Sustainable Development of Post-disaster Community: Comparative Study of Reconstruction Mode under Social Network Measure

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Abstract: The current urban environment is faced with the potential threat of frequent natural disasters, and the sustainable development of post-disaster community has become a global issue. As an intrinsic motivation influencing the social interaction and capital operation of community, social network is an important mechanism promoting such sustainable development. However, the difference in social network caused by different member structure, spatial arrangement and management mechanism of post-disaster communities in different reconstruction modes has influenced such sustainable development process. Therefore, reasonable selection of reconstruction mode is crucial. This paper applied analytic hierarchy process to comprehensively measure and compare the social network strength in post-disaster communities in the four reconstruction modes adopted by the government of China, i.e. unified planning and unified construction, unified planning and independent construction, in situ reconstruction and relocation resettlement, with communities after the 2008 Sichuan earthquake in Chengdu, China as study objects from the perspective of three social relations (the relations between residents and residents, residents and managers, and residents and servers). The results showed that strong connections are generally presented in the social network of post-disaster communities in unified planning modes, that the strength is significantly higher than that of those in non-unified planning modes, and that the strength of UPIC communities is the highest. Meanwhile, government intervention, residents' free participation and market operation are positively correlated to government trust, community interaction and community service respectively. The positive impact of government intervention is the most significant, but it has a peak value. No government management and excessive government intervention will exert negative impacts. The coordination of government, society and market is the key contents of post-disaster community reconstruction. The reconstruction modes based on "government leadership, resident participation and market operation" may become a feasible path for such sustainable development.

Keywords:

Post-disaster community; sustainable development; social network; government management

1. Introduction (Heading 1)

Since the beginning of the new century, the world-wide frequency of natural disaster has remained high and seriously threatened the safety of urban and rural community environment and the quality of life (Figure. 1). Taking China as an example, according to the statistical data, there has been nearly 40 cases of earthquakes above magnitude 6 since 2000, affecting more than 200 million people and more than 300,000 communities [1]. Especially the 2008 Sichuan earthquake on May 12, 2008, 440,000 casualties and a direct economic loss of CNY 845.1 billion were caused to China. The sociological school of disaster treats disasters as a social phenomenon and thinks that disasters are a function of the society [2] and can reflect the degree of vulnerability of the society [3]. As the basic unit of social residential pattern, community has become the most significant variable in disaster function relation [4]. Under strong external negative effects, the internal environment, economic form and social network of community are faced with significant challenges. The reconstruction and sustainable development of post-disaster community have become a social issue. As an intrinsic motivation influencing the social interaction among individuals, households and organizations and capital operation of community, social network is an important mechanism to promote the sustainable development of post-disaster community [5].
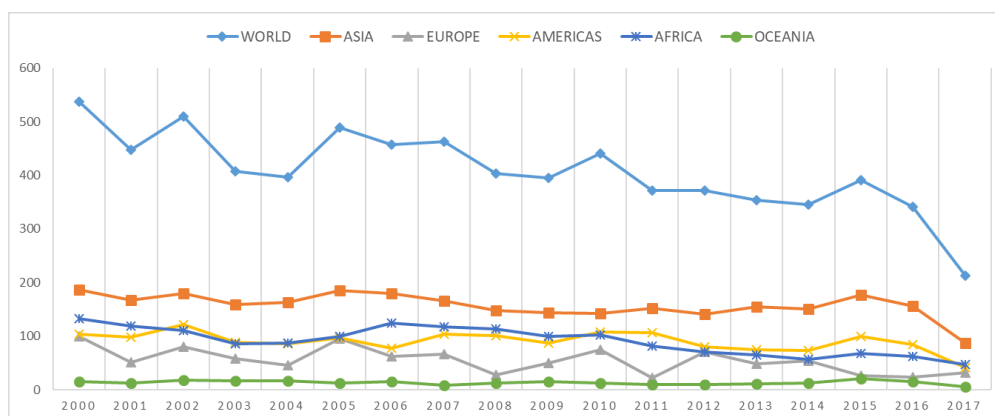

Figure 1. Statistics on the number of world-wide natural disasters between 2000 and 2017(Data source: International Disaster Database/ EM-DAT)

Proposed by Georg Simmel, a German sociologist, social network refers to the relatively stable relation system formed by the interaction among social individual members and is the sum of the social relations in a certain region [6]. Mark Granovetter holds that social network has strong and weak relation differences, acts on the process of social production as an "invisible hand" by embedding currency circulation, commodity trading, market operation and other economic actions in the production process and decides the social nature of the whole production system in the reconstructed community [7,8]. Kimura Shuhei, a Japanese scholar, holds that post-disaster community is an "atsumari" of the order of human society and that social network reflects the recovering efficiency of the living and production function of the "atsumari" [9]. When a community forms informal social system, social network plays an important role in maintaining the social system [10]. Lin Juren believes that the core

of the sustainable reconstruction of post-disaster community is the reorganization of social network [11]. The support of social network should be drawn to maintain the stable order of society [11]. Social network can improve the emotional intensity and trust of internal members of community in a short time to form strong structural forces in the community and stimulate the public activity of the community [12]. To measure the sustainable development capacity of post-disaster community with social network as an important index has formed a basic consensus.

However, existing studies focus on the planning, business, space and social network features of a single post-disaster community [13,14,15,16], and there are relatively few comparative studies on different reconstruction modes from social network perspective. Actually, the post-disaster communities constructed in different reconstruction modes are different. Such difference is one of the important factors influencing the sustainable development of post-disaster community. After the 2008 Sichuan earthquake, the government of China (referred to as GOC) mainly adopted four reconstruction modes (Table 1), i.e. unified planning and unified construction (referred to as UPUC), unified planning and independent construction (referred to as UPIC), in situ reconstruction (referred to as ISR) and relocation resettlement (referred to as RR), in the process of post-disaster reconstruction and completed the reconstruction of more than 3,000 post-disaster communities. While reconstructing the physical space environment of the community, help was given to the restoration of the mentality of the residents and the social network of post-disaster community [17]. After ten years' restoration, post-disaster communities have completed the regeneration and reorganization of new social network and realized the normal operation of social economy.

Table 1. Reconstruction modes for communities after the 2008 Sichuan Earthquake.

Reconstruction mode	Subsidy objects	Construction mode	Shape and structure of residence	Type of residents
UPUC	Residents whose original housing is damaged, with weak economic affordability	The government planned the land and constructed houses in a unified manner and allocate houses by 35m²/person.	Multi-storey townhouse without private courtyard only for residence	100% affected residents
UPIC	Residents whose original housing is damaged, with certain economic	The land was planned by the government in a unified manner; houses were constructed by community residents	Point block community with single-family courtyard, could not be used as for-	100% affected residents

	affordability	themselves; the compensation of CNY 8,000/person was made by the government.	profit business premises	
ISR	Residents whose original address was not in the danger zone of geological hazards	Residents planned and constructed on the original homestead; and the government subsidized 50% of the house-building costs.	Point block community with single-family courtyard, could be used as for-profit business premises	100% affected residents
RR	Subsidy objects who had entrepreneurial ability and were willing to relocate their families	The government gave a one-off monetary compensation (CNY 30,000) according to the market-oriented allocation principle. Residents moved to unaffected or newly-developed communities.	Modern community houses with different shapes and structures and unlimited functions	Some unaffected residents and some affected residents

2008 Sichuan earthquake took place ten years ago. It can be found by reviewing the post-disaster community development process that social network has played an important role in promoting the sustainable development of post-disaster communities. On the one hand, social network has improved the cohesion and public vitality of the residents in post-disaster communities; on the other hand, social network has established a communication bridge for the capital circulation of community currency and public management of community [18]. However, the comparative studies on the post-disaster communities in four reconstruction modes showed that the structure of community members in post-disaster communities in different reconstruction modes is significantly different and that the strength of the social network in communities changes accordingly and directly affects the public vitality, business vitality and trust of communities. Therefore, the comprehensive measure of social network can detect the potential and problems in the sustainable development of communities in different reconstruction modes, thus different reconstruction modes can be selected scientifically.

This paper selected the post-disaster communities in four reconstruction modes as study objects based on the continuous follow-up survey on the communities reconstructed after 2008 Sichuan earthquake. An evaluation index system was reasonably built by establishing the evaluation model for the social network strength of post-disaster communities to measure the social network strength of communities in

different reconstruction modes in order to compare the advantages and disadvantages relations among different reconstruction modes from the perspective of social network strength of communities and provide important information for the selection of reconstruction modes for post-disaster communities in the future. In order to detect the difference in the social network among communities in different reconstruction modes, the following research hypotheses are formulated:

Hypothesis 1: the connective degree of the social network of post-disaster communities in unified planning mode is higher than that of post-disaster communities in non-unified planning mode.

Hypothesis 2: the connective degree of the social network of post-disaster communities in UPIC mode is the highest among all reconstruction modes.

2. Research Background and Sample Selection

2.1 Research Background

2008 Sichuan earthquake had significant impacts on southwest China. Close to the source of the earthquake, the urban and rural communities of Chengdu were also severely damaged. According to statistical data, 4,276 Chengdu residents died and 26,413 were injured; 868 residential communities (including villages) were damaged; 231,300 houses were destroyed (data source: Chengdu Bureau of Statistics). After the earthquake, Chengdu efficiently completed the reconstruction of post-disaster communities with the help of the rescue forces from all sectors of the society and showed strong tenacity. In 2011, United Nations International Strategy for Disaster Reduction (UNISDR) fully recognized the experience and achievements of Chengdu in the reconstruction of post-disaster communities by granting an award of "the Model City for Post-disaster Reconstruction and Development" to Chengdu.

As the only mega-city in quake-hit area, the post-disaster communities in Chengdu include the community types in all reconstruction modes and are historical epitome and representative example of post-disaster community reconstruction in China. Therefore, the study on the post-disaster communities in Chengdu is of typical value. In addition, the selection of communities in a single city can eliminate the impacts of the difference in city system on the development of post-disaster communities, ensuring that the study samples are consistent in system, facilities and environment, etc.

2.2 Sample Selection

The communities within the administrative region of Chengdu reconstructed after 2008 Sichuan earthquake were selected as study objects in this paper. Three communities in each of the four reconstruction modes are selected as study sample. The criteria for sample selection are as follows:

(1) The communities should be located within the administrative region of Chengdu.

(2) The supporting facilities levels, traffic location conditions and related

management policies of the communities should be basically similar.

(3) The community size should be 500-650 households and the total population 1,500-2,500.

The following 12 communities are selected as study samples (Table 2 and Figure. 2) according to the above principles:

Table 2. Relevant Conditions of Sample Communities.

Reconstruction mode	Sample community	Code	Location	Scale of community	
				Households	Population
	Shixin	A1	Xujia town, Dujiangyan	510	1850
UPUC	Shidongren	A2	Danjingshan town, Pengzhou	568	1654
	Jingshan	A3	Tongji town, Pengzhou	620	2006
	Fenglechang	B1	Guihua town, Pengzhou	613	1781
UPIC	Yuwangcun	B2	Tianma town, Dujiangyan	608	1957
	Lianhuahu	B3	Cifeng town, Pengzhou	628	2186
ISR	Guanqu	C1	Lichun town, Pengzhou	618	1767
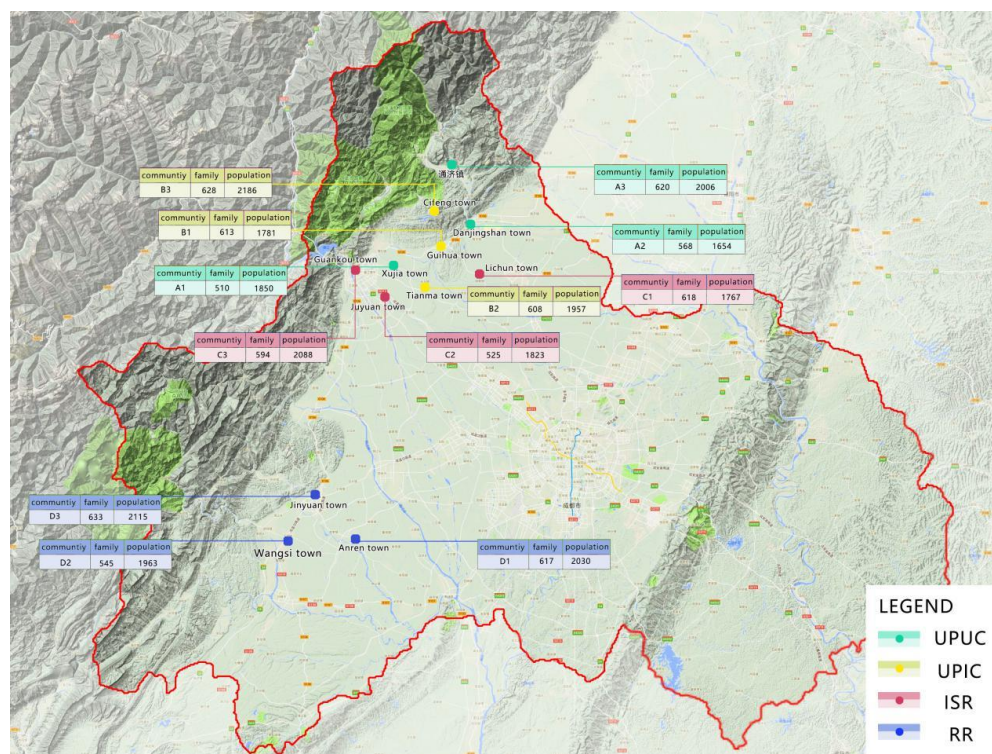
	Wulong	C2	Juyuan town, Dujiangyan	525	1823
	Pingyi	C3	Guankou town, Dujiangyan	594	2088
	Jinjing	D1	Anren town, Dayi	617	2030
RR	Wujiacun	D2	Wangsi town, Dayi	545	1963
	Xinlong	D3	Jinyuan town, Dayi	633	2115

Figure 2. Spatial Location Pattern Diagram for Sample Communities.

3. Materials and Methods

Two kinds of methods were mainly applied to the study in this paper. The first kind is data collection methods, including field observations, questionnaires and semi-structured interviews, used for obtaining first-hand actual data from the sample communities selected in this study. The second kind is data analysis methods, including AHP and SPSS statistical analysis method, mainly used for measuring the strength of the social network of post-disaster communities.

3.1 Data collection methods

(1) Field observations

The study team paid three field visits to sample communities between 2017 and 2018 and obtained detailed community data. This method is mainly used to collect the structural features of the social members in post-disaster communities. This study divided the social members of post-disaster communities into residents, managers and servers (Table 3) according to field observations and the public functions undertaken by members. Residents refer to pure residential group which undertakes no function; managers refer to the grassroots government employees engaged in community management; servers refer to the community group engaged in commerce, medical care, education and other public services. According to observations, since the functions undertaken by individuals may coincide, the roles of community members are simplified to eliminate related impacts. That is, the sum of the proportion of the three kinds of members is 100%.

Table 3. Interpretation of Structural Categories and Features of Community Members.

Member categories	Features	Special instructions
Residents	Pure residential group living in community in long term	Since there is coincidence among members to some extent, repeated indexes are rejected in subsequent statistics to calculate by single member category and
Managers	The group living in the community and engaged in grass-roots management in the community	

Servers	The group living in the community and engaged in commerce, education, medical care and other services	ensure the sum of the proportion of the three kinds of members is 100%.

In post-disaster communities, residents are main relation nodes and the member group of residents is the absolute majority. Meanwhile, the work objects of managers and servers are residents, too. Therefore, the social relations in communities mainly are the relations between residents and residents (SR1), residents and managers (SR2) and residents and servers (SR3). The social relation between managers and servers is neglected (Figure. 4). SR1 reflects the emotional intensity and social closeness of the community; SR2 reflects the trust intensity to government; and SR3 reflects the public vitality index of the community.
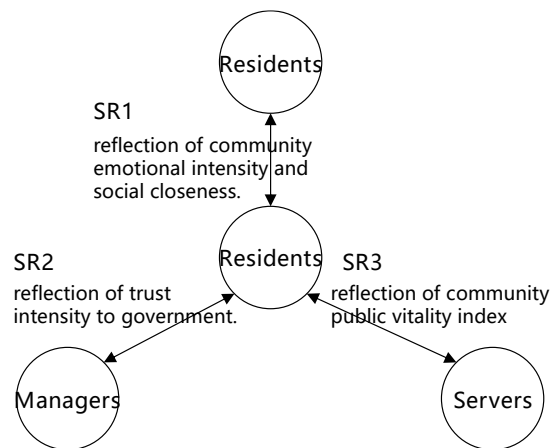

Figure 3. Diagram of Three Kinds of Social Relations in Post-disaster Communities.

(2) Questionnaire

In order to conduct accurate statistics of the functions of the residents in communities, questionnaire is adopted in this study. The method is mainly applied to collect the basic information of community groups and their social relations. The questionnaire includes two parts (Figure. 4). Part 1 is individual variables, such as age, gender, job and income (Table 4). Part 2 is social variables, which mainly are the relevant index statistics of the strength of social network, including community communication, management, service and other related indexes (see Part 2 of Chapter 3, figure 5).
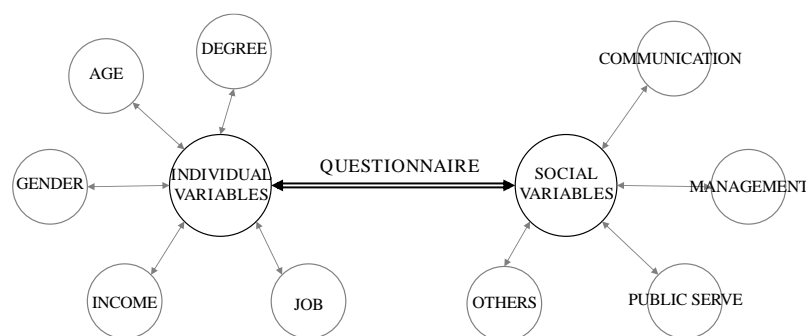
Figure 4. Diagram of Content Design of Questionnaire.

The study was conducted on each sample community. Questionnaires were distributed by three surveys. A total of 1,258 households were surveyed; and a total of 600 questionnaires (50 for each community) were distributed. 572 valid questionnaires were recovered.

(3) Semi-structured interviews

Semi-structured interviews are widely used data-collection methods in social science research. Compared with the written data collection by questionnaires, semi-structured interviews can have friendly conversations with interviewees in a more humanized manner by means of direct verbal communication so as to dig deep into the real thoughts of the groups in the community and check whether the results of data analysis are the same as the real situation.

In this study, the study team randomly selected community groups as interviewees and asked such questions as daily community public activities, community business environment, community management contradictions and potential community risks in a detailed manner. The interviews are filed in the form of records to ensure the authenticity of data.

3.2 Data analysis methods: measure of social relation strength in community

Social network theory deems that the information bridge constructed by interpersonal relationship is the main channel for social group emotion transmission and communication [20]. The stability of the information bridge in the community reflects the capacity and durability of the sustainable development of the community [21]. The key to evaluate the social network strength in post-disaster community is the comprehensive measure of the social relation strength in community [22]. Mark Granovetter used the four indexes, i.e. "interaction frequency", "emotional intensity", "intimacy" and "mutual-help" to measure the strength of social relations [23]. High index value represents strong relation network and low index value means weak association. He deems that the power of strong relations is better than that of weak relations in a certain social network, but weak relations promote the information flow among different social groups. Nevertheless, different from western capitalist countries, Chinese society has always paid attention to interpersonal communication and social customs, showing a social network feature of the absolute dominance of strong relations

[24]. Supported by strong relation network, Chinese communities can realize orderly life management, residents association, social activities and public services.

The reasonable establishment of evaluation index system is an important link of the scientific research on the social network of post-disaster community. Mark Granovetter proposed the four indexes, i.e. interaction frequency, emotional intensity, intimacy and mutual-help to measure the strength of social relations. Wellman et al. hold that the individual characteristics of community members will also impact the strength of social relations [25]. Some scholars believe that different types of community and different construction modes, special environment and other factors will also exert significant impacts on the strength of social relations [26]. In addition, community economic vitality, the frequency of public activities, the area of public places and other factors will also affect the strength of community social relations [27]. According to the above studies, it can be concluded that the strength of community social relations will be affected by two kinds of factors. The first kind is individual characteristics, including gender, age, job, degree of education, income and other variables; the second kind is social characteristics, including social emotional intensity, trust, public vitality index and other indexes.

For purpose of this study, this paper discusses the difference in the social network strength in post-disaster communities in different reconstruction modes; and individual characteristics of members in a single community are not discussed herein. The results of the questionnaires for sample communities show that the difference in the individual characteristics of the members in post-disaster communities in different reconstruction modes is generally minor; and there is only significant difference in community member structure variable (Table). However, the community member structure variable directly causes different composition of the social relations in community. Therefore, the evaluation index system for social relations in community should be established in a differentiated manner according to different types of social relations.

Table 4. Statistics of the Results of Questionnaires for Sample Communities.

Sample community	female （%）	mean age	Monthly average incomes CHY	Average education degree	Member structure （%）		
					Residents	Managers	Servers
A1	45	45	3000~4000	3	90	5	2
A2	42	38	4000~5000	4	92	6	2
A3	45	40	3000~4000	4	90	7	3
B1	48	45	3000~4000	3	89	6	5
B2	51	51	3000~4000	3	85	8	7

B3	44	39	4000~5000	4	84	6	10
C1	42	43	4000~5000	4	68	7	25
C2	47	45	3000~4000	4	70	10	20
C3	46	49	3000~4000	3	74	8	18
D1	44	47	3000~4000	3	60	12	28
D2	52	43	3000~4000	4	54	11	35
D3	50	48	3000~4000	3	58	10	32

Note: the average education degree is averaged according to the choice score, and the standard is: no admission =1; Primary school = 2; Junior high school = 3; High school = 4; University = 5；

According to the above analyses, this paper reasonably selects evaluation index variables to establish differentiated evaluation index hierarchy model for the social relation strength in post-disaster communities (Figure. 5) and the corresponding attribute features of variables (Table 5) on the basis of Mark Granovetter's relation evaluation model and with the three kinds of social relations among community residents, managers and servers as evaluation objects. Where:

SR_1: four indexes, i.e. emotional intensity, interaction frequency, intimacy and mutual-help, a total of 13 sub-variables (U1-U13);

SR_2: two indexes, i.e. trust and satisfaction, a total of 7 sub-variables (V1-V7);

SR_3: three indexes, i.e. interaction, satisfaction and convenience, a total of 9 sub-variables (X1-X9);
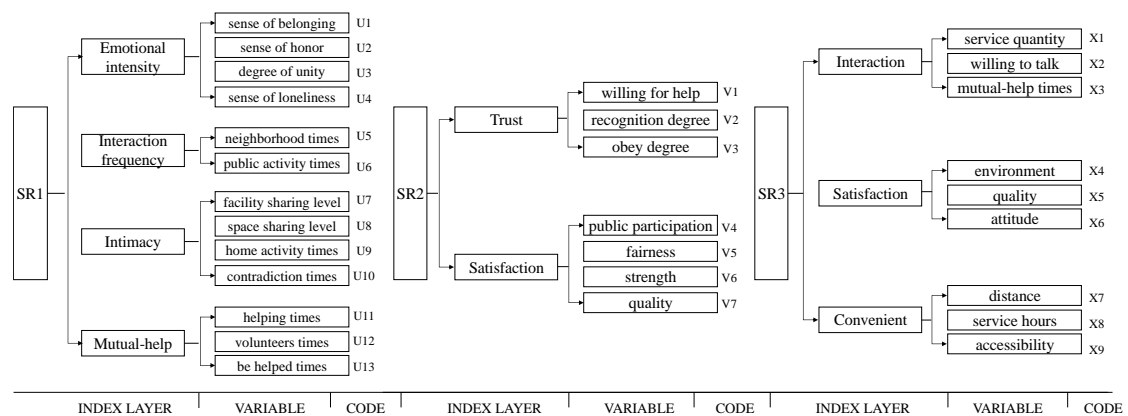

Figure 5. Evaluation Index Hierarchy Model for Social Relation Strength in Post-

disaster Community.

Table 5. Interpretation of Attributes of Evaluation Indexes of Social Relation Strength in Post-disaster Community.

variables	Interpretation
U1	The extent to which residents depend on the community
U2	Residents' collective identity of community
U3	Community residents' degree of participation in collective activities
U4	Community residents' sense of loneliness
U5	Frequency of neighborhood conversation in community
U6	Including community competitions, theatrical performances and other public activities.
U7	Sharing level of public and personal goods
U8	Sharing level of public and private space
U9	Times of neighborhood visits and family gatherings
U10	Times of contradiction and conflict among community residents
U11	Times of offering mutual-help, including fetching express delivery, taking out the garbage and carrying things
U12	Frequency of working as a volunteer in community
U13	Times of being mutually helped
V1	Residents' willingness to ask managers for help
V2	Recognition of managers' legal status
V3	Degree of obedience to community management
V4	Residents' degree of participation in community
V5	Fairness of community management and enforcement
V6	Strength of community management
V7	Quality of community management
X1	Frequency of contacts between residents and servers
X2	Willingness to talk

X3	Frequency of mutual-help between servers and residents
X4	Conditions of the environment where residents enjoy services, including health and size of sites
X5	Quality of the serving products provided by servers
X6	Servers' attitude in providing services
X7	Distance between service places and residential places
X8	Servers' service hours
X9	Accessibility of service places

Based on the evaluation index hierarchy model, comprehensive measure and analysis are conducted on the social network strength in post-disaster communities in different reconstruction modes, specifically as follows:

(1) Determination of variable weight by AHP

The principle of AHP: pairwise judgment is conducted on evaluation indexes by experts and community members; the ratio of relative importance of each index is given by a scale; mathematical calculation is conducted on the judgment matrix obtained with SPSS19.0 to get the weight (W) of each index [28]. The results of variable weight are checked for consistency with the following formula:

$$CR = \frac{\lambda_{Max} - n}{RI(n-1)} \tag{1}$$

Where: λ_{Max} is the maximum eigenvalue; RI is random index; and n is the number of indexes.

When CR<0.1, it is proved that the weight results are consistent.

According to relevant literature [29], the value of random index RI is as shown in Table 6:

Table 6. Valuation of Random Index RI

n	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

(2) Statistics of variable scores by quinquepartite method

Quinquepartite method refers to the process in which the statistical results of each variable are classified in a unified manner and divided into five sets, with each set valued 1-5; and then the average scores (P) of each variable of each sample community.

(3) Calculation of the strength of three kinds of social relations in sample communities

The strength of three kinds of social relations in each sample community (S) is calculated on the basis of the comprehensive calculation of the results of the weight of the evaluation indexes for the social relation strength in post-disaster communities and the average scores of each variable. The calculation formula is as follows:

$$S = \sum_{i=1}^{n} W_i Q_i \tag{2}$$

Where: Wi is the weight of the ith variable; Pi is the average scores of the ith variable in sample community.

(4) Measure of the connective degree of social network in sample community

The connective degree of social network in sample community (SN) is obtained in combination with the member structure and three kinds of social relations in ample community. The measure formula is as follows:

$$SN = \frac{\sum_{i=1}^{3} K_i S_i}{3} \tag{3}$$

Where: Ki is the frequency of occurrence of the ith social relation; and Si is the strength of the ith social relation.

The calculation formula of K is as follows:

$$K = N_i * M \tag{4}$$

Where: N_i is the proportion of the ith kind of community member; and M is the proportion of community residents among community members. Community residents are the 1st kind, managers the 2nd kind and servers the 3rd kind.

4. Results and Discussion

4.1 Statistical results of questionnaires on social relations in post-disaster communities

The statistical scores of all variables of the three kinds of social relations in the 12 sample communities (Figure. 6) are collected and sorted out on the basis of questionnaires and semi-structured interviews for sample communities. According to the statistical results, the evaluation indexes of the three kinds of social relations in post-disaster communities in four reconstruction modes are different in the statistical results to some extent, specially:

(1)   The scores of the SR2 variables in post-disaster communities in unified planning modes (UPUC and UPIC) are higher than those of the communities in non-unified planning modes (ISR and RR); and the difference is significant. The maximum difference between post-disaster communities in unified planning modes and non-unified planning modes

lies in the role of government in post-disaster reconstruction. In the post-disaster communities in unified planning modes, the government develops post-disaster community reconstruction planning and provides residents with economic, living, spiritual and other multifaceted assistance, enhancing the residents' trust and dependence on managers. The role of managers, by contrast, is weaker in communities in non-unified planning modes, causing such connective features as community residents' lower trust in and satisfaction with managers and not close social relations.

(2)   Among communities in unified planning modes, the interaction frequency and intimacy among residents in post-disaster communities in UPIC mode are higher than those in post-disaster communities in UPUC mode, but the total difference is not significant. In fact, post-disaster communities in independent construction modes are more similar in spatial layout, lifestyle, residential type and other aspects with those before the disaster and often have more social atmosphere of traditional neighborhood, making community members more willing to interact.

(3)   Among post-disaster communities in four reconstruction modes, the overall scores of SR1 and SR2 in post-disaster communities in RR mode are low, but the scores of SR3 variables, especially service satisfaction and service convenience, are relatively higher than those in other reconstruction modes. The results show that in post-disaster communities under market operation, the overall levels of public services and commercial services are relatively high, while the overall service levels in post-disaster communities under government control are relatively low.
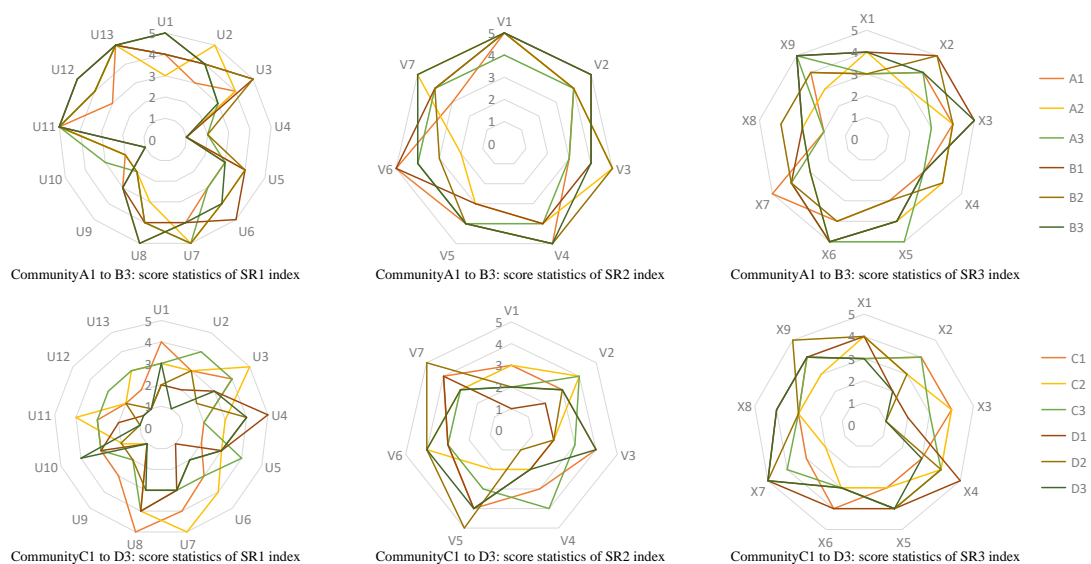

Figure 6. Statistical results of questionnaires on evaluation indexes of social relations in sample communities.

4.2 Calculation results of evaluation index weight of social relation strength in post-disaster community

This paper invited 20 experts (including university professors, government officials and planners) and 30 community member representatives to participate in variable judgment and develop judgment matrix for each of the three kinds of social relations. Then AHP was adopted to calculate the judgment matrix to obtain the weight of the evaluation indexes of social relations as shown in Table 7.

	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13
U1	1	7	5	3	/4	1/3	1/3	1/3	1/2	1/3	1/4	1/2	1/3
U2	1/7	1	1/3	1/5	1/7	1/5	1/5	1/4	1/4	1/6	1/5	1/4	1/5
U3	1/5	3	1	1/5	1/5	1/3	1/3	1/5	1/3	1/5	1/5	1/3	1/4
U4	1/3	5	5	1	1/5	1/4	1/3	1/4	1/3	1/3	1/4	1/2	1/3
U5	4	7	5	5	1	2	3	3	5	2	4	3	4
U6	3	5	3	4	1/2	1	3	3	4	2	3	3	3
U7	3	5	3	3	1/3	/3	1	1	3	2	4	3	3
U8	3	4	5	4	1/3	1/3	1	1	4	2	5	2	3
U9	2	4	3	3	1/5	1/4	1/3	1/4	1	1/3	1/4	1/3	1/3
U10	3	6	5	3	1/2	1/2	1/2	1/2	3	1	3	3	3
U11	4	5	5	4	1/4	1/3	1/4	1/5	4	1/3	1	2	1
U12	2	4	3	2	1/3	1/3	1/3	1/2	3	1/3	1/2	1	1/2
U13	3	5	4	3	1/4	1/3	1/3	1/3	3	1/3	1	2	1

Judgment Matrix of SR1

	V1	V2	V3	V4	V5	V6	V7
V1	1	2	2	3	7	5	5
V2	1/2	1	3	1/2	5	4	3
V3	1/2	1/3	1	1/3	2	3	4
V4	1/3	2	3	1	3	4	2
V5	1/7	1/5	1/2	1/3	1	3	1/2
V6	1/5	1/4	1/3	1/4	1/3	1	1/3
V7	1/5	1/3	1/4	1/2	2	3	1

Judgment Matrix of SR2

	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	1	1/5	1/2	3	1/5	1/4	1/2	1/2	1/3
X2	5	1	2	5	2	3	5	4	3
X3	2	1/2	1	3	2	2	4	5	3
X4	1/3	1/5	1/3	1	1/3	1/5	1/3	2	1/3
X5	5	1/2	1/2	3	1	1/2	3	3	3
X6	4	1/3	1/2	5	2	1	3	4	2
X7	2	1/5	1/4	3	1/3	1/3	1	3	1/3
X8	2	1/4	1/5	1/2	3	1/4	1/3	1	1/3
X9	3	1/3	1/3	3	1/3	1/2	3	3	1

Judgment Matrix of SR3

Figure 7. Judgment Matrix of Evaluation Indexes of Three Kinds of Social Relations.

Table 7. Statistics of Evaluation Index Weight of the Strength of Three Kinds of Social Relations.

Index of SR1		Weight	Index of SR2		Weight	Index of SR3		Weight
layer	variable		layer	variable		layer	variable	
Emotional intensity	U1	0.047		V1	0.322		X1	0.047
	U2	0.015	Trust	V2	0.190	Interaction	X2	0.246
	U3	0.023		V3	0.124		X3	0.174
	U4	0.035		V4	0.194		X4	0.038
Interaction frequency	U5	0.187		V5	0.057	Satisfaction	X5	0.133
	U6	0.147	Satisfaction	V6	0.038		X6	0.144
	U7	0.107		V7	0.075		X7	0.062
Intimacy	U8	0.113				Convenient	X8	0.065
	U9	0.040					X9	0.092
	U10	0.099						
Mutual-	U11	0.072						
help	U12	0.052						

U13	0.064

Meanwhile, according to formula (1), the weight of the three kinds of social relations is checked for consistency. The results are below 0.1 (Table 8), proving that the judgment matrix developed for the three kinds of social relations has satisfactory consistency.

Table 8. Statistics of Consistency Check of Evaluation Index Weight of the Strength of Three Kinds of Social Relations.

Social Relation	λ_{Max}	CR	RI	CI
SR_1	14.824	0.152	1.56	0.097
SR_2	7.611	0.102	1.36	0.075
SR_3	9.025	0.003	1.46	0.002

According to the results above,

(1)   In social relation 1, the weight of emotional intensity (0.334) and interaction frequency (0.259) is the highest. The weight of variables U5 (0.187), U6 (0.147), U7 (0.107), U8 (0.113) and U10 (0.099) is above the average weight 0.077 and has significant impacts of the strength of social relations; the weight of U2 (0.015) and U3 (0.023) is lower than 0.03 and has no significant impacts on the strength of social relations. The results show that the interaction frequency is the most direct assessment standard for measuring the strength of social relations and an important sign of the closeness of the daily social relations among community residents.

(2)   In social relation 2, the variable V1 (0.322) has the highest weight; the weight of variables V2 (0.19) and V4 (0.194) is above the average weight 0.14 and has significant impacts on the strength of social relations. The results show that it is believed that residents and managers should be based on mutual trust and that the public participation in community management should be strengthened. That is to say, multilateral participation mechanism should be established for community management to effectively improve the efficiency of community management and enhance the social relation between residents and managers.

(3)   In social relation 3, the weight of the three kinds of indexes is relatively balanced; and the weight of the variable Interaction (0.467) is relatively high; the weight of all variables X2 (0.246), X3 (0.174), X5 (0.133) and X6 (0.144) is above the average weight 0.11. The results show that the role of subjective will in social relations is greater than that of material environment. Especially the behavioral intention of community members decides the frequency of social interaction and the strength of social

relations.

4.3 Measure Results of the Strength of Three Kinds of Social Relations in Sample Communities

The strength of the three kinds of social relations in post-disaster communities is calculated (Figure. 8) with formula (2) based on the hierarchical structure model for the strength of social relations in post-disaster communities and in combination with the calculation results of evaluation index weight and the statistical results of questionnaires.
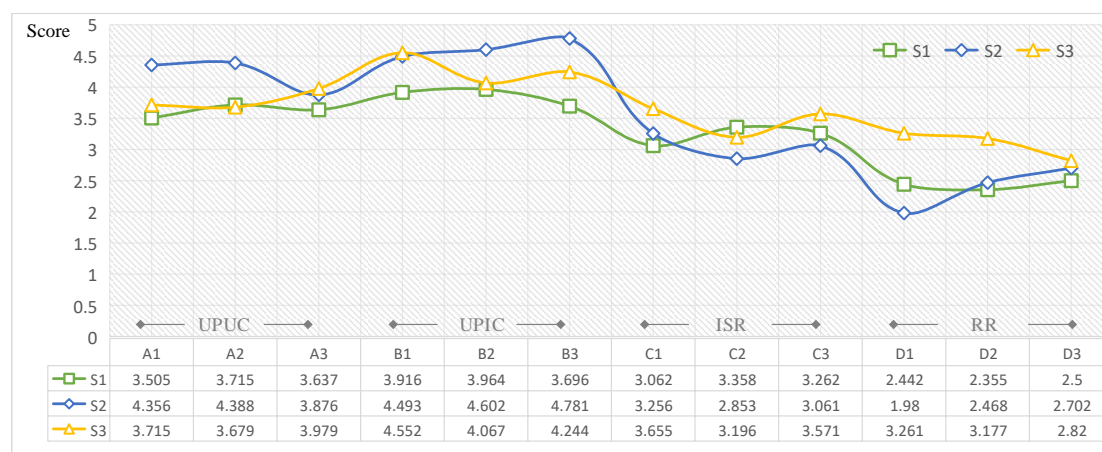

	UPUC			UPIC			ISR			RR	
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
S1	3.505	3.715	3.637	3.916	3.964	3.696	3.062	3.358	3.262	2.442	2.355	2.5
S2	4.356	4.388	3.876	4.493	4.602	4.781	3.256	2.853	3.061	1.98	2.468	2.702
S3	3.715	3.679	3.979	4.552	4.067	4.244	3.655	3.196	3.571	3.261	3.177	2.82

Figure 8. Measure Results of the Strength of Social Network in Sample Communities.

According to the calculation results: in SR1, the scores of communities B1 (3.916) and B2 (3.964) are the highest; and the scores of D1 (4.442), D2 (2.335) and D3 (2.5) are the lowest and below 2.5. In SR2, the scores of A1 (4.356), A2 (4.388) B1 (4.493), B2 (4.602) and B3 (4.781) are relatively high and those of D1 (1.98) are the lowest. In SR3, the overall scores of B1 (4.552), B2 (4.067) and B3 (4.244) are the highest and above 4.0; and the scores of D3 (2.82) are the lowest.

The standard deviation (SD) is often used to describe the dispersion degree of a set of data and reflect the variation range and range of dispersion of variables in statistics. Among the scores of the three kinds of social relations in all sample communities, the SD of SR1 (0.55) and SR3 (0.477) is lower than that of SR2 (0.919). The results show that the SR2 in different reconstruction modes is significantly different. Nevertheless, although the SD of SR1 and SR3 is relatively small, the range of SR1 (1.609) and that of SR3 (1.732) are above 1.5, showing that there is certain difference in SR1 and SR3 in post-disaster communities in different reconstruction modes.

It is found by further calculating the average scores of the strength of the social relations in post-disaster communities in the four reconstruction modes that in such post-disaster communities, the average strength of the three kinds of social relations in post-disaster communities in UPUC and UPIC modes is significantly higher than that in post-disaster communities in ISR and RR modes. Meanwhile, the strength of the three kinds of social relations in post-disaster communities in UPIC mode is the highest

and 3.859, 4.625 and 4.288 respectively. However, the strength of the three kinds of social relations in post-disaster communities in RR mode is the lowest and 2.432, 2.383 and 3.086 respectively (Figure. 9). According to the comprehensive analysis, the reasons for the results above are as follows:

(1)   For SR1, since all the community members in post-disaster communities in UPUC, UPIC and ISR modes are affected groups, they have consistent psychological identity and mutual-help mental state in the process of post-disaster reconstruction. Therefore, the social relations between community residents and residents are significant stronger than those in RR communities. The residents in post-disaster communities in UPIC mode have received the unified monetary compensation and spiritual relief from the government and have been entitled to construct houses independently and reserve traditional residential courtyard houses, thus such residents are more likely to form rural social network in traditional Chinese countryside. Unit townhouse, by contrast, is the main resettlement form in post-disaster communities in UPUC mode. In the mode of "centralized moving into storied houses" and "compact resettlement", the public space for residents' daily communication is often small [30]. In addition, unit houses hinder the daily communication of the villagers, causing communication plight in vertical elevation difference: "discipline and punishment of the stairs", low social interaction frequency and lack of external public space [31]. Meanwhile, the only public space in community fails to have substantial effect; and the connective degree of community neighborhood and the interaction frequency among residents are low. With regard to the post-disaster communities in ISR mode, since the government let community residents manage by themselves, there is no regular community activity or public beneficial community public management institution, causing the lack of daily interaction among community residents and indifferent social relations.

(2)   For SR2, in post-disaster communities reconstructed after unified planning by the government, grassroots government has played an important role in maintaining public order in community, restoring community environment, remodeling residents' psychology and other aspects in the restoration and development processes of communities. Moreover, such role is stable and continuous and has been effective in the ten years' development and construction of community. In post-disaster communities in non-unified planning modes, since the government adopts one-off compensation mechanism, after the end of the three-year assistance mandated by the state, the power of the government exits quickly from the social development of post-disaster communities; and link between community residents and grassroots government and community managers is cut off, causing low social relation strength. Meanwhile, in communities in RR mode, some members are unaffected groups and have not received the unified monetary compensation and spiritual relief from the government and managers, causing the lowest emotional strength towards community managers and weak social relations.

(3)   With regard to SR3, with the continuous improvement of modernized service level, the social relation between residents and servers is relatively

close. Residents are more likely to have high interaction willingness in the process of enjoying daily services. Therefore, the general levels of the strength of the social relation between residents and servers are relatively high in post-disaster communities in the four reconstruction modes. Nevertheless, although modernized communities, such as communities in RR mode, have higher service levels, community services show "snackification" and "consumerization" due to fast-paced lifestyle, lacking communication time and subjective will to interact and causing low frequency of social interaction. In communities in UPIC mode, the type and mode of community services are highly similar to those before disaster, the interaction intention among community members is stronger and the strength of social relations is higher.
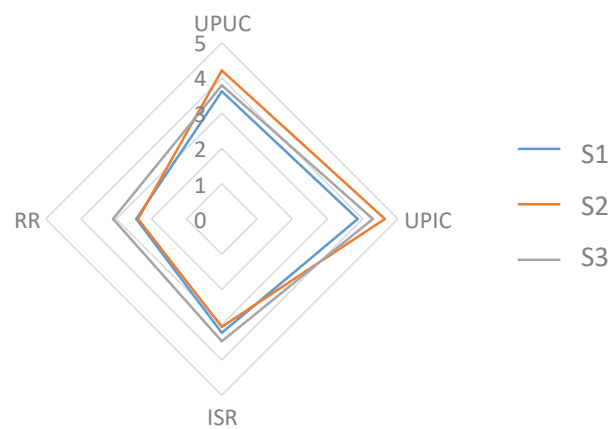
Figure 9. Average Scores of Social Relation Strength in Post-disaster Communities in Four Reconstruction Modes.

4.4 Measure Results of the Strength of Social Network in Post-disaster Communities

The strength of the social network in sample post-disaster community is calculated with formulas (3) and (4) on the basis of the calculation and statistical results above and in combination with the structural feature of the social members in sample communities (Figure. 10).
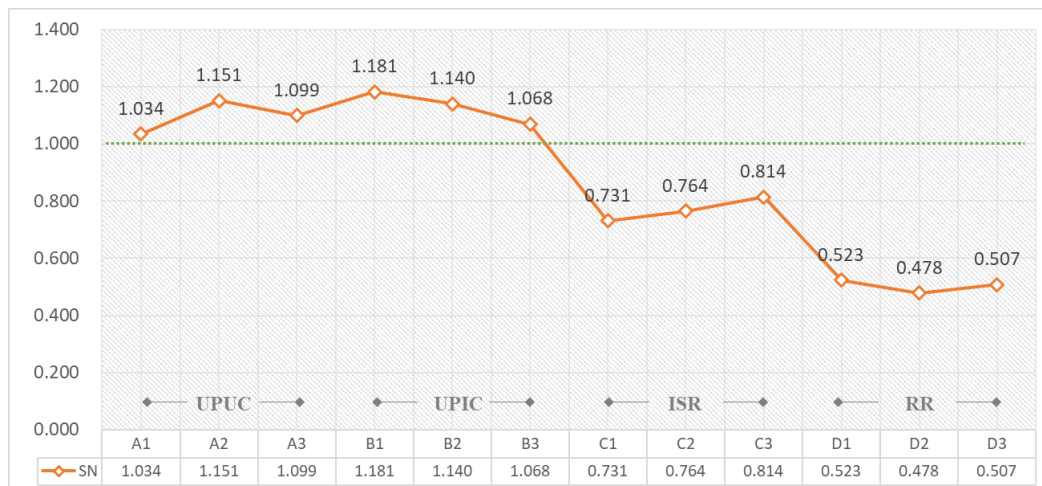
Figure 10. Measure Statistics of the Strength of Post-disaster Social Network in Sample Communities.

The calculation results show that the strength of the social network in post-disaster communities in UPUC and UPIC modes is above 1.0 point. The strength of the social network in post-disaster communities in ISR and RR modes, by contrast, is below 1.0 point. The scores of B1 community are the highest and 1.181; the scores of D2 communities are the lowest and only 0.478. The results prove that Hypothesis 1 is true. The average scores of the post-disaster communities in four reconstruction modes are UPUC (3.285), UPIC (3.390), ISR (2.309) and RR (1.508) respectively. The results show that Hypothesis 2, which proposes that the strength of social network in communities in UPIC mode is the highest among the communities in the four reconstruction modes, is true, too.

According to the results above and relevant statements, the strength of the social network in post-disaster communities in the four reconstruction mode is significantly different; and the order (from high to low) of strength measure values is UPIC, UPUC, ISR and RR. The reasons and mechanism for the difference in the social network in the four kinds of communities are as follows:

(1)   UPIC communities complete the accumulation of trust and the continuation of the traditional lifestyle by the residents' self-construction under government intervention by means of the resultant action of government control and resident freedom in the process of reconstruction, thus the high strength of the social network in such communities is realized.

(2)   Although UPUC communities are in the reconstruction mode of unified planning, excessive intervention by government power is found in the process of reconstruction, causing residents' psychological inversion to some extent. Besides, the unified construction dominated by the government deprives the community residents of the right to choose community environment and family housing. Unit houses cause lower frequency of daily interaction among residents and communication plight in vertical elevation difference.

(3)   Although ISR communities are reconstructed in situ and can continue the

community vitality before the disaster and meet the "countryside complex" of traditional Chinese community residents, the housing construction in the community is unordered and public space severely squeezed due to the lack of restraint of residents' construction behavior by the government; and the number of contradictions among community residents is significantly higher than that in the other three kinds of communities. In addition, the one-off compensation mechanism of the government cannot meet the living needs of affected group, which is also an important reason for community residents' low trust in government managers.

(4)   RR communities adopt the mode of relocation. In this mode, community residents are forced to move out of the original location. The familiar lifestyle and environment are forced to be updated; the original neighborhood relations and social network are disconnected; community residents have to live in new community environment and establish new social network with unfamiliar affected and unaffected groups, thus the strength of social network is lowered.

5. Conclusions

In the foreseeable future, the restoration, reconstruction and sustainable development of post-disaster communities will still be an important issue facing mankind all over the world. How does the government to do a good job in the construction of post-disaster communities, protect the public interest of the affected groups and build a harmonious and beautiful social network environment as a legitimate manager is the important content to promote the sustainable development of the communities. This paper selected the Chinese communities constructed in the four reconstruction modes after 2008 Sichuan Earthquake as study objects and conducted comparative analysis on the difference of the four reconstruction modes on the basis of the study on the strength of the three kinds of social relations in post-disaster communities and the comprehensive measure of the features of the social network in post-disaster communities. The following conclusion was drawn:

(1) Government intervention plays a significant role in improving the strength of social network in post-disaster communities.

The results of the survey on sample communities show that the intervention and participation of grass-roots government, especially community manager, in post-disaster reconstruction directly affect the strong or weak features of the social network in post-disaster communities for a long time to come. Under powerful government intervention, the residents develop trust in and dependency on managers. Such "trust in government" (we call this trust in managers the trust in government) reflects the community members' psychological recognition of and submission to community management [32], making community management ethically legitimate and guaranteeing the effective implementation of community management. Thus the community management cost is effectively lowered and the community environment with highly connective social network maintained. On the one hand, the community life under government constraint is in stable order, community public activities can be regularly carried out and regular community interaction can be formed. On the other hand, government intervention can better maintain community environment health and public security, guarantee residents' public interest and living needs, improve residents' community happiness and significantly lower the frequency of internal contradictions.

(2) The resultant force of government management and resident participation is the intrinsic motivation of the sustainable development of post-disaster communities.

According to the comparative study on the four reconstruction modes in China, the liberalized and marketized ISR and RR communities and completely constrained UPUC community have some problems in social network. The highly free right of choice and right of discretion of the members in ISR and RR communities provide such communities with liberalized social interaction environment and cause certain management chaos and disorder. The disadvantages are accumulated in the absence of government management and cause concentrated outbreak of community contradictions. The excessive government intervention in UPUC communities deprives community members of their right of freedom, causes the subjective aversion and resistance of community members and weakens the strength of community network. Therefore, no government management and excessive government intervention are not sensible choice for the sustainable development of post-disaster communities. The driving force mechanism for the sustainable development of post-disaster communities is to give full play to the resultant action of government management and resident participation. Moderate decentralization of government management becomes an important means to stimulate community vitality.

(3) Introduction of market forces to participate in reconstruction will also become one of the important paths of the sustainable development of post-disaster communities.

The survey on sample communities show that although RR communities show weak connection in the overall strength of social network, the superior public community service and business service environment, quality and levels created in modern communities under pure market operation are significantly higher than those in other three kinds of communities. With the normalization of community life, convenient community services will be the core competitiveness of the sustainable development of post-disaster communities in the future. The community services under government management always pursue maximum fairness and ignore quality optimization. Therefore, the introduction of market forces to participate in the reconstruction of post-disaster communities can provide better community services and create good and convenient community environment.

Based on the conclusion above, this paper believes that the reconstruction mode of "government leadership, resident participation and market operation" should be taken in the restoration and reconstruction of post-disaster communities in the future. The government should be the main body to promote the unified planning of communities, maintain the fairness and life order in communities and improve the trust in grass-roots government and the cohesion of community residents. Meanwhile, community residents should be provided with certain right of choice and right of discretion to strengthen residents' participation into the process of community management and community construction and improve the self-identity of community residents. Then the market should be introduced to participate in community commercial and public service operation, seek fair and efficient balanced development, create highly connective social network in community and realize the sustainable development of post-disaster communities.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgments

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