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Social Network Analysis as an Organizational Diagnostic Tool: The Case of Small Business in Russia

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ABSTRACT

The science of social networks is at the intersection of computer science, communication studies, mathematics and sociology. The first area is already "invested" by communications networks, hardware and software, and has attracted many users. Communication science studies the network not only as a computer network, but also as a network of discourse. Contributions of mathematics are the theory of graphs and various related calculations. "Weak" in this triad is a sociological interpretation of quantitative ratios network. The purpose of this work is defining the concept of social network analysis (SNA) as an organizational diagnostic "tool" and its implementation is using a quantitative analysis method. The article considers the following questions: The definition of the diagnostic process in relation to social networking organization; the possibility of social networking quantitative analysis; the illustration of how to use the theory of social capital as a sociological basis for the social networks diagnostics in the small business and the calculations of illustrative indicators and real networks in the case of a small business organization in Russia. Data processing was carried out with the use of UciNet. As a result, the classes (diagnosis) of organizational social networks are offered, and opportunities, along with their limits of the application of quantitative indicators making up the method of SNA to diagnose the network of organizations with a variety of responses, are presented.

Keywords: Social Network Analysis, Organizational Diagnostic Tools, Measurement of Social Capital, Management Sociology
JEL Classifications: D85, M12, M14

1. INTRODUCTION

The science of social networks is at the intersection of computer science, communication studies, mathematics and sociology. The first area is already "invested" communications networks, hardware and software, and has attracted many users. Communication Science studies the network not only as a computer network, but also as a network of discourse (e.g. Wallemacq, 1998; Bowonder and Sharma, 2003; Downing and Mujic, 2011; Pavenkov et al., 2015). "Contributions" of mathematics — the theory of graphs and various related calculations — is seen to have a "weak link," recognized as a sociological interpretation of quantitative ratios network.

The purpose of this work is centered on defining the concept of "social network analysis (SNA) as an organizational diagnostic tool," with the implementation of a quantitative analysis method. The article considers the following queries: The definition of the diagnostic process in relation to social networking organization; the possibility of social networking quantitative analysis; the illustration of how to use the theory of social capital as a sociological basis for the social networks diagnostics; and the calculations of illustrative indicators and real networks.

The modern Greek word for "diagnostics" infers the capability of recognizing (Slovar' Inostrannyh Slov, 1949. p. 205). Perhaps it has its roots in ancient Greek; it is a relatively new word in the Russian language. It cannot be found in the domestic XVIII century dictionary of the Institute of Linguistic Studies, RAS. For the first time, it is included in the dictionary N. Yanovsky, year 1803-1806 (Yanovskij, 1803). More often, talk relating to the diagnosis applied medicine, technology and, most recently,

the organization. There are many definitions, some of which are discussed herein. Thus, medical diagnosis is "determining the nature of the disease on the basis of observable symptoms and medical history of the patient" (Bellman, 1968. p. 15). Technical diagnostics involve the recognition of the state of the technical system, which includes a wide range of issues pertaining to the receipt and evaluation of diagnostic information (Birger, 1978. p. 3). Finally, within organizational diagnosis, which is defined as a complex case study, the aim is centered on measuring the current state of the object and vision of the situation (Nekrasov, 2009. p. 48). These definitions differ not only in the subject area, but also in meaning.

We adhere to the following understanding of the diagnosis. The system is described by complex indicators:

$$K = (k_1, k_2, \ldots, k_j \ldots, k_v) \quad \text{(a)}$$

Feature space is divided into regions diagnosis (classes) (b); it is a known possible state of the system.

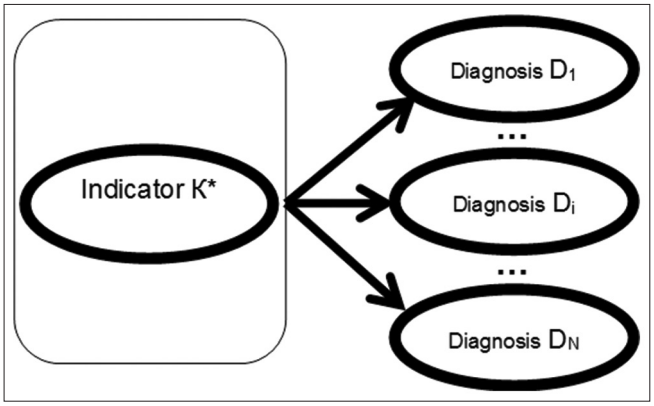
$$D_j \ (j = 1, \ldots, N) \quad \text{(b)}$$

The diagnostic task can be reduced to classifying the diagnosed object, which is characterized by the implementation of complex indicators (a), with a certain possible states of the system (Figure 1).

Within the diagnosis of the social network, we realize its assignment to one of the possible grades (diagnoses). It can be assumed that the diagnosis (network classes, their reference structures) depends on the purpose, destination and other characteristics of the organization. If network diagnostics is to be diagnosed as follows, we need to relate the list of indicators and parameters of the network, as well as its possible states (multiple diagnoses).

A variety of network characteristics is proposed in the method of SNA. In implementing its software (e.g., UciNet), parameters characterizing the network as a whole (density, coefficient of clusternode, indicators of hierarchy, etc.), its component sub-group (clique, N-clique, N-clan, etc.), as well as separate nodes (different variants of centrality, mediation, ego-networks, structural holes, etc.), are calculated.

Figure 1: Toward the definition of diagnostics



The main problem in the practical use of SNA is identified in the choice of indicators needing to solve a specific problem, as well as in their sociological, organizational and managerial interpretation.

The term "social capital" was used first in 1916, at which time state inspector of rural schools, Hanifan, introduced the term inferring to a habit to come together for cooperative action, social contacts and personal satisfaction (Hanifan, 1916. p. 130). Jacobs (1961) examined the concept of "social capital" in relation to local government. Management will be successful if it is based on the indivisible community of people who support good neighborly relations (Jacobs, 1961. p. 138). In 1976, Loury used the term "social capital" in justifying the importance of taking into account the social component in the economic theory of human capital (Loury, 1977. p. 176). However, such studies did not provide the analysis of social capital in terms of class (the diagnosis), social networking and quantitative indicators.

Later, there were more than two-dozen definitions of social capital. In one of the publications one table consolidated 23 definitions, divided into "external," "internal" and "mixed" (Adler and Kwon, 2002. p. 20). 10 of the definitions were found to use the keyword "network," whilst eight used "relation," six used "resource," four used "social structure" and three used "collective" ("co-operative"). Interestingly, irrespective of a rather popular belief, social networks are not necessarily included in the concept of social capital. A set of quantitative indicators to measure the network component of social capital depends on whether we consider the individual or group of actors, as well as what type of connection (internal or external). From this point of view, there are four cases:

- "Individual actors—internal communications": Corresponds to the "human capital" of an individual
- "Individual actors—external communications": Social capital is seen as a private good. It is measured using indicators of individual nodes
- "Collective actors—internal communication": Social capital understood as a public good. Measured using indicators that characterize the network as a whole
- "Collective actors—external communications": Mixed social capital of the group. An example of this case is the team with the set internal structures when team members are external links. In particular, it is measured using indicators of a group of central and bimodal networks (Borgatti et al., 1998).

Most of these features are standard options in the appropriate software packages. In the last three cases, we have a group of network indicators that allow us to quantify social capital corresponding to the internal network of one organization, group of organizations, as well as their mixed version. These estimates are of interest, for example, for comparative theoretical research or to the task of designing the organization with the required level of social capital.

In turn, we aim at drawing from theoretical constructs information pertaining to the classes of networks and associated characteristics. Therefore, we consider the models discussed in the subsequent paragraphs.

1.1. Weisbord 6-Box Model

Communication within the organization is in the separate block. It takes into account the relationship of subordination and informality between the different parts of the organization, as well as between humans and the technologies adopted. It is recommended that the quality of actual relations be diagnosed with regard to their required level, which is necessary in order to do a good job. There are two possible dysfunctions: Staff need to work together, but this is not apparent to the necessary extent; there is no need of close employee co-cooperation, but it is forced under the pretext that "it must be so." In the block "relationship," the existing conflicts and the organization's efforts to resolve them are also revealed. Besides this, relationships are taken into account in the formal structure of the organization, which should be consistent with the objectives and "relationship-oriented" management style (Weisbord, 1976. p. 430-447).

1.2. Nadler–Tushman Congruent Model

The organization is seen as a system that implements the "transformative process." It uses the different structures, processes and methods, etc., which are formally established to allow individuals to carry out the tasks. They are complemented by forming structures, in which the behavior of the leader, intercompany relationships, informal interaction in the labor process – especially communication and mutual influence – are completely shown. It is assumed that the needs, requirements, goals, objectives and/or structure of informal organization should be agreed and seen to contribute to three other blocks of the model (consistent individual, formal organization and its objectives). In fact, this is the analysis of the organization, without its diagnostics, chosen in this article (Nadler and Tushman, 1982. p. 35-48).

The model discussed above (and various others not included in the text), are used in the so-called "general" diagnosis organizations; however, the selected level of generalization and emphasis are such that do not allow specification of the classes (diagnoses) of networks.

Information about the types of internal informal networks of organizations was accumulated in the everyday practice of companies. Informal networks help organizations to recognize opportunities or challenges and coordinate appropriate responses. Configuration of informal networks can be very different and depending on the strategic objectives and the nature of work within a given organization. They are customized response networks, modular response networks and routine response networks. The first of these types of networks contributes to new and creative challenges. It is characterized by a high density of external and internal communications, as well as the absence of explicit clusters. The second type of network consists of several modules connected together. The module components (employees) are experts for each sub-group area. They can join to find a solution to the client tasks. Finally, the third type of organization's network structure resembles the conveyor of employees aimed to perform the specified functions for client requests. The three types of networks are classes (diagnoses) that will be found in our research.

Our research question is the following:
How can we offer the version of diagnostics intra-social network to include the determining of network type, corresponding to the goals of the organization?

2. METHODS

2.1. Research Design

Internal organizational social networking diagnostics include the definition of the type of network, its compliance with to the nature of work and goals of the organization. The topological features of networks allow for the identification of quantitative indicators and to use the SNA method.

This study involves the use of the following methods and procedures:

- Creating graph models that reflect the characteristics of social networks of organizations with customizable, modular and standard responses. This procedure is necessary to select the parameters SNA, allowing to allocate the required classes networks
- Analysis of the SNA case of one firm in St. Petersburg
- Data processing with the use of UciNet 6 for Windows. We reveal some features and give an interpretation of the SNA indicators in relation to the case.

2.2. Limits of Study

The result`s application is limited to the case of small or medium companies.

2.3. Ethical Considerations

Taking ethical considerations into account, we used an informed consent form to the participants. All participants were initially contacted, asked to participate in the study and informed about the purpose and aims of the research. Participant consent to participate was gained. They were assured of the anonymity of their responses through the use of pseudonyms to report the results, and were guaranteed of the confidentiality of collected data. This study was conducted in line with the Professional Ethical Code of Sociologists by the Russian Society of Sociologists.

3. RESULTS

Model graphs are drawn up in such a way as to reflect the characteristics of networks of organizations with customizable, modular and standard responses. In the first case, focus is directed to the high density and high connectivity; the second, on modularity; the third, to the presence of several components (Figures 2-4). Selecting procedures SNA involves the use of standard options, such as components, bicomponents, subgroups (factions, cliques, etc.) and others. Preliminary calculations showed that the indicators of SNA subgroups allows us to identify some of the common types of networks. In more complex cases, the quantitative calculation of the sub-groups should be complemented by other factors (e.g., central) and sociological analysis of the organizational network. That can be done in the exploratory research.

Let us now turn to the case study company and compare it with that obtained by SNA. We changed the name of the company to EAST. EAST is an independent studio dedicated to the creation of designs of vinyl stickers for decoration as one of the largest Russian retailers. EAST provides buyers with the opportunity to "convert the standard models of furniture to your unique taste." All designs are the author's works "of talented artists, designers and photographers."

In regard to "infancy," in the spring of 2013, a social network project team consisted of three members: The author's ideas and the informal leader of the group (node It, Figure 5) (*It*), his friend (*At*), coordinating work with suppliers, manufacturers and logistics services and designer, (*Pt*) with experience in the furniture mall. It was involved in the project a group of artists, designers (X_1... X_7) and selected technical performers, responsible for programming and support (*iT*), work with typography (*Pe*), the supply of materials (*Me*) and service delivery (*De*). Figure 5 peaks corresponding to the project team, represented as circles, artists as squares, technical performers as triangles. On the stage of the project is formed a social network that is more reminiscent of a modular type, whereas a subnet within the project team is customizable. Horizontal communication occurs between managers and founders (the project team) and is absent amongst workers and performers.

In view of the possible changes in the range of furniture products, the founders expected the creation of Internet stores and attracting new professionals, both in the modules and in the project team. The "electronic" store sought to implement closer cooperation artists to "the emergence of new cooperation and new ideas." Sharpen, during the 2014 economic crisis, made significant adjustments to the expansion plan; however, by the summer of 2014, the project formed a social network, as shown in Figure 6. As can be seen, it has become more customized. This "drift" is associated with

Figure 2: An illustrative graph of the network organization with a customizable response

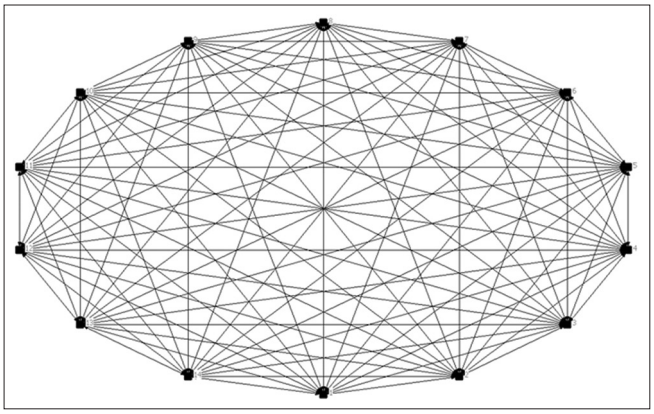


Figure 3: An illustrative graph of the network organization with a modular response

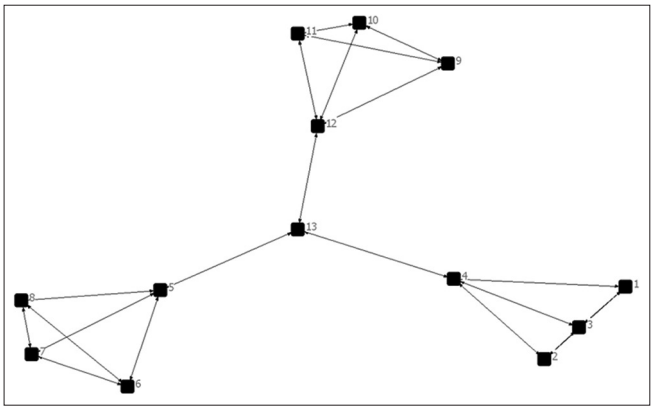


Figure 4: An illustrative graph of the network organization with a typical response

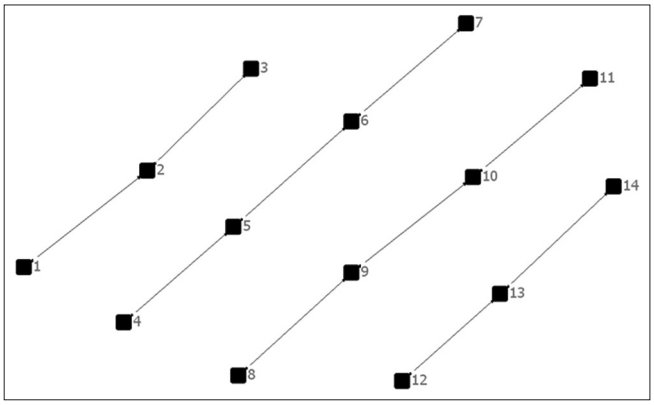


Figure 5: The structure of the social network of the company EAST at the initial stage of its development

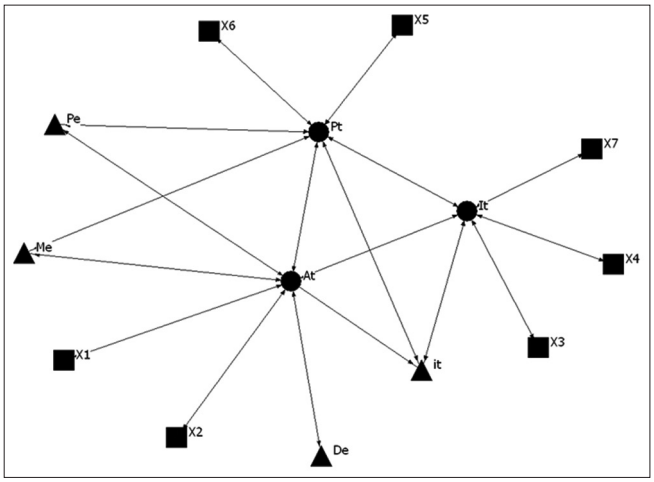
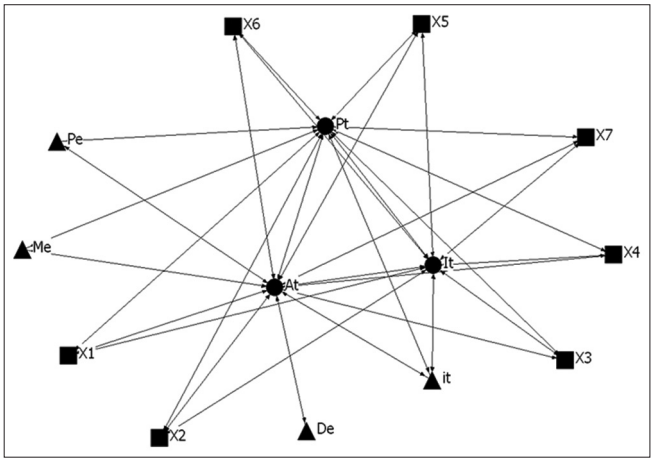


Figure 6: The structure of the social network of the company at the stage of growth



a significant creative component in the nature of employees of the company, along with its products. In addition, increasing the number of links and artists with the project team can be interpreted as an indirect expression of the growth of the degree of unity between the two values. The practice brought about changes in the network transformation, "forcing" the management to maintain a modular structure. The latter circumstance is due to the fear of the members of the project team in concern of when the full "web" of relations organization will lose control.

The values of several indicators SNA and brief comments to them for the company EAST on the stages of its formation and growth are presented in the summary in Appendix Table 1.

4. DISCUSSION AND CONCLUSION

Our paper continues a series of studies of the Department of Sociology of St. Petersburg State University (Derjugin, 2001; Rasskazov, 2012; 2013; Rasskazov and Dalal, 2014; Rubtsova 2007; 2011; Volchkova and Menshikova, 2014; Malinina et al., 2015; Martianova et al., 2015; Pavenkov et al., 2015; Rubtsova et al., 2015; Tarando et al., 2015; Vasilieva et al., 2015, etc.). In current paper, the classes (diagnosis) of the organizational social networks are offered, with the presentation of the opportunities and their limits of the application of quantitative indicators making up the method of SNA in order to diagnose the network of organizations with a variety of responses.

Detailed results are presented in the Appendix Table 1 and in the following comments:

1. The density of connections is increased during the transition from the formation stage through to the growth stage
2. The members of the project team have the maximum values of centrality by a large margin from the rest
3. Increased centralization of the network reflects the increase in the number of relationships between employees and members of the project team
4. The members of the project team have the maximum values of centrality, whereas the value of the rest is zero; that is, the members of the team hold a unique position in the relations between other employees
5. Reduction of index of network centrality means that the development of the company leads to the growth of duplicate links
6. The variants of centrality indicator, based on degrees of vertices (degree), proximity to other nodes (closeness) and the intermediate position between them (betweenness), confirmed the central position of the members of the project team
7. When the average centrality value (in the sense of degree and closeness) increases, this means that the number of connections increases, with participants closer to each other. For this reason, the indicator "betweenness" is decreased
8. The value of the compactness (connectivity, based on the distance) varies from 0 to 1; the large value indicates a greater connectivity. Network connectivity (in the sense of closeness in distance) increases
9. Points of connection on the formation stage are the project team members that are governing modules. At the growth stage, "At" became a key member
10. The groups in the formation stage include the three members of the project team. There is a proper distribution of their employees, but controversial-Pe, Me, it. At the growth stage, groups are difficult to interpret through such a procedure
11. The splitting on clique at both stages of company development is difficult to interpret. We can assume the central role of the members of the project team
12. At the formation stage, the participants' partition on 2-cliques (2-clans) indicates a possible central role of the project team, whilst splitting the other members of cliques and clans is controversial. In the growth stage, we have one 2-cliques (2-clan), which is explained according to the growth of network connectivity
13. Identifying the core and the periphery shows that the density of the periphery increases.

Omitting the details, the following can be argued:

- As the company has increased in density and connectivity (the comments [1], [5], [7] and [8]), this indicates the displacement of the structure connections to the corporate network with customizable response
- Various parameters (comments [2], [4], [6], [9] and [10]) indicate the central position in the project team members network, both in terms of the number of directly related peaks, and on the winning team position on routes between other nodes. The procedure of "core/periphery" (comment [13]) shared the network core consisting of the project team, and the periphery formed by the rest of the company
- Different procedures, split into subgroups, provide disjoint results. The correctly allocated articulation point (members of the project team, the comment [9]) and with the observations—groups in their infancy (comment [10]), the greatest difference in the number of units and their composition are (10, 12) to the growth phase, which can be interpreted as the formation of a network organization with customizable response.

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Appendix Table 1: The calculation results of the indicators SNA (see comments in "discussion and conclusion")

Indicator	Formation stage	Growth stage
The density of connections (1)	0.19	0.35
Normalized central nodes (on the basis of the degree of vertices) (2)	*At*=61.5, *Pt*=53.8, *It*=46.1; *it*=23.1; *Me*=*Pe*=15.4, *De*=7.7; $X_1 \ldots X_8$=7.7	*At*=100.0, *Pt*=92.3, *It*=76.9; *it*=23.1; *Me*=*Pe*=15.4, *De*=7.7; $X_1 \ldots X_8$=23.1
Network centrality (based on the degrees of the vertices) (3)	48.7%	75.6%
The normalized centrality (by taking into account the provisions of the node on the shortest paths between other vertices) (4)	*At*=48.7, *Pt*=38.5, *It*=43.6; 0 – to other nodes	*At*=39.5, *Pt*=24.1, *It*=12.0; 0 – to other nodes
Index of network centrality (based on consideration of a node on the shortest path between other nodes) (5)	42.4%	36.7%

Normalized centrality measures of individual vertices (6)

		Degree	Closeness	Betweenness
1	*At*	61.538	72.222	49.359
2	*It*	46.154	65.000	42.308
3	*Pt*	53.846	68.421	36.538
4	*De*	7.692	43.333	0.000
5	*Me*	15.385	48.148	0.000
6	*Pe*	15.385	48.148	0.000
7	*it*	23.077	56.522	0.000
8	X_1	7.692	43.333	0.000
9	X_2	7.692	43.333	0.000
10	X_3	7.692	40.625	0.000
11	X_4	7.692	40.62	0.000
12	X_5	7.692	41.935	0.000
13	X_6	7.692	41.935	0.000
14	X_7	7.692	40.625	0.000

		Degree	Closeness	Betweenness
1	*At*	100.00	100.00	39.530
2	*It*	76.923	81.250	11.966
3	*Pt*	92.308	92.857	24.145
4	*De*	7.692	52.000	0.000
5	*Me*	15.385	54.167	0.000
6	*Pe*	15.385	54.167	0.000
7	*it*	23.077	56.522	0.000
8	X_1	23.077	56.522	0.000
9	X_2	23.077	56.522	0.000
10	X_3	23.077	56.522	0.000
11	X_4	23.077	56.522	0.000
12	X_5	23.077	56.522	0.000
13	X_6	23.077	56.522	0.000
14	X_7	23.077	56.522	0.000

Normalized centrality measures (7)

Degree	19.780
Closeness	49.586
Betweenness	9.158

Degree	35.165
Closeness	63.330
Betweenness	5.403

Compactness (8)	0.544
Bicomponents (9)	*At, It, Pt*
Groupings (if there are three blocks) (10)	1 block: *Pt Pe it* X_5 X_6 2 block: *It* X_3 X_4 X_7 3 block: *At De Me* X_1 X_2

	1	2	3
1	0.40	0.10	0.12
2	0.10	0.50	0.05
3	0.16	0.05	0.40

Compactness (8)	0.676
Bicomponents (9)	*At*
Groupings (if there are three blocks) (10)	1 block: *Me Pe it* 2 block: *At It Pt* X_2 X_4 X_5 X_6 3 block: *De* X_1 X_3

	1	2	3
1	0.00	0.29	0.00
2	0.29	0.64	0.29
3	0.00	0.29	0.00

Cliques (the number of participants at least three) (11)	1: *At It Pt it;* 2: *At Pt Me;* 3: *At Pt Pe*	1: *At It Pt it;* 2: At It Pt X1; 3: *At It Pt* X_2; 4: *At It Pt* X_3; 5: *At It Pt* X_4; 6: *At It Pt* X_5; 7: *At It Pt* X_6; 8: *At It Pt* X_7; 9: *At Pt Me*; 10: *At Pt Pe;*
2-cliques, 2-clans (the minimum number of participants is two) (12)	1: *At It Pt De Me Pe it* X_1 X_2; 2: *At It Pt Me Pe it* X_5 X_6; 3: *At It Pt it* X_3 X_4 X_7	1: *At It Pt De Me Pe it* X_1 X_2 X_3 X_4 X_5 X_6 X_7
Core/periphery class memberships (13)	1 (core): *At It Pt*; 2 (periphery): *De Me Pe it* X_1 X_2 X_3 X_4 X_5 X_6 X_7 The density matrix	1 (core): *At It Pt*; 2 (periphery): *De Me Pe it* X_1 X_2 X_3 X_4 X_5 X_6 X_7 The density matrix

	1	2
1	1.000	0.455
2	0.424	0.000

	1	2
1	1.000	0.879
2	0.879	0.000

SNA: Social network analysis