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Optimizing Governance Networks in Multi-Actor Collaboration: A Case Study of Community Service in China

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Abstract

Grassroots community governance has gained increasing attention for its vital role in resource integration and multi-actor collaboration. As an innovative governance model, the “Five-Sector Linkage” (FSL) mechanism enhances service efficiency by aligning the efforts of communities, social organizations, social workers, volunteers, and philanthropic actors. However, quantitative research on interaction dynamics within such mechanisms remains insufficient, particularly regarding the optimization of collaborative networks for improved governance outcomes. This study applies Social Network Analysis (SNA) to the “After-School Program” project in Community B, Chengdu, to examine the structural features and interrelations of multi-actor cooperation under the FSL framework. The collaboration network consists of 39 nodes and 1482 links, with a density of 0.370 and an average path length of 1.632, indicating efficient communication and moderate cohesion. Degree and betweenness centrality analyses identify social workers (C1–C3) as key hubs, with C2 holding the highest bridging role ($B_C = 81.401$). The overall network shows low centralization (4.19%) and limited heterogeneity (2.74%), reflecting a polycentric and resilient structure. Inter-sectoral analysis showed that all nodes interacted with at least one social worker, while community actors (A1, A2) engaged broadly across 18 nodes. Volunteers maintained extensive grassroots connections, while philanthropic resources formed selective but strategic links with 13 nodes. These findings provide empirical insights into the coordination logic of the FSL mechanism and offer guidance for building adaptive, decentralized community governance networks. Future research should explore longitudinal dynamics and cross-community comparisons to further enhance the applicability of the model.

Keywords: Five-Sector Linkage; social network analysis; grassroots governance; multi-actor collaboration; community service networks; China



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1. Introduction

Contemporary communities are confronted with the dual challenges of evolving social structures and escalating demands for grassroots governance. As a critical pillar for fostering social harmony and stability, community governance fundamentally relies on resource integration and multi-actor collaboration [1]. However, rapid urbanization and growing

resident autonomy have intensified governance fragmentation, uneven resource distribution, and overlapping service provision [2]. In developing countries, improving community efficacy through collaborative governance models has emerged as an urgent imperative.

In China, the Guidelines on Strengthening the Modernization of Grassroots Governance Systems and Capabilities, jointly issued by the Central Committee of the Communist Party and the State Council in July 2021, explicitly emphasized the need to “innovate mechanisms for synergizing communities with social organizations, social workers, volunteers, and charitable resources.” Despite progress, China’s grassroots governance continues to grapple with resource dispersion and insufficient inter-sector coordination, rendering traditional single-actor governance models inadequate for rapidly evolving societal needs [3,4]. This underscores the necessity of advancing the “Five-Sector Linkage” (FSL) mechanism to integrate diverse social resources, optimize governance structures, and foster cross-sector participation.

Although the FSL mechanism has gained scholarly attention as an innovative governance paradigm, existing research predominantly focuses on theoretical frameworks and qualitative explorations. For instance, Lu analyzed functional roles of governmental and non-governmental actors [5]. Zhao et al. highlighted its resource integration potential [6]. Wang et al. emphasized its capacity to enhance governance efficiency [7]. Nevertheless, critical gaps persist in quantitatively examining interaction dynamics, resource flows, and information exchange among stakeholders, resulting in superficial understandings of the mechanism. Practically, collaboration networks among governance actors remain suboptimal. Challenges such as low coordination efficiency between governments and social organizations, uncoordinated resource allocation, and limited information-sharing incentives hinder the FSL mechanism’s effectiveness [8]. To address these limitations, a systematic analysis of multi-actor interaction networks is imperative.

Given the complexity of interactions under the FSL framework, conventional qualitative methods often fail to capture its nuanced dynamics. Social Network Analysis (SNA), as a quantitative tool, offers robust capabilities to unravel structural and functional patterns within multi-actor collaboration networks. In community governance contexts, SNA has been widely adopted to analyze relational dynamics, enabling practitioners to identify and leverage existing networks for resource sharing and collaborative problem-solving [9,10]. Furthermore, it provides empirical foundations for designing context-specific governance strategies [11]. To theoretically construct this analytical framework, we situate FSL within the broader literature on collaborative governance and network governance [12]. These perspectives highlight how trust, legitimacy, and power dynamics shape multi-actor coordination. Furthermore, FSL mechanisms exhibit characteristics of a polycentric system [13], wherein multiple semi-autonomous actors self-organize under a set of rules. This study employs social network analysis (SNA) to empirically examine whether interaction patterns among the five sectors form such a decentralized and adaptive network. In this way, this study aims to deepen our understanding of how collaborative governance models operate within non-Western, state-led policy contexts such as China.

This study investigates collaboration networks within the FSL mechanism using Social Network Analysis (SNA) to explore three key aspects. First, it maps interaction networks among FSL actors to reveal their roles and interdependencies. Second, it examines how trust-building and resource coordination mechanisms can be strengthened to improve governance efficacy. Third, it assesses how SNA can be used to evaluate the adaptability and innovativeness of the FSL mechanism in the context of grassroots governance.

2. Theoretical Framework: Collaborative Governance, Network Governance, Multicentric Governance, and “FSL”

To provide theoretical grounding for our analysis of the FSL mechanism, this study draws upon three interrelated fields of literature: collaborative governance, network governance, and polycentrism. These frameworks offer conceptual tools to understand how multiple independent actors from different domains can cooperate to achieve public objectives.

2.1. Collaborative Governance and “FSL”

The theory of collaborative governance serves as a crucial theoretical framework in public administration. Ansell and Torfing define it as “a form of governance in which multiple public and private actors jointly formulate and implement public policies and deliver public services through formal and informal interactions within complex contexts characterized by blurred boundaries, conflicting objectives, and dispersed resources.” This theory emphasizes the plurality of governance actors, breaking away from traditional government-dominated models. It advocates for collaboration among diverse stakeholders, including governments, social organizations, market entities, and citizens, based on shared interests.

The effective operation of collaborative governance relies on a series of key mechanisms, with trust serving as the core foundation. Trust reduces transaction costs among actors, minimizes opportunistic behavior, and safeguards long-term stable collaborative relationships [14]. The legitimacy mechanism ensures that collaborative processes and outcomes gain societal recognition, aligning participants’ behaviors with social norms and value orientations, thereby enhancing sustainability. Additionally, mutual accountability mechanisms and power equilibrium serve as vital supports for collaborative governance: the former clarifies responsibilities and obligations to prevent free-riding, while the latter balances power distribution among actors to avert collaborative imbalances caused by asymmetry.

The “FSL” mechanism aligns strongly with collaborative governance theory. Communities, social organizations, social workers, volunteers, and charitable resources serve as core governance entities, transcending departmental and sectoral boundaries to engage in interactive collaboration centered on the shared goal of community service. Within this process, trust mechanisms facilitate resource sharing and information exchange among entities; legitimacy mechanisms ensure policy support and social recognition for collaborative frameworks; and power equilibrium is achieved through the equal participation of diverse stakeholders. These elements align with the core tenets of collaborative governance theory.

2.2. Internet Governance and “FSL”

Network governance theory centers on “relationships” as its core analytical unit, focusing on the interactive network structures formed among diverse actors and their impact on governance effectiveness. This theory posits that governance activities are not confined to formal institutional frameworks but unfold through complex network relationships among actors. The characteristics of network structures, such as density, centrality, and network architecture, directly influence resource flows, information transmission, and collaborative efficiency [15].

Network governance emphasizes mutual dependence and reciprocal symbiosis among actors. Entities assume distinct roles within networks, achieving governance objectives through resource exchange and functional complementarity. Compared to traditional hierarchical governance, network governance offers greater flexibility and adaptability, better equipped to navigate complex and dynamic governance contexts. In community governance contexts, network governance theory provides a crucial lens for analyzing

the operational logic of the “FSL” mechanism: communities as platform builders, social organizations as service providers, social workers as professional coordinators, volunteers as grassroots participants, and charitable resources as support enablers. Their interactions form complex governance networks where the connectivity and interaction intensity among nodes determine governance effectiveness.

2.3. Multicenter Governance Theory and “FSL”

Multicenter governance theory, proposed by Ostrom, posits that in the governance of public affairs, no single dominant actor exists. Instead, multiple independent decision-making centers collectively participate in governance, acting autonomously and collaborating under certain rules. This theory transcends the binary governance paradigm of “government-led” or “market-led” approaches, emphasizing the equal participation and autonomous governance of diverse actors. It posits that a multi-center structure enhances the efficiency and resilience of public affairs governance through decentralized decision-making, mutual oversight, and flexible adjustments.

The “FSL” mechanism fundamentally represents a multi-center governance model. Communities, social organizations, social workers, volunteers, and charitable resources function as distinct governance centers, each possessing relatively independent decision-making space and operational capacity while simultaneously forming collaborative relationships around shared community service objectives. This multi-center structure avoids the limitations of single-entity governance, fully mobilizing diverse resources and leveraging the comparative advantages of different actors. For instance, communities leverage their official standing and organizational strengths to establish governance platforms; social organizations provide targeted services through professional expertise; social workers facilitate coordination and communication; while volunteers and charitable resources supplement grassroots human and material support. These centers work in concert to form a multi-stakeholder governance framework, aligning closely with the core tenets of multi-center governance theory.

2.4. Theoretical Connections and Research Positioning

Theories of collaborative governance, network governance, and polycentric governance collectively provide a robust theoretical foundation for studying the “FSL” mechanism. Collaborative governance theory focuses on the motivational mechanisms and core elements of multi-stakeholder collaboration; network governance theory examines the structural characteristics and operational patterns of interactive networks; while polycentric governance theory emphasizes the diversity and autonomous collaboration of governance actors. These three theories complement each other, forming a comprehensive theoretical interpretation of the “FSL” mechanism.

This study, grounded in the aforementioned three major theories, employs social network analysis methods to empirically examine the structural characteristics of governance networks under the “FSL” mechanism—such as density, centrality, and network structure. It analyzes the role positioning and interaction patterns of various actors within the network, thereby revealing the practical manifestations of theoretical mechanisms in state-led policy contexts such as non-Western and Chinese settings. This research addresses existing gaps in the integration of theory and empirical evidence, offering new perspectives to deepen our understanding of multi-stakeholder collaborative governance in grassroots communities.

3. Materials and Methods

3.1. Research Context

This study examines the “After-School Program” (Chengdu China) in Community B, Chengdu, Sichuan Province, as a representative case of the Five-Sector Linkage (FSL) mechanism. The program involved seven key actors (see Table 1 for participant IDs):

Table 1. Participant IDs and Roles.

Node	Representative Entity	ID
A	Community Office Staff	A1, A2
B	Social Organization Leader	B1
C	Social Workers	C1, C2, C3
D	Volunteers	D1–D6
E	The head of the Child Care Association	E1
F	Charitable Enterprise Representatives	F1, F2, F3
G	Participating Children	G1–G23

Community office staff (A1, A2) were responsible for resource coordination and governance oversight. Social organization leader (B1) represented a local NGO managing program operations. Social workers (C1–C3) provided direct services and served as intermediaries between various stakeholders. Volunteers (D1–D6) supported daily activities and promoted community engagement. The head of the Child Care Association (E1) was responsible for providing auxiliary support and facilitating liaison with external child welfare resources. Charitable enterprise representatives (F1–F3) contributed funding and material resources. Participating children (G1–G23) were the primary beneficiaries of the program.

Data were collected through three methods: Participant Observation: Researchers documented interactions among actors during program implementation (July–August 2023). In-Depth Interviews: Semi-structured interviews with 39 key stakeholders, including office staff, social workers, and volunteers. Archival Analysis: Policy documents, service records, and news reports from February to August 2023 were reviewed to extract interaction frequency and content.

3.2. Data Processing

Social network analysis is a method and technology centered on graphological measurement [16]. That is a method for studying the interaction and social structure between participants (groups). Social network analysis methods can help us understand the interaction and cooperation in the service process, so as to propose measures to improve the quality of social work services.

This study’s interactive data integrates materials from the “After-School Care Program,” primarily sourced from the following three channels:

- (1) Participatory observation. By fully engaging in the daily operations and specialized activities of the “After-School Care Program,” the research team systematically documented interactions among various actors and identified the core functions of representatives from each collaborating party.
- (2) In-depth interviews. Based on nominations from representatives of each partner identified through participant observation, the study conducted semi-structured interviews with 39 key informants. The interviewee group included community office staff (A1, A2), social organization leaders (B1), social workers (C1–C3), volunteers (D1–D6), child welfare association leaders (E1), corporate philanthropy representatives (F1–F3), and children participating in the program (G1–G23).

- (3) **Archival document analysis.** This study systematically reviewed policy documents, service records, work reports, and news coverage related to the service program. The aim was to map the program's overall operational logic and extract specific information regarding interaction frequency and content to supplement and cross-validate observation and interview data.

This study cross-validated three types of data sources. Interaction data was converted into a 39×39 adjacency matrix, where the value “1” indicates interaction between two nodes and “0” indicates no interaction. In this study, “interaction” was explicitly defined as any observed or reported instance of communication, resource exchange, or joint activity related to implementing the “After-School Program.” This included jointly attending meetings, transferring information or funds, co-organizing events, and direct service provision documented in project files or confirmed through interviews. UCINET 6.0 was used to generate a binary matrix visualizing the network structure. By synthesizing data from participant observations, in-depth interviews, and archival analysis, a comprehensive record of interactions among the 39 participants was created.

3.3. System of Indicators

(1) Network Density

Network density is defined as the ratio of actual connections between nodes to the theoretical maximum connections. In public space network analysis, density measures the degree of association between a node and its neighbors, reflecting the intensity of interactions. Higher density values indicate tighter node connections, resulting in a more compact network structure and robust functionality [17]. The formula is expressed as:

$$D = \frac{2L}{N \times (N - 1)} \quad (1)$$

In the formula, L is the number of actual connections, N is the total number of nodes.

(2) Average Path Length

The average path length is defined as the mean of the shortest path lengths between all pairs of nodes in a network. It serves as a global metric for evaluating network transmission efficiency. A smaller average path length indicates tighter connectivity between nodes, reflecting faster information or resource flows across the network. The formula is expressed as:

$$A_P_L = \frac{\sum_{i=j} d_{ij}}{N(N-1)/2} \quad (2)$$

In the formula, N is the total number of nodes, d_{ij} is the shortest path length between nodes i and j .

(3) Block Models

Block model analysis is a method for identifying spatial characteristics of network nodes through clustering, which characterizes the internal structure of associative networks and the roles of individual members. Subgroups are formed by nodes with similar functional roles [18]. This study adopts UCINET's CONCOR (CONvergence of iterated CORrelations) algorithm for block model analysis. This iterative correlation convergence method identifies global structural patterns and evaluates interaction intensities within subgroups [19]. While the process relies on algorithmic computation rather than explicit mathematical formulas, the quality of community partitioning can be assessed using modularity:

$$Q = \frac{1}{2m} \sum_{ij} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j) \quad (3)$$

In the formula, A_{ij} is the weight of edge between nodes i and j , k_i is the degrees of nodes i and j , m is the total weight of all edges in the network, $\delta(c_i, c_j)$ is the indicator function (1 if nodes i and j belong to the same community, 0 otherwise).

(4) Degree Centrality

Degree centrality quantifies a node's relative importance by measuring its direct connections. A higher centrality value indicates a greater likelihood of the node occupying a central position in the network. The formula is defined as:

$$C_D(i) = \frac{\deg(i)}{N_{all} - 1} \quad (4)$$

In the formula, $\deg(i)$ is the number of nodes directly connected to node i , N : is the total number of nodes.

(5) Betweenness Centrality

Betweenness centrality measures the extent to which a node acts as an intermediary in facilitating communication between other nodes. Nodes with higher betweenness centrality occupy central positions in the network, serving as bridges for interactions among distinct members. This metric also reflects a node's structural centrality and its ability to control critical pathways of information and resource flows. The formula is defined as:

$$C_B(i) = \sum_{s \neq i \neq t} \frac{\sigma_{st}(i)}{\sigma_{st}} \quad (5)$$

In the formula, σ_{st} is the total number of shortest paths between nodes s and t , $\sigma_{st}(i)$ is the Number of shortest paths between s and t that pass through node i .

4. Results

4.1. Network Structure and Global Analysis

The network structure of the service project is illustrated in Figure 1, generated using the Fruchterman-Reingold algorithm. This algorithm treats nodes as charged particles subject to two forces: Coulomb repulsion (between all nodes) and Hooke's attraction (along edges). Under these forces, the layout stabilizes into an equilibrium state [20]. Node sizes correspond to their degree centrality, while colors denote modularity-based communities (groups of nodes with shared characteristics, see Table 2). The "After-School Program" network exhibits a decentralized multi-core structure, characterized by multiple high-centrality nodes rather than a single dominant hub. No isolated nodes were observed, indicating resource flows and communication rely on a system of interconnected key nodes. Tightly connected subgroups suggest collaboration clusters formed around shared goals or interests.

In social network analysis, network density serves as a core indicator for measuring the degree of interconnectedness among nodes. This metric reflects both the frequency of interactions and the overall cohesion within a service network. In the present study, a total of 39 nodes were involved in the network, which exhibited a density of 0.370 (see Table 3). This indicates that only 37% of all possible connections were realized, revealing a relatively loose network structure. From a structural perspective, the network displays a distinct core-periphery pattern. Within this configuration, certain nodes—characterized by a high degree of connectivity—occupy central positions, thereby facilitating the concentrated flow of information and resources. In contrast, nodes situated at the periphery have fewer connections and thus play weaker and more limited roles within the network. This structural

pattern illustrates the functional diversity of network members and their differentiated positions and roles within the overall system.

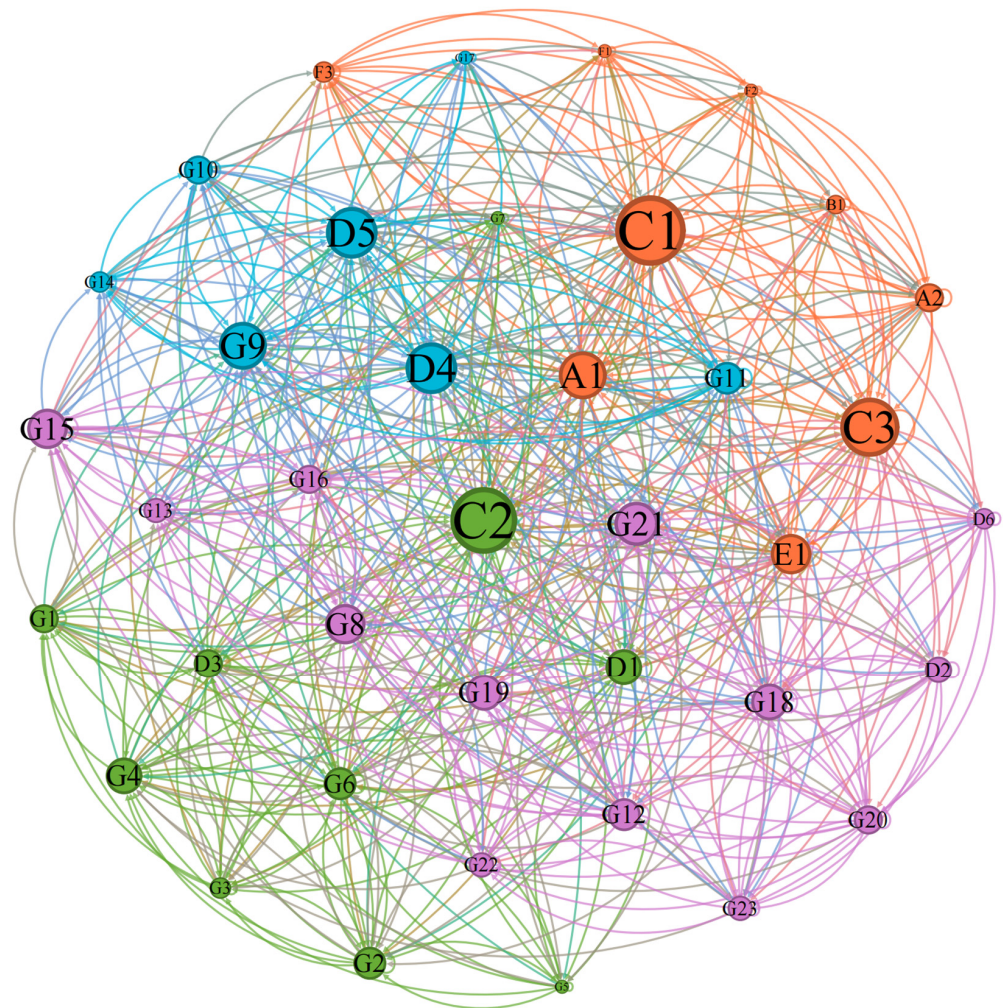


Figure 1. Social Network of the “After-School Program” Service Project.

Table 2. Modularity-Based Communities.

Community (Color)	Node Distribution
1 (Orange)	A1, A2, B1, C1, C3, E1, F1, F2, F3
2 (Blue)	D4, D5, G9, G10, G11, G14, G17
3 (Green)	C2, D1, D3, G1–G7
4 (Pink)	D2, D6, G8, G12–G16, G18–G23

Table 3. Global Network Metrics.

Network Density	Standard Deviation	Average Path Length	Compactness	Breadth
0.370	0.483	1.632	0.685	0.315

According to the distribution of distances between nodes (see Table 4), 37.0% of node pairs are directly connected (distance = 1), suggesting a considerable proportion of immediate interactions. 62.7% of node pairs are connected via a second-degree path (distance = 2), indicating that most nodes are linked indirectly. Only 0.3% of node pairs are separated by a distance of three, implying that remote connections are rare. The average

path length (APL) of the network is 1.632, meaning that, on average, information passes through approximately 1.632 intermediary nodes before reaching its target. This reflects the network's relative compactness and efficiency in facilitating information flow. The network cohesion index is 0.685, suggesting that despite a somewhat loose structure, the network maintains strong internal cohesion. Meanwhile, the distance-weighted fragmentation index stands at 3.15, indicating that the network simultaneously exhibits a high degree of dispersion and hierarchical differentiation. This highlights the wide distribution and varied functional roles of members across the network.

Table 4. Node Distance Distribution.

Distances	Frequency	Proportion
1	549	0.370
2	929	0.627
3	4	0.003

4.2. Ego Network Analysis

Centrality measures the extent to which a participant is positioned between other nodes within a network, reflecting the degree of control an actor holds over network resources and their influence on interactions among others [21–23]. In general, nodes with higher centrality possess greater control over information and resources within the network. These nodes often serve as key hubs for information dissemination and may act as potential leaders in guiding group behavior [24].

Various methods are used to calculate centrality, with commonly applied metrics including degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality [25]. In this study, we focus on degree centrality and betweenness centrality. Degree centrality measures the number of direct connections a node has with others, while betweenness centrality evaluates the extent to which a node functions as an intermediary in the flow of information.

Nodes with high centrality often play crucial bridging roles within the network. They are not only capable of controlling the flow of information but also serve as effective regulators of interactions among other nodes. For instance, in social diffusion networks, individuals with high centrality often act as opinion leaders or decision-makers, exerting a dominant influence over group dynamics and information dissemination. However, it is important to note that an overreliance on central nodes may introduce potential vulnerabilities. The failure or removal of a highly central node can lead to significant disruptions in both the structure and function of the overall network [26]. Therefore, in addition to analyzing centrality, it is essential to consider the network's redundancy and backup mechanisms to enhance its robustness and stability. In the context of this study, this refers specifically to strengthening redundant connections within the network, thereby ensuring that other nodes can continue to maintain effective information flow even in the event of a central node failure.

4.2.1. Degree Centrality Analysis

Table 5 presents the degree centrality (ID_C) and normalized degree centrality (ND_C) indices for all participants in the “After-School Program” network, calculated from the adjacency matrix. Table 6 summarizes the descriptive statistics. Degree centrality quantifies the number of direct connections a node has, while normalized degree centrality (ND_C) represents the ratio of actual connections to the maximum possible connections, reflecting a node's control over interactions and its centrality in resource allocation.

Table 5. Degree Centrality of Participants.

ID	D_C	ND_C (%)	ID	D_C	ND_C (%)
C1	24.000	63.158	G1	13.000	34.211
C2	23.000	60.526	G10	13.000	34.211
C3	21.000	55.263	D2	13.000	34.211
D4	19.000	50.000	A2	13.000	34.211
D5	19.000	50.000	D3	13.000	34.211
G9	18.000	47.368	G20	13.000	34.211
A1	18.000	47.368	G23	12.000	31.579
G21	17.000	44.737	G13	12.000	31.579
G15	16.000	42.105	G22	12.000	31.579
G8	16.000	42.105	B1	11.000	28.947
E1	16.000	42.105	D6	11.000	28.947
D1	15.000	39.474	G14	11.000	28.947
G18	15.000	39.474	F3	11.000	28.947
G4	15.000	39.474	G3	11.000	28.947
G19	15.000	39.474	F1	9.000	23.684
G12	14.000	36.842	G7	9.000	23.684
G11	14.000	36.842	G17	9.000	23.684
G6	14.000	36.842	F2	9.000	23.684
G2	14.000	36.842	G5	9.000	23.684
G16	13.000	34.211			

Table 6. Descriptive Statistics of Degree Centrality.

Indicators	Degree Centrality	NrmDegree Centrality
Mean	14.103	37.112
Std_Dev	3.671	9.661
Sum	550.000	1447.368
Variance	13.477	93.329
SSQ	8282.000	57,354.570
MCSSQ	525.590	3639.818
Euc_Norm	91.005	239.488
Minimum	9.000	23.684
Maximum	24.000	63.158
Network Centralization = 27.45%		
Heterogeneity = 2.74%		Normalized = 0.18%

According to the descriptive results presented in Table 6, the average degree of nodes within the network is 14.103, with a standard deviation of 3.671. This indicates that most nodes have a similar number of connections, concentrated within a relatively narrow range. The average normalized degree is 37.112, suggesting a generally balanced level of connectivity among nodes. However, a few nodes—such as node C1—exhibit notably higher degrees, indicating that a small number of core actors hold central positions within the network.

The network centralization is 27.45%, reflecting a moderately centralized core structure. This implies that the core nodes possess stronger capacities for resource control and information flow, which may enhance the overall efficiency of the network. The network heterogeneity is 2.74%, and the normalized heterogeneity is 0.18%, both of which are relatively low. This suggests that functional and role-based differences among nodes are limited, and that the network overall demonstrates a relatively balanced structural composition. Such a configuration facilitates collaboration among different types of actors, enabling tighter cooperation and the formation of effective service chains, thus strengthening the integration and complementarity of the service network.

An examination of degree centrality (see Table 7) shows that core nodes such as C1, C2, and C3 have high degrees—24, 23, and 21, respectively—indicating their extensive connections within the network. These nodes likely play key roles in resource allocation, information dissemination, and decision support. In contrast, nodes with lower degrees—such as F1 and G5—can be identified as peripheral participants, with limited engagement in the network. These nodes are more likely to function as recipients or executors of information and services during program implementation. Nevertheless, the presence of multiple connections between peripheral and core nodes contributes to the redundancy of the network. Even though core nodes facilitate a large share of information flow, the distributed interactions across the network help mitigate the risk of overall system disruption in the event of a central node failure.

Table 7. Betweenness Centrality of Participants.

ID	B_C	NB_C (%)	ID	B_C	NB_C (%)
C2	81.401	5.790	G22	16.13	1.147
C1	75.141	5.344	G12	15.718	1.118
C3	64.294	4.573	D3	15.61	1.11
G21	43.263	3.077	G23	14.965	1.064
A1	38.218	2.718	A2	14.961	1.064
D5	38.215	2.718	G16	14.407	1.025
G15	38.058	2.707	D2	14.155	1.007
G9	35.791	2.546	G1	13.598	0.967
D4	34.889	2.481	G3	11.8	0.839
G19	32.247	2.294	F3	10.548	0.75
G8	29.917	2.128	G13	9.837	0.7
G4	29.114	2.071	G17	9.239	0.657
G18	29.028	2.065	G5	8.389	0.597
G6	28.885	2.054	D6	8.146	0.579
D1	26.217	1.865	G14	8.065	0.574
E1	23.477	1.670	G7	7.111	0.506
G2	22.46	1.597	B1	6.774	0.482
G11	21.339	1.518	F1	6.046	0.430
G10	19.835	1.411	F2	2.389	0.170
G20	17.324	1.232			

The network reveals a clear core–periphery structure formed primarily between project social workers (C1–C3) and community volunteers (D1–D6). Social workers act as central nodes, responsible for resource coordination, information transmission, and overall network management. In contrast, the community volunteer nodes occupy more peripheral positions, assuming supportive and operational roles, including the execution of specific services and dissemination of information at the grassroots level.

4.2.2. Betweenness Centrality Analysis

Table 7 presents the betweenness centrality (B_C) and normalized betweenness centrality (NB_C) indices for participants in the “After-School Program” network. Table 8 summarizes descriptive statistics. Betweenness centrality measures the frequency with which a node acts as a bridge in mediating communication between other nodes, reflecting its influence over information flows [27–29]. A higher value indicates greater control over critical pathways in the network [30].

Table 8. Descriptive Statistics of Betweenness Centrality.

Indicators	Betweenness Centrality	Betweenness Centrality
Mean	24.026	1.709
Std_Dev	17.938	1.276
Sum	937	66.643
Variance	321.775	1.628
SSQ	35,061.258	177.36
MCSSQ	12,549.232	63.481
Euc_Norm	187.247	13.318
Minimum	2.389	0.17
Maximum	81.401	5.79
Network Centralization Index = 4.19%		

As shown in Table 8, the mean betweenness centrality of nodes in the project network is 24.026, with a standard deviation of 17.938. This indicates that most nodes exhibit relatively low levels of betweenness centrality and that there is a notable degree of dispersion. The minimum value is 2.389 and the maximum is 81.401, suggesting that while a few nodes play crucial roles in information flow, the majority of nodes serve relatively weak intermediary functions within the network. The network centralization index is 4.19%, which reflects a broadly decentralized structure. Despite the existence of key nodes that facilitate information exchange, the low degree of centralization suggests that information flows through multiple pathways and is not overly reliant on a small subset of nodes. This decentralized configuration enhances the system's robustness and resilience, making it well-suited for sustainable and efficient service delivery in grassroots community governance.

In the node-level analysis (see Table 7), betweenness centrality is used to evaluate the importance of individual nodes and their capacity to control information flow. Node C2 exhibits the highest betweenness centrality at 81.401, with a normalized value of 5.790%, ranking first in the network. This indicates that C2 plays a critical bridging role, serving as a key conduit for information exchange among otherwise disconnected nodes. Nodes C1 and C3 follow closely with betweenness centrality scores of 75.141 and 64.294, respectively, confirming their pivotal roles in facilitating communication and coordination. Their high betweenness centrality makes them key actors in promoting collaboration and supporting the effective implementation of the project.

In contrast, node G22 has a moderate betweenness centrality of 16.13, with a normalized value of 1.147%. While not central, G22 still participates in multiple interactions, indicating a supportive role in facilitating information flow and resource exchange. Nodes associated with charitable resources—specifically F1, F2, and F3—display relatively low betweenness centrality scores. Notably, node F3 has the lowest value at 2.389, suggesting that it rarely serves as an intermediary in the flow of information. These nodes are likely located at the periphery of the network and perform more specialized or limited functions, maintaining fewer connections with other actors. Nonetheless, they may still play important roles in specific domains or targeted activities.

The network's low centralization index further reflects a decentralized and flexible structure, which contributes to the overall resilience and adaptability of the project during implementation. This structural feature enhances the capacity of the network to function effectively in dynamic and complex grassroots governance contexts.

4.3. Grassroots Community Governance System Analysis

The "Five-Sector Linkage" (FSL) mechanism refers to a modern grassroots governance framework guided by Party leadership, in which the community residents' committee (or village committee) plays an organizing role. The mechanism operates with the community

as a platform, social organizations as carriers, social workers as key service providers, community volunteers as auxiliary forces, and philanthropic resources as supplementary support. To gain a deeper understanding of how this mechanism functions in practice, this study analyzes five key types of actors: the community, social organizations, social workers, community volunteers, and philanthropic resources. Using the “Four-Thirty Classroom” service project as a case example, the analysis highlights the synergistic effects among different actors within the FSL mechanism. Table 9 and Figures 2–6 illustrate the specific interaction patterns and corresponding social network diagrams of these nodes.

Table 9. Interaction Patterns of Key Nodes.

Sector	Representative Nodes	Interacting Nodes
Community	A1, A2	B1, C1–C3, D4–D5, E1, F1–F3, G1–G3, G11–G12, G19–G20
Social Organization	B1	A1–A2, C1–C3, D2, D4, E1, F3, G17–G18
Social Workers	C1–C3	All nodes interact with at least one C-series node
Community Volunteers	D1–D6	All nodes except A2, F1, F3 interact with at least one D-series node
Social Charitable Resources	F1–F3	A1–A2, B1, C1–C3, D1, D5, G3, G6, G10, G15, G19

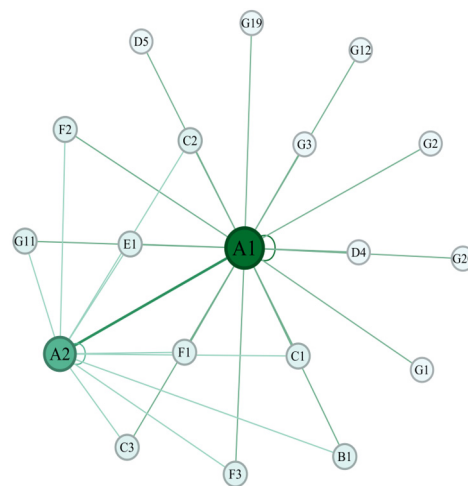


Figure 2. Social Network of “Community” Nodes (A1, A2).

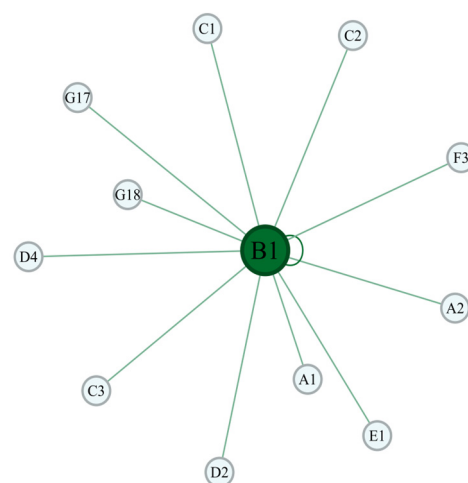


Figure 3. Social Network of “Social Organization” Node (B1).

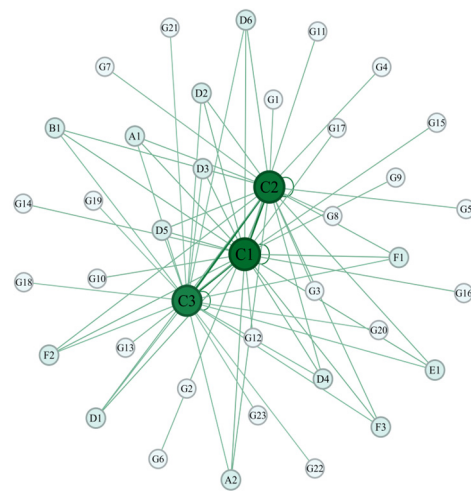


Figure 4. Social Network of “Social Workers” Nodes (C1–C3).

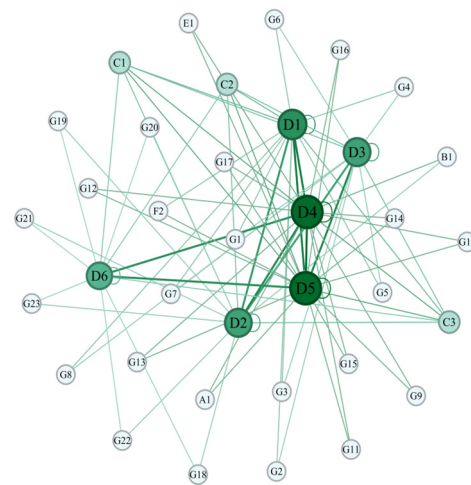


Figure 5. Social Network of “Community Volunteers” Nodes (D1–D6).

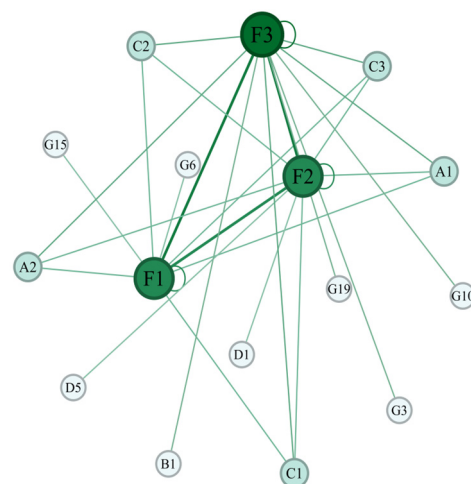


Figure 6. Social Network of “Social Charitable Resources” Nodes (F1–F3).

In this project, the community serves as the core platform for governance and service delivery, carrying out the primary functions of community management and public service provision. Community actors (nodes A1 and A2) engage in close interactions with multiple other nodes, including social organizations, social workers, volunteers, and philanthropic entities. Through organizational structures such as the Party-Mass Service Center and

the Residents' Committee, the community connects with diverse social resources. Social Network Analysis (SNA) reveals that the significance of community nodes lies in their broad participation and influence across the network. For example, node A1 interacts with social organizations (B1), social workers (C1, C2, C3), community volunteers (D4, D5), NGOs (E1), philanthropic resources (F1, F2, F3), and participating children (e.g., G1), jointly advancing the project's goals.

Social organizations represent a central force in driving service provision and fostering civic participation. The social organization node (B1) maintains frequent interactions with several other nodes, especially the community (A1, A2), social workers (C1, C2, C3), and community volunteers (D1, D2). Through project management and resource integration, social organizations play a critical role in both governance and service delivery systems within the project framework.

Social workers function as essential connectors among the community, social organizations, and residents. They are responsible for delivering services, coordinating resources, and mediating conflicts. In practice, social workers (C1, C2, C3) engage with all other nodes, forming an extensive and integrated social network. Their roles extend beyond service provision to include delivering professional support, conducting individual and group-level needs assessments, and performing targeted interventions within the community.

Community volunteers are indispensable actors in grassroots governance. By providing voluntary services, they help enhance community cohesion and collaboration. Volunteer nodes (D-series) are connected to all nodes except A2, F1, and F3. Specifically, volunteers participate in routine service tasks and activity coordination, assist social workers, and contribute to the implementation and development of community projects.

Philanthropic resources constitute a vital form of support within the community, participating primarily through financial and material contributions. Nodes F1, F2, and F3 maintain close interactions with the community (A1, A2), social organizations (B1), social workers (C1, C2, C3), and select volunteers (D1, D5). These philanthropic actors provide essential financial guarantees and material support for a wide range of community services. Their involvement ensures sufficient resources for services targeting specific groups such as the elderly and children, thereby enhancing the sustainability and quality of community governance and service provision.

5. Discussion

5.1. Enhancing the Adaptability of Polycentric Collaborative Networks

This study employs Social Network Analysis (SNA) to reveal the polycentric collaborative network characteristics embedded within the "FSL" (FSL) mechanism in community governance. The findings indicate that the patterns of interaction among key actors—including community institutions, social organizations, social workers, volunteers, and philanthropic resources—significantly affect the efficiency and quality of governance. In particular, the collaboration density and information flow between core nodes (e.g., community management entities and social workers) and peripheral nodes (e.g., volunteers and philanthropic organizations) enhance the network's adaptability to external changes, thereby improving the resilience and flexibility of community governance.

The strength of polycentric collaborative networks lies in their high adaptability, which enables effective responses to rapidly changing social environments and community needs. Within this structure, nodes engage in mutual collaboration and interaction, facilitating resource and information sharing, and contributing to the accumulation and deployment of social capital [31]. The results further support key theoretical assumptions in SNA, namely that node connectivity and network density play a crucial role in enabling the efficient flow

of resources [32]. Notably, the bridging roles of social workers and community volunteers enhance the network's responsiveness in managing emergencies and complex challenges.

Policy makers should proactively guide and encourage broader inter-sectoral cooperation to strengthen the adaptability and stability of governance networks. By optimizing organizational structures and workflow processes, diverse actors—such as social workers, community volunteers, and social organizations—can collaborate effectively within a transparent and efficient framework, thus minimizing potential inefficiencies such as resource waste and information silos. Additionally, social organizations should be encouraged to diversify their roles in governance networks—not only by continuing their role in resource integration but also by increasing their participation in decision-making processes.

5.2. Practical Implications and Future Directions

Close cooperation between communities and social organizations, active participation of social workers and volunteers, and efficient information flow are key determinants of enhancing the quality and efficiency of community governance. Future efforts in community governance should focus on strengthening inter-node collaboration, particularly by fostering more effective interaction between core and peripheral actors, to further optimize governance architecture.

In practice, both government bodies and community-level decision-makers should place greater emphasis on the construction of robust social networks, especially by improving mechanisms of collaboration between communities and social organizations and by promoting cross-sectoral coordination and resource sharing. The roles of social workers and volunteers should be further supported and institutionalized, particularly in promoting community self-governance and driving social service innovation.

Future research may explore the dynamic nature of social networks and their long-term impacts on governance outcomes. For instance, longitudinal studies could be conducted to trace the evolution of networks across varying social contexts and assess their influence on governance effectiveness over time. Additionally, incorporating qualitative research methods such as in-depth interviews and case studies can provide deeper insights into the behaviors and interaction patterns of participating actors, thereby offering more evidence-based support for policy formulation.

6. Conclusions

This study employs social network analysis (SNA) to examine the structural patterns and operational logic of the “FSL” mechanism, using Chengdu’s “After-School Care Program” as a case study. Findings reveal that this mechanism forms a decentralized, multi-hub collaborative network characterized by moderate density and short average path length, effectively facilitating information flow and resource exchange. Social workers (C1–C3) occupy central network positions as core nodes, possessing the highest degree and betweenness centrality. They serve not only as direct service providers but also as primary bridges and coordinators connecting communities, social organizations, volunteers, and charitable resources. The network's low centrality-of-degree index and absence of isolated nodes demonstrate its resilience and adaptability—core elements of an efficient polycentric governance system. This structure enables the FSL mechanism to maintain operations even when core nodes are disrupted, thereby enhancing the sustainability of community services.

This study demonstrates the significant practical value of social network analysis as a powerful tool for quantifying and visualizing the dynamics of implicit relationships within collaborative governance frameworks. Empirical evidence from this case offers actionable insights for policymakers and community practitioners: optimizing such networks can be

achieved by strengthening key bridge roles, fostering cross-domain trust, and designing institutional mechanisms that support decentralized collaboration. Despite its substantial contributions, this research has limitations. Findings from Chengdu's resource-rich urban community may not fully transfer to contexts with divergent socioeconomic characteristics. Future research should employ longitudinal designs to track governance network evolution and conduct comparative case studies across diverse communities. Integrating qualitative insights into actor motivations and perceived challenges would further deepen our understanding of successful multi-stakeholder collaboration mechanisms in China's grassroots governance.

Beyond its empirical findings, this study makes a unique theoretical contribution to the collaborative governance literature. While concepts like polycentricity and network coordination have been extensively discussed in Western contexts, their operationalization and validation within non-Western, state-led policy environments—such as China—remain relatively rare. Our application of social network analysis (SNA) to the FSL mechanism provides an empirically grounded theoretical model demonstrating how state-coordinated collaboration can generate decentralized, adaptive network structures. We demonstrate that grassroots governance can exhibit and benefit from the resilience of polycentric networks even within broader hierarchical political systems. These findings reveal a distinctive coordination logic prevalent in this context: social workers (C-series nodes) emerge not only as service providers but as critical system integrators—a role that transcends the bridging functions typically assigned to nonprofit organizations or community leaders in other settings. This highlights the critical importance of state-recognized yet professionally embedded actors in facilitating cross-sectoral collaboration within China's distinctive social governance landscape. Consequently, this study advances understanding of collaborative governance by elucidating the contingent nature of network hubs and how polycentric principles manifest through unique participant configurations across different political systems.

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