analysis method with integral and global characteristics, which can show the whole network structure,

density, and the relationship between the whole network members. The measurement indexes of the whole network structure mainly include network density, network centrality, clustering coefficient, and the average shortest path length. Network density is the ratio of the actual number of edges in the network to the maximum number of edges that can be accommodated [55], which is used to describe the density of interconnected edges between nodes in the network [56]. In social networks, network density is often used to measure the density and evolution of social relations. The level of network centrality indicates how much weight a node (individual) has in the whole network. In other words, it also indicates how much capacity a node has to block the transmission of information or distort the content of the information in the process of information transmission, thereby affecting the behavior of other nodes. The clustering coefficient is a coefficient indicating the degree of clustering of nodes in a network [57]. Studies have shown that in real networks, due to the relatively high density of connection points, nodes always tend to establish a set of tight organizational relationships, which is often more likely than a random connection between two nodes. The clustering coefficient includes the global clustering coefficient, local clustering coefficient, and average clustering coefficient [58], where the global clustering coefficient is based on node triples and calculated by the number of closed triples/the number of all triples. The local clustering coefficient of a node indicates the degree of compactness of its adjacent nodes to form a cluster. The average clustering coefficient is the mean value of the local clustering coefficient of all nodes defined by Watts and Strogatz [59]. According to the social network theory, an efficient network should be like any node in the network that can quickly reach other nodes through the shortest path. In this way, individuals in the network can quickly obtain resources, such as information flow. The average shortest path length is the average of this path [60].

In 1966, Friedman, in his book *regional development policy*, formally proposed the “core-periphery theory,” also known as the “center-periphery theory” [61]. The theory afterward became the main analytical tool for developing countries to study the space economy. Later, some scholars applied the “center-periphery theory” to the analysis of the social network structure in sociology. The core-periphery structure in a social network refers to a unit structure composed of a large number of individuals with a close connection in the center and sparsely dispersed periphery. The central part of the node plays an obvious leading role in the network, while the peripheral nodes are marginalized [62]. Core-periphery structure exists in many social phenomena, such as the citation network of scientific journals. The core area and the periphery area together constitute a completed space system; the two functions are different but interdependent and develop together.

At the beginning of the study of social networks, researchers believed that random networks were the most suitable to describe real networks [63]. However, with the deepening of the study, they found that a large number of real networks were neither regular networks nor random networks, but complex networks with unique characteristics. Qian Xuesen gave a strict

definition of the complex network, which refers to a network with self-organization, self-similarity, attractor, small world, and part or all of the network with scale-free. The complex network models mainly include small-world network, scale-free network, and random network. Small-world network [59] and scale-free network [64] were proposed by Watts, Strogatz, and Barabasi in 1998 and 1999, respectively. Both networks are between regular and random networks. Small-world networks are characterized by a short average path length and large clustering coefficient [65]. Scale-free networks have serious heterogeneity, and their degree distribution conforms to power-law distribution [66]. Compared with scale-free networks, scholars pay more attention to small-world networks. Small-world network theory develops rapidly and has been widely applied in physics, computational science and technology, biology, and other fields. For example, Taylor used the concept of the small world to study protein structure and function [67]. Ebel et al. also established a complex network dynamic model based on acquaintance networks [68]. Domestic scholar Cao Rui used the small-world property of complex network theory to construct and analyze EEG functional brain network of alcoholic patients [69]. In addition, small-world networks are also applied to relevant researches of enterprises [70] and weibo [71]. Generally speaking, there are relatively few researches related to complex networks in China, especially small-world networks.

There are also other indicators for the study of the macrolevel of social networks. For example, Peng et al. proposed a hierarchical structure in 2017. Hierarchy structure represents the degree of orderliness in a relationship, usually determined by identity or prestige. When computing the hierarchical structure of a network, UCINET software is usually first used to halve the network matrix, and then, the hierarchical routine program is run to measure the specific values [72]. In 2016, Gupta et al. proposed structural equivalence. Structural equivalence means that two actors in a network have an equal relationship with other actors, and the measurement is carried out by calculating Euclidean distance of paired actors. The smaller the Euclidean distance between actors, the more equal they are in the structure. If the Euclidean distance between the two actors is 0, they are completely equivalent in structure [73].

The relationship in the Chinese society is a special, emotional social bond with the function of the exchange of favors among the actors. Different from the weak linkage of the western relationship, the social capital of China's relationship is a strong relation bond [13]. However, Chinese and Western social relation networks also have something in common. They are not regular networks or random networks, but complex networks with a core-periphery structure.

2.1.4. Comprehensive Study of Microstructures, Mesostructures, and Macrostructures. Although micro, meso, and macrostudies can reveal the structure of social networks at corresponding levels, they cannot reflect the evolution process of networks and have certain limitations. Therefore, the complex network model arises at the historic moment and evolves.

(1) *Regular Graph Network.* The regular network refers to the translational symmetry lattice, and the number of neighbors of any lattice in the network is the same. Some scholars call one-dimensional chain and two-dimensional square lattice the regular network, and they think that the regular network can be applied to the relationship research of real systems. However, with the deepening of complex network research, scholars find that regular network does not conform to the characteristics of the complex network, so a random graph model is proposed.

(2) *Random Graph Model.* Compared with the regular network, the random network is the other extreme. Given a fixed number n and the probability P of generating an edge between two points, the network generated by this method is $G(n, P)$ random network [74]. In 1960, Erdos and Rényi first proposed the theory of random graphs. The model they proposed is also known as the Erdos and Renyi model (ER model) [75], which views the observed network as the implementation of a random process, that is, a specific implementation of a series of networks with similar important characteristics. Although randomness conforms to the main characteristics of the formation of most real networks, it is difficult for people to have a visual understanding of the formation of complex networks and the interaction between different nodes. There are two kinds of random network models. The first is that there are N nodes in the random network, and the possibility of each node group connecting with each other is P . The random network model with fixed P is called the $G(N, P)$ model. The other random network model is the $G(n, L)$ model, which specifies the number of connections in the network. Nevertheless, the stochastic graph model has made an important contribution to the social network model. Later scholars developed the P1 model, P2 model, and exponential random graph model on the basis of the random graph model.

P1 model, also known as the binary relation model, was proposed by Holland and Leinhardt in 1981 [76]. The binary model assumes that some pairs of nodes in physics are reciprocal for directed networks, that is, the binary relation is independent of each other.

P2 model is a random effect model of covariates of network directed graph, which aims to associate binary network data with covariates for analysis while considering a specific network structure [77].

Markov model is made up of Frank and Strauss in 1986 after a summary of the development of the early social network analysis model, proposed by Frank and Strauss [78]. It is the earliest exponential random graph model, Markov model is the basic idea of "under the condition of the given current only or information, (i.e., before the current state of history) in the past, is irrelevant to predict the future (i.e., after the current state of the future)." Then, Wasserman and Pattison [79] and Frank [80] put forward a more general exponential random graph model based on the Markov model, but the model still has some shortcomings. Therefore, Snijders et al. [81] proposed three new statistics of the model, using alternative k -stars, triangles, and paths, using

independent Markov models, which could also solve the problem of degradation of the Markov model.

The social network analysis model is constantly developing in order to better reveal the social process and characteristics reflected by the network structure. At present, domestic applications of stochastic graph models mainly focus on related fields. For example, the formation mechanism of the patent reference relationship is explained from the perspective of the exponential stochastic graph model [82], network news media analysis and research are carried out based on the exponential stochastic graph model [83]. There is a lack of optimization research on the stochastic graph model itself. The international study of social network theory and stochastic graph model is in the leading position.

(3) *Small-World Network Model*. Small-world network was first proposed by Watts and Strogatz [59], who pointed out that such network graphs could be identified by two independent structural features, namely, the clustering coefficient and the average distance between nodes (also known as the average shortest path length). In the subsequent research, Watts and Strogatz proposed a new graph model (namely, the current WS model), which has two features: (1) the average shortest path length is small and (2) the aggregation coefficient is large. After years of development, small-world networks have been widely used in the studies of sociology, Earth science, and brain [84–88].

(4) *Scale-Free Network*. Scale-free network was proposed by Barabási in 1999. Scale-free network is between regular and random network [64]. A network is said to be scale-free if most of the “normal” nodes have few connections and a few of the “hot” nodes have extremely many connections [89]. In more technical terms, the degree distribution (approximately) of scale-free networks satisfies the power-law distribution. In addition to the power-law distribution of node degree, scale-free networks also have robustness and vulnerability [90]. Robustness and vulnerability are some of the basic characteristics of large-scale networks and also important topological characteristics that show the significant difference between random graph networks and scale-free networks. Due to the existence of hub nodes, the scale-free network has strong fault tolerance to random failures. If errors occur randomly, the scale-free network almost will not be affected with a small number of hub nodes, and the deletion of other nodes has little impact on the network structure. However, if the hub nodes are deliberately attacked, the network structure will be easily damaged and become discrete and broken [91].

According to the scale and level of the research object, this paper summarizes and expounds the social network structure from three levels: micro, meso, and macro. The study of the single hierarchical network structure of the complex network system is not enough to explain the complex sociological problem. Therefore, scholars begin to pay attention to the relationship between complex networks at different levels, that is, to discuss the two-way influence relationship and mechanism of different hierarchical

networks. At present, research on complex networks at home and abroad has achieved certain results [92–95], but there are still few research on the relationships between complex networks at different levels, which is also a direction worthy of research.

2.2. Review of Relevant Studies on Social Network Structure.

Social network analysis is a set of an analytical method that combines the sociology, the graph theory, mathematics, and metrology, which based on the study of the interaction between social actors, conducting precise quantitative analysis on the relationship between the social network structure and properties, thus provide quantitative tools for the construction of social network theory and empirical propositions inspection. Social network analysis is not only a set of techniques for the analysis of relationships or structures but also a theoretical method of structural analysis, which is widely used.

Social network is a collection composed of social actors as nodes and their relationships. Social support and social discussion are the main causes of such connections. The former is based on the material and spiritual support between individuals to quantify the relationship network, and the latter is based on whether the individuals discuss important issues to quantify the relationship network. Therefore, the social support network and social discussion network are two important contents of social network research.

2.2.1. *Social Support Network*. The concept of social support first appeared in social etiology of mental disorders in the 1970s. In the beginning, social support was associated with the individual’s physiological, psychological, and social adaptability. Then, it gradually developed into the research on the relationship between the individual’s social relation network and social support network and the individual’s health. Cobb believes that social support consists of three aspects. One is that individuals believe that they are cared for and loved; the other is that individuals believe that they are respected and valuable; and the third is that individuals believe that they belong to a common information network and assume responsibility in this network [96]. Huang believed that social support refers to the material and spiritual help that individuals receive from the society (such as relatives, friends, and units) [97]. Zhou and Feng hold that social support includes the recipient, the giver, the content, and methods. The recipient can be any individual and also the vulnerable group in the society. The giver may be the state, society, family, friends, and colleagues. Content and methods include many aspects, such as emotion, material and information [98]. Scholars’ definitions of social support have two points in common: first, social support takes place among social actors; second, social support transmits spiritual and material information. Then, a social support network is the interaction between individuals, through which individuals can maintain their social identity and get emotional support and material assistance.

Scholars have different definitions for the types of social support. Van del. P divides social support into three aspects: practical support, emotional support, and social interaction support [99]. Xiao and Yang believed that social support involves three aspects. First, it is objective and visible, such as social network, group relationship, and direct material assistance. The second is a subjective experience, which mostly refers to the subjective feeling and experience of being respected, understood, and supported in social practice. The third is the utilization efficiency of social support. Sometimes, social support may not be well accepted and utilized for some reasons, although there are appropriate social support resources and conditions [100]. The author believes that social support can be divided into two categories: first, objective, and practical support, that is, actual social support, including material assistance and direct service; second, received social support. Subjective experienced or emotional support refers to individuals' emotional experience and satisfaction in feeling respected, supported, and understood in society.

Social support can relieve individual psychological pressure and eliminate individual psychological barriers and plays an important role in promoting individual mental health [101]. Therefore, it is widely used in the study of happiness and physical and mental health. In 2016, Fang Liming conducted the study of social support and subjective well-being of rural elderly people. The study showed that, in the formal social support factors, medical insurance and pension and other social security system construction made a significant effort in increasing the subjective well-being of the elderly. For the different living arrangements of the rural elderly, the influence of different social support on the subjective well-being of them [102] is different. Tao and Shen studied the impact of social support on the physical and mental health of the rural elderly and pointed out that both informal social support and formal social support had positive effects on the physical and mental health of the rural elderly, and the addition of formal social support had no significant crowding-out effect on the informal social support. Domestic relevant studies mainly focus on exploring the relationship between social support of college students, the elderly, rural population and other groups, and psychological concepts such as happiness and physical and mental health [103].

Due to the strong relationship between China's social capitals, domestic scholars have carried out new year greetings network research with Chinese characteristics [104]. New year greetings are a traditional Chinese folk custom, a way to express good wishes to each other, people bid farewell to the old, and welcome the new; it indirectly reflects human relations. Using data from The Spring Festival Greetings website, Bian Yanjie found that the quality of social capital among Chinese urban residents is influenced by class status and occupational activities.

In addition to its role in individual psychology, social support networks also contribute to the individual process of job-hunting [105]. As the size of a job seeker's network structure (the number of network members) increases, job seekers get more information that can help them find better

jobs. Weiyan et al. found in their research that subjective support and social support can predict employment intensity, short-term or long-term job-hunting, and work status, and subjective support in social support is more conducive to students' job-hunting behavior [106]. Granovetter found in his study that job seekers in the United States rely mainly on weak connections to find jobs and that those with more connections to high earners receive more benefits than those with less connections [107].

2.2.2. Social Discussion Network. Social discussion network is the core relationship discussion network. It is a clear and specific operational definition to define the network relationship by asking surveyors who they have discussed important issues with in the past six months [108]. As a part of social network analysis, social discussion network studies the interaction between individual behavior and network [109]. The concept of a discussion network was put forward by Marsden in his research in 1985. He found that the discussion network of Americans is relatively small, relative-centered, relatively dense, and homogeneous [110]. In 1986, Ruan and Lu conducted research and investigation on the discussion network of urban residents in Tianjin and found that compared with the discussion network in the United States, Tianjin had a larger scale, lower heterogeneity, higher homogeneity, and stronger closeness [111]. Based on the whole network data of the special survey of rural floating population, Li et al. analyzed the network characteristics of different types of migrant workers' social support networks and social discussion networks. The study found that the two-party relationship, three-party relationship, and whole network characteristic indexes of the social support network for migrant workers were significantly higher than that of the social discussion network [42].

In social discussion networks, individuals' ideas and opinions may influence the studies of other individuals through social networks [112]. Li et al. used the scoring matrix of user projects in their research to find out the importance of user ratings and determine their impact on the whole social network [113]. In their study, Xiong et al. mentioned that, after users reposted a topic, the influence of the users on their neighbors was always present [114].

Social discussion network also includes marriage discussion network, fertility discussion network, contraception discussion network, and elderly-care discussion network. The research of Ren et al. pointed out that, in social discussion networks, migrant workers formed more subgroups in the discussion of marriage, childbirth, and the elderly, while few subgroups formed in the discussion of contraception, a privacy issue [115]. Through the analysis of the social support network and social discussion network, it is found that migrant workers are less willing to discuss more private topics, and relatively speaking, they are more likely to have supportive behaviors [115]. Relevant studies on marriage networks also found that the opinions and opinions of members in the network would affect the individual's satisfaction and risk degree of

marriage. In their research, Wang and Zhou found that the quality of social networks was lower, and marital happiness was also lower [116]. Jin et al. pointed out that the attitudes and concepts of social network members of migrant workers towards unmarried pregnancy and extramarital love can be transmitted to migrant workers through social networks and have an impact on them. Social network variables that may have an impact on the concept of love and marriage of migrant workers include the comprehensive effect of scale, weak relationship, and the influence of network members [117]. Similarly, social networks influence the spread of ideas about fertility, contraception, and elderly-care among individuals. Buyukkececi found in his research that the birth, marriage and divorce of siblings all have certain influences on the birth, marriage and divorce of individuals [118]. As discovered in S Pink's book, *Fertility and social interaction—a simulation approach*, parents, brothers and sisters, and her colleagues have a great influence on the result of social interaction effect on bearing.

By combing the domestic and foreign literature, we found that social support network and discussion network is mainly used in the subjective feeling of different groups (such as satisfaction and loneliness) and ideas (birth, contraception, and pension). It involves a wide range of research objects, but most of the studies start from the individual level and lack the research from the overall network perspective, as well as the visualization and dynamic evolution of the network, which is a future research direction.

3. Conclusion

In this paper, the theory of the social network is sorted out, and then, the research methods of the social network structure are reviewed from the micro, meso, and macro-levels. Finally, the research on the social support network and social discussion network in the social network structure are reviewed.

As a sociological research perspective, social network research method has been widely used in other fields, providing a new way of thinking for the research of relation and network problems research. The visualization and dynamic study of the network also enables us to see the structure and dynamic evolution of the society more intuitively, which deepens our understanding of the research problem.

It can be summarized as follows:

- (1) There are many researches on the single hierarchy structure of social network, but a few researches on the combination of multiple-level structure. There are few researches on the micro, meso, and macro-level of the social network structure, especially on the model of an exponential random graph.
- (2) There are more studies on the static perspective of social network, but less on the dynamic perspective. The analysis and research of social network mainly focus on the static study, analyzing the network structure and characteristics, and seldom grasp the evolution of the network from the dynamic perspective. Dynamic

network research can capture the characteristics and phenomena that static network research cannot.

- (3) There are many researches on individual network, but few researches on whole network. According to different research objects, social networks can be divided into individual networks and whole networks. Individual network research focuses on the relationship between the attributes of individuals/nodes and individual networks, while whole network research focuses on the structure, graph-theoretic nature, and location attributes of networks. At present, there is a lack of relevant research on the whole network.
- (4) There are many researches on support networks of social networks, but few researches on discussion networks. The development of social support network theory is relatively complete. Although social discussion network has developed, it generally lags behind social support network. At present, the research mainly focuses on social support networks, and the research on the social discussion network needs to be further expanded and deepened.
- (5) There are many traditional social network analysis methods, but few studies from the perspective of complex networks. Once the theory of the complex network was put forward and developed rapidly, it soon became the key research direction of social network theory. However, there are relatively few in-depth studies and applications of complex network.

In short, the existing research on social networks lacks systematicness and comprehensiveness. Most of the research are just simple statistical analysis, which are not in-depth enough and lack the whole network research in the social network structure. The research direction is relatively single, focusing on the social support network and lacking the theoretical and applied research on the social discussion network. Since the development of social networks, complex networks have gradually become the research focus of social networks. However, in the academic research field, there is a lack of attention paid to the development and improvement of complex network models and the research of complex network analysis methods, and the research of complex networks has not been widely applied into the research of various fields. All these provide space for future research.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Ning Li was responsible for writing the original draft, review and editing, and literature collection. Qian Huang was responsible for determining the framework of paper, funding

acquisition, and review and editing. Xiaoyu Ge was responsible writing the original draft. Miao He was responsible for review and editing. Shuqin Cui was responsible for review and editing. Penglin Huang and Shuairan Li were responsible for literature collection. Sai-fu Fung was responsible for funding acquisition.

Acknowledgments

This work was supported in part by the National Natural Science Foundation of China under Grant nos. 61440036 and 61040029 and the National Social Science Foundation of China under Grant no. 16ATY002.

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