How Small Groups Form in an Organization? --A Simulation Model for Distribution of Working Load

Luo, Jar-Der[1] and Wang, Shu-Sen

Graduate School of Social Informatics, Yuan-Ze University

I. Theoretical Model for Simulation

This paper will examine the reasons why an organization's employees form small groups by simulating their networking behaviors. Let us assume there is a department in an organization with 20 employees. All of them execute very similar job, so that they can mutually support each other. Whenever any person can't finish his/her job in one day, he/she will ask colleagues for helps. Our model illustrates that mutual helps make people tie together, and some of them form mutual support association due to reciprocity principle and efficiency of resource exchange. Eventually, these associations exclude others' participation. That is reason why cliques form in a firm. Our simulation will explore what kinds of working environment turn mutual-help behaviors to exclusive mutual-support cliques.

A. Theoretical Bases for Behavioral Assumptions

This simulated explanatory model can find its sound theoretical base. Social exchange theory (Blau, 1964) argues that social exchange is based on reciprocity. Whenever a person offers helps to another person, he expects return of favor. If this

[1] Corresponding to Luo, Jar-Der. Tel:886-3-463-8800 EXT. 762 ; Fax:886-3-463-8884 ; E-mail: jdluo@saturn.yzu.edu.tw Address: Graduate School of Social Informatics, Yuan-Ze University, 135 Yuan-Tung Rd., Chung-Li 320 Taiwan, ROC.

expectation gets fulfilled, their social exchange will continue and cooperation relation is therefore strengthened. Unlike economic exchange, social exchange involves more or less uncertainty, since it gets no instant rewards. There is always some possibility of break of reciprocal promise, so a person needs to trust the other side's goodwill when he/she offers help. If this expectation of goodwill is not betrayed, trust will be stronger and stronger. A person for sure tends to seek help from and return favor to those trustworthy persons (Granovetter, 1985). In addition to trust, learning curve theory tells us that long-term and frequent social exchange helps reducing the inefficiency of interaction, since past cooperative experience helps making interaction smooth and solving possible conflicts. So an individual also tends to cooperate with those people engaging in long-term relations, in order to reduce "transaction cost" in social exchange (Williamson 1996; Granovetter 1992). Furthermore, group dynamics shows that a dense group will exclude others' participation. When a group of people has stronger and stronger trust among group members, who tends to seek helps in the group, and therefore a clique form.

Based on these theoretical arguments, there are several behavioral assumptions in our explanatory model. First, we assume that an employee with overloaded work, at very beginning, will randomly pursuit the help from others, who may offer helps when their time is free. When he has experience of asking and offering helps, this individual will seek for helps according to his/her experience. In other words, he/she will ask help from and return favor to those who once help him/her.

The second assumption is related to experience. That is the memory of N times of mutual benevolent behaviors makes an employee build a consulting tie with the helpful person. A consulting tie therefore forms. The consulting tie makes both sides put each other into their priority pool, which they first return favor to and ask more favors from. By the same token, a consulting tie can be disconnected if one's requests for helps are rejected N times by the other side.

The third assumption is about behavioral pattern of seeking helps. If a worker has overloaded n jobs, we assume that he/she will find n colleagues and distribute each of them one job. If he/she can not find enough persons to offer helps, the only solution is working-by-himself to finish all jobs in off-duty time. In other words, no jobs are allowed staying overnight.

B. Parameters Specification in Simulation Model

We developed a simulation program based on the programming environment Turbo C. Our program is intended to provide a simple way to experiment different employees' behaviors and observe their dynamical interactions in the model we presented above. This program consists of the following main components:

1. Some environmental variables to define employee's characters like the number of employee, the working capacity of each employee, how many times of simulation in an experiment, etc

2. A random generator of gamma distribution to produce working load for every individual employee:

Gamma Distribution： $\Gamma(\alpha,\lambda)$

Definition: If a random variable *X* has a density function given by

$$f(x) = f(x;\alpha,\lambda) = \frac{\lambda^{\alpha}}{\Gamma(\alpha)} x^{\alpha-1}\cdot e^{-\lambda x} \qquad 0 \le x \le \infty \ ; \ \alpha,\lambda > 0$$

where $\Gamma(\alpha) = \int_0^{\infty} x^{\alpha-1} e^{-x} dx$ is a gamma function.

3. Some behavior assumptions for employee behaviors stated above, including individuals seeking for helps according to their experience, memory of mutual support to build up consulting ties, and priority of seeking cooperation in consulting ties.

Eventually, this model generates two results:

1. A matrix records all employees' experience for asking help in each round of simulation.
2. An output matrix of final consulting ties good for network analysis

In the following simulation experiments, we change only the working load parameters in the model , i.e. α and λ, to observe the impacts of load and distribution of jobs on employee's networking behaviors. Other parameter specification is fixed, as summarized as the following:

1. Environment parameters: The number of employee in the organization is set

to 20 employees, as stated above. Times of simulation in each experiment are set to 100 rounds. Working capacity of each employee is set to 8. The absolute number of working capacity is not important, while the difference between capacity and mean of working load is actually the key factor for interaction dynamics. A big difference means that everybody generally works very easily, while a small difference indicates that everyone in average uses up his/her energy for the work.

2. In simulation experiments, different distributions are specified for the arrival speed of jobs. Gamma distributions of jobs with parameters α, λ are assigned to each employee. High α is defined by that α is equal to 6 or 8. That means every employee generally keeps busy. α can not be higher than 8, otherwise the jobs of the whole organization will not be completed in the long run. Median α is to be 4, in which environment working load is not too heavy or too light. Low α, that is 1, indicates a relax climate in the organization in which most employees are free in most of time. High λ means huge variance of work loading, or saying uncertain job assignment to different employees in each unit of time. Low λ shows pretty stable job assignment by which working load of employees will not be fluctuate.

3. Memory state N is set to be 3, 4, 5, 6, 7, and 8 at very beginning. High N indicates an organizational culture with “strong memory”, in which to build a consulting tie is difficult but it is not easy to be broken up, either. Low N means a “weak memory” culture, in which workers easily shift ask for helps, and also easily break up consulting ties. In our findings, when N is lower than 6, it is very difficult to form a long-term stable consulting tie. So in the following experiments, we set N to 7.

II. Experimental Results

A. Structure of Simulation Experiments

Each employee's initial working load is determined accordingly to random generator of gamma distribution. Employees' asking for help may be observed on the relative grid. In each round, each employee choose others depending on his/her experience to form a group. The general structure of the simulation can be sketched as follows.

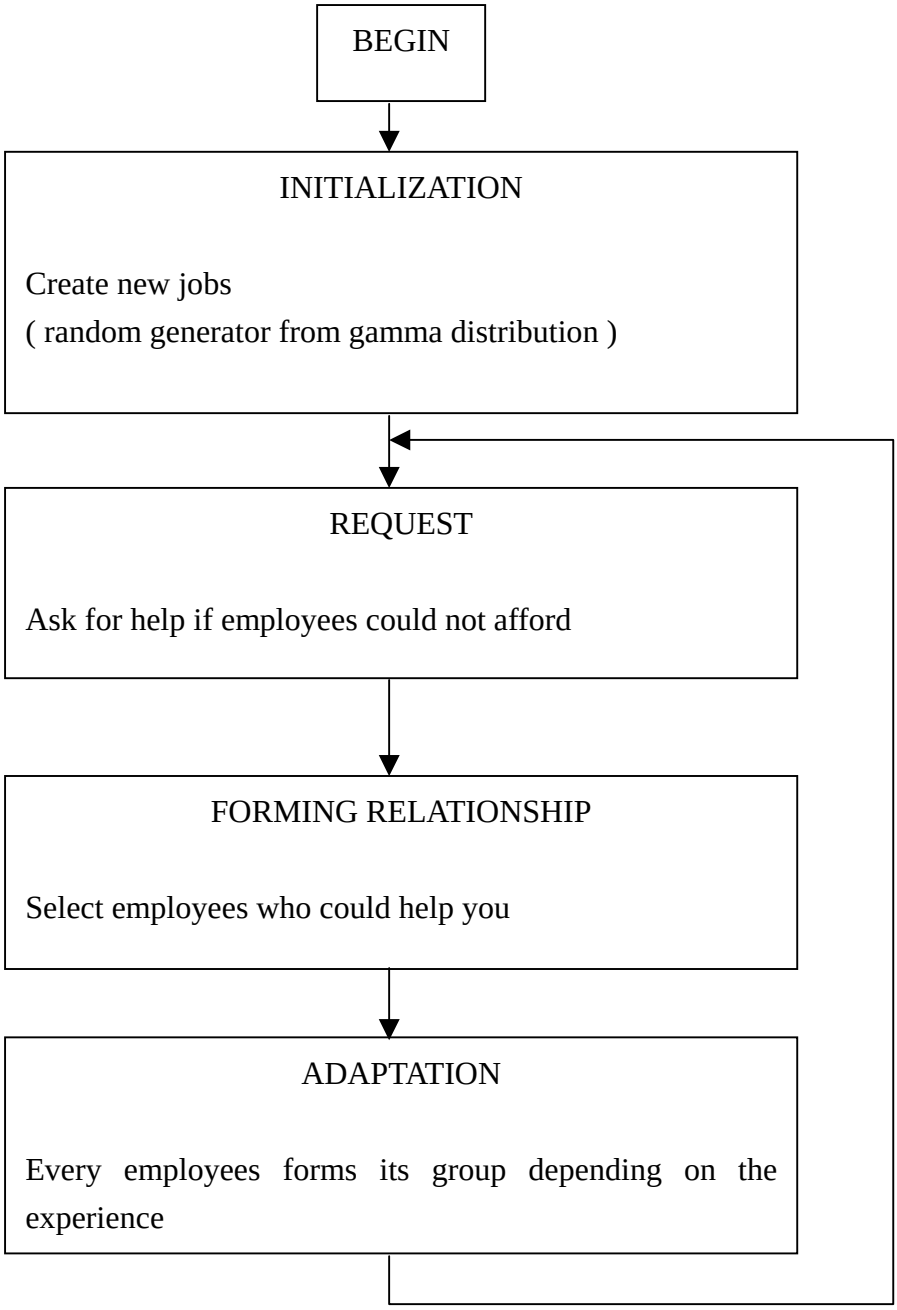

Figure 1. General structure of the simulation

B. Simulation Experimental Results

After 100 rounds of simulation in each experiment, we get the output matrix to show the consulting relations among the 20 employees. In each experiment, we change α and λ to examine the change of consulting network. Different experiments show variant working load and distribution of jobs. We first use UCINET to compute the density of consulting tie network for all experiments. The results are diagrammed as

the following figure:

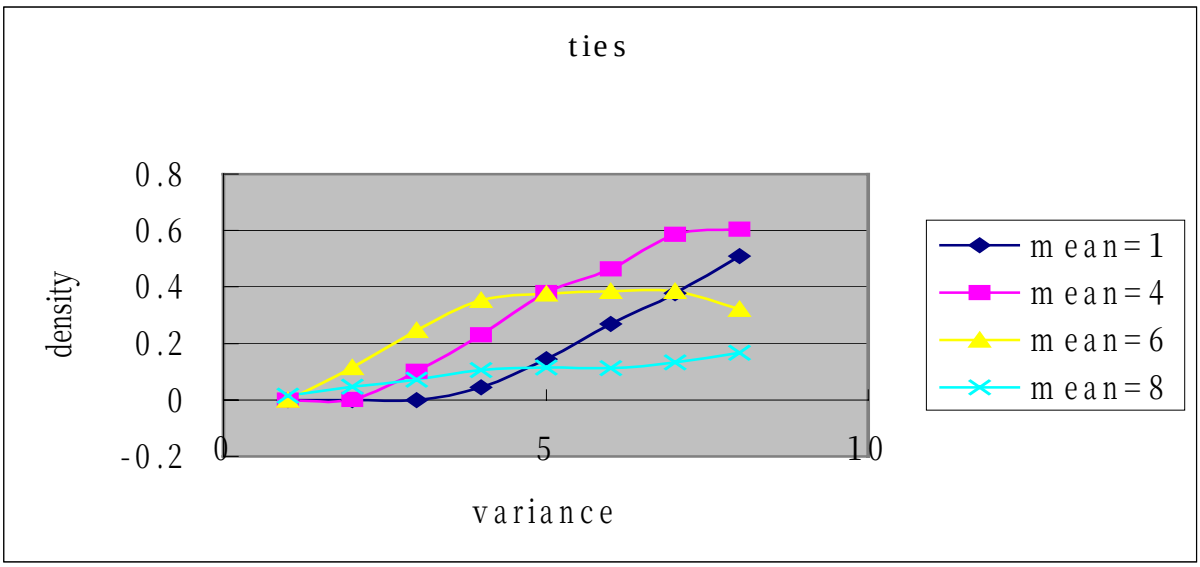

Figure 2. The Diagram of Density of Consulting Ties

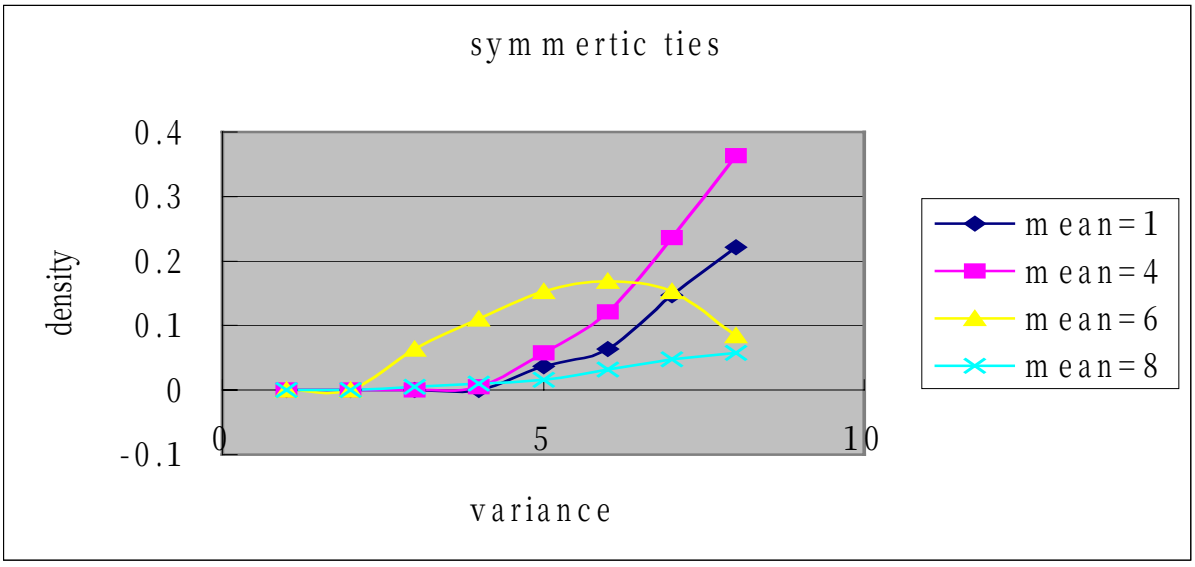

Figure 3. The Diagram of Density of Symmetrical Consulting Ties

We then write a program to make consulting ties symmetrical. In other words, only those ties in which both sides choose the other as partner are left. Figure 3 is the diagram of density of symmetrical consulting ties. Finally, UCINET is utilized again to compute 2-core of symmetrical consulting networks. In addition, we also use Kp3 to delineate the social diagrams of these consulting ties, so that we can directly identify cliques out in the networks. In other words, there are at least two connections for each group member in a clique, and either no connection or only one “bridge” can

be found between two cliques.

As shown in figure 3, density of symmetrical network is very low when α and λ both are low. When job distribution parameter λ gets higher, density gets higher, too. When α is high (that means α is near 8) and λ gets higher, density starts to decline. Very interestingly, density becomes stable and low when working load is extremely high (that means α is 8). Furthermore, we also find that cliques form when density turns to be median high, i.e. a little above or below 10%. But when it gets higher, the originally disconnected cliques start to connect together, and form a single large group in a department.

III. Some Evidences from Organizational Data

A. Choosing Research Sites

There were three research sites used in this study, each one has a different cultural and organizational structure. They are one famous multinational corporate in Taiwan, one city government in Taiwan, and one of the public administrative units for river management in Mainland China. In brief, I will call them the MNC Taiwan, the Taiwan City Government and the Mainland China River Administration separately, since I have been asked to keep their real name secret.

The Multinational Corporate (MNC) is famous with its organizational culture, which once was taken as one of typical models "in searches of excellence" (Peters and Waterman 1982). Its branch in Taiwan inherits mother company's good tradition, includes walking-around management, teamwork spirit, flexibility, inventiveness, and mutual trust. In general, the employees always keep busy as described by the slogan "high pressure with high pay", but working load can be fairly distributed to everyone by the formation of temporary teams in a flexible organizational structure. The two departments under our investigation are for customer consultation (Customer Service Dept.) and after-sale maintenance (PSC). Each person’s jobs arrive at a random pace. However, the structure of the organization is a type of matrix form, which turns extra important jobs to be projects assigned to temporarily organized team. Therefore, non-routine work may be properly adjusted according to workers’ conditions in such a

flexible structure. The MNC Taiwan is a good example of the experiment setting with high work loading and median-high fluctuate job distribution.

The Mainland China River Administration is a bureaucracy, an extreme contrast example to the MNC Taiwan. Its employees generally stay in this organization for more than 20 years, since their jobs are whole-life guaranteed by the Central Government in alleged “iron bowl” policy. Even more, the employees' children may inherit their parent's position to be hired by the unit. Printing shop is the department to print newspapers and journals of the organization. These job contents keep unchanged over last 30 years. Just like most of Mainland Chinese state-owned enterprises, problems of inefficiency and superfluous staffs exist also in the Mainland China River Administration. The Mainland China River Administration demonstrates low work-loading environment with pretty stable job flow.

The Taiwan City Government is also a typical bureaucratic form of organization. Its boundaries between departments are rather clear. The labor bureau is a department doing job-match for its citizens. Most employees in the labor bureau are white-collar clerks responsible for collecting information of job and job seeker. In general, routine job is stable. But in addition to this routine work, computerization of the organization and required improvement of public service make them busy recently. Service requests from the publics are fairly fluctuate, and the requirement of instant response makes their job flow a little unstable. In comparison with the Mainland China’s bureaucratic public unit, the Taiwan City Government shows much higher working load. However, it should not be so competitive as a world-famous high-tech company. Its job flow is also somewhat not very stable, probably equal to or less than the degree of uncertainty of the MNC Taiwan.

B. Data Collection

Several different departments from these sites were chosen in which to distribute our questionnaire. Intensive interviews and field observations were conducted at each research site before these departments were chosen. Data related to the employee’s daily lives, working interactions, job characteristics, office climate and a department’s management styles were collected in these interviews and field studies. Two pilot surveys were employed at the MNC Taiwan and the Taiwan City Government in order

to modify the questionnaire. Finally, 64 questionnaires were distributed to two departments at the MNC Taiwan, from which 58 were collected back. 52 questionnaires were given out in the labor bureau of the Taiwan City Government with a 100% respondent rate. 22 questionnaires were returned from one department of the Mainland China River Administration—that is the Printing Shop.

The questionnaire was designed in matrix form, such as those surveys that collect whole network data (Burt 1984[4]). The nine questions were listed in the first column and the names of departmental employees were listed in the first row. Each respondent was asked to make a “yes or no” among his colleagues for these nine questions.

We adopted a typology that showed two types of social networks related to -offering helps in a job, i.e. asking for help and job consultation. Consulting ties are important for transferring experience, improving efficiency, creating cooperation, and smoothing business processes in the work place (Baker 1994[1]). “Know-how” obtained from colleague consultations is generally the cornerstone to do a good job (Granovetter 1992b[20]). An individual with a high density of consultative relationships is a key person for solving work problems (Krackhardt and Hanson 1993[26]). A work team will always encounter bottlenecks if it does not have proper consultative relationship (Krackhardt and Hanson 1993[26]). Research about consultative relationships can help us to understand how to create a no-barrier environment for diffusing knowledge within an organization.

There are two questions to be asked that will enable drawing a picture of the two types of relationship networks: 1. “When you encounter difficulty in your job, from whom do you ask for help?” This measures consultative relationship in which more or less trust needs to be involved (i.e. the asking-for-help tie). 2. “With whom do you like to consult in your routine work?” This indicates consultative relationships built on routine working partnership (i.e. the job-consultation tie).

Dimensions of network	Questions being surveyed	Denotation
Consulting network	When you encounter difficulty in your job, from whom you ask for help?	The asking-for-help tie

	Whom you like to consult with in your routine job?	The job-consultation tie

Table 1: The questions about social network in the questionnaire

We first picked out those who answered “yes” for more than 80% of the persons in their department (i.e. he/she trusts almost everyone), and making this invalid data. Then, an “insider” was asked to help us check validity of the survey in his department. Three departments in The MNC Taiwan had too many missing and invalid values, and therefore the whole network data from the departments became useless. Finally, 6 questionnaires were invalid, 4 from the four MNC departments and 2 from the Mainland China River Administration. The four MNC departments are the Customer Service Department, the 1st Support Department, the 2nd Support Department and the PC Service Center, with 25, 8, 6 and 15 employees respectively. Only those departments with more than 10 employees were analyzed, since small departments generally have very dense networks. Two departments in the MNC Taiwan were therefore not included in the following study.

C. Density Analysis

After viewing the result of density analysis of asymmetrical consulting networks, there is clear evidence showing that the MNC Taiwan, with a matrix form of organization, is significantly different from the Taiwan City Government and the Mainland China River Administration, that have a bureaucratic form. In the MNC Taiwan's Service Department, an average of 26% to 40% of the colleagues were reported to be helpful by each individual. On the other hand, both the Taiwan City Government had a figure about 13%. Printing Shop in the Mainland China River Administration was especially low, i.e. 4%.

In addition to having more helpful persons, the MNC Taiwan also had a high density of job-consultation relations. The density of job-consultation networks in the two MNC Taiwan departments was high—from 28% to 32%. Like their asking-for-help network, both the Taiwan City Government and the Mainland China River Administration employees did not have dense consultation relations--in general,

lower than 10%. Ironically, the average length of employee tenure at the latter two organizations was much longer than in the MNC Taiwan—i.e. at least more than 10 years compared to one or two years. It seems that long-term social interactions don't guarantee a dense consultation network and more helps.

	Asking-for-help Network	Job-Consultation Network	Observation
The MNC Taiwan			
Service Dept.	0.26	0.28	25
PC Service Center	0.40	0.32	15
The Taiwan City Government			
Labor Bureau	0.13	0.08	52
The Mainland China River Administration			
Printing Shop	0.04	0.03	22

Table 2: Density of Networks Analyzed for MNC Taiwan, the Taiwan City Government and the Mainland China River Administration

D. Clique Analysis

Since the density of networks of the Mainland China River Administration is very low, as predicted by the simulation with low α and λ, it basically is unable to form any clique. So only the data of the MNC and City Government in Taiwan is analyzed. We first make the network data symmetrical --that is only those arcs in which both sides recognize the existence of consulting relations are left, and those arcs with single-direction arrows are erased. Then the software Krackplot3 is utilized to diagram the symmetrical networks of the two organizations.

Figure 4 is the picture of asking-for-help network of the Customer Service Dept. in the MNC Taiwan. The density of symmetric ties is pretty high, so all employees basically form a large group. According to the definition 2-core, one large clique and one triad can be found, and the two cliques have a bridge between G7 and H9. There are also some isolated pair and individuals, in addition to four persons with only one tie connecting to the large clique. This picture is pretty similar to the network diagram of simulation with high working load (α is equal to 6) and median-high unstable job-flow (λ is about 5 to 6).

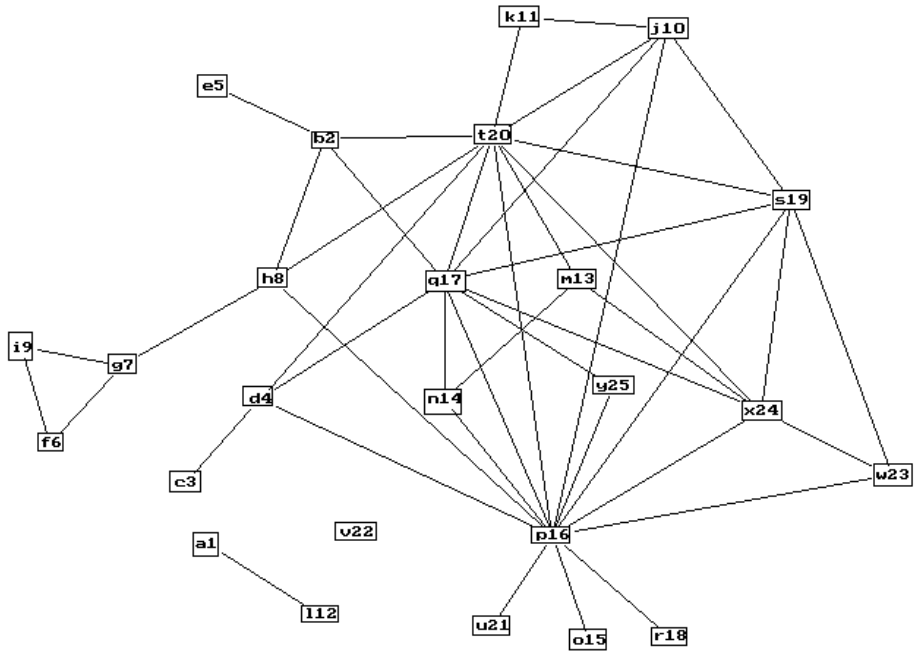

Figure 4: The Asking-for-help Network of the Customer Service in the MNC Taiwan

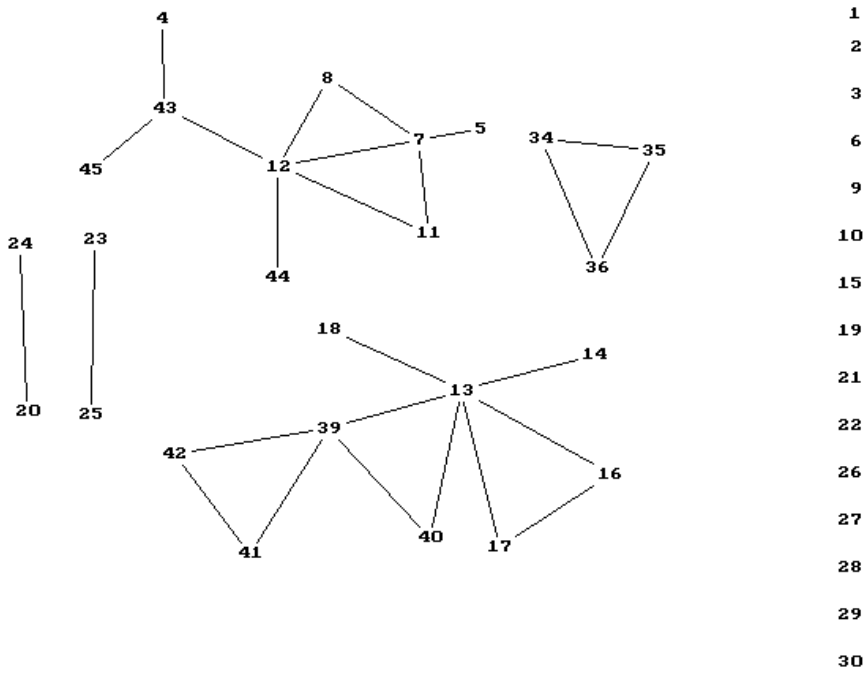

Figure 5: The Asking-for-help Network of the Taiwan City Government

Figure 5 is the picture of symmetrical asking-for-help network of the Taiwan City Government. We can find 5 disconnected components in this picture, among which three are cliques by the definition of 2-core. Clique formation in this relational network is pretty clear. As stated above, the working load of the Taiwan City Government should be high, but not higher than that of the MNC Taiwan. In addition, its job flow is somewhat unstable, but its job contents should be taken as routine work, if comparing to the MNC Taiwan. In our simulation results, the experiments with α equal to 3 or 4 and λ equal to 4 or 5 will get network diagrams of this sort.