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Differences among Social Network Structures in the Private Sector, Politics and NGOs in Croatia

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Abstract **– The paper describes and interprets differences among social network structures in the private sector, politics (local administration) and non-governmental organisations (NGO) in Croatia. Social network analysis (SNA) methodology was used to examine networks in three sectors, which were found to differ in terms of centrality measures and substructures. In the private sector network, centrality values of network members were related to their respective positions in the organisational hierarchy. In the politics network, centrality measures values of members were influenced both by hierarchy and by the number of same-party members. In the NGO network, all members had high centrality values. Substructure sizes were low in the private sector and high in the NGO sector; in the politics network, they were dependent on the number of same-party members.**

Keywords **– network, social network analysis, SNA, politicians, NGO, private sector**

1. Introduction

The term *social network* has become familiar in most people's lives, mainly in the context of web networks such as Facebook, Twitter and Instagram. However, the term need not necessarily relate to an ICT context, as members of families, organisations, classes and so on also form social networks. The methodology used to analyse such social networks is known as social network analysis (SNA). The main elements of a social network are nodes and connections (or ties) [1]. In [2], social networks are categorised as local or global. The main criteria for this division are the number of members (i.e. people or nodes) in the given network. The same author proposes the application of SNA to a network of news keywords from a Croatian portal, as well as to a network of news items in which the nodes are not people. There are many examples of the application of SNA in various contexts in which the term *social network* may represent more than a network of people. In [3], for instance, SNA was applied to the prioritisation of research projects; the results informed strategic planning and decision making in funding research on rare diseases. Other examples of SNA can be found in the areas of scientific and bibliographic production (publication) [4],[5],[6],[7],[8],[9], investigating co-authorship networks and identifying the main areas and topics of interest in certain journals or conferences. Based on an analysis of keywords, some of those papers explored dynamics and trends in conference and journal topics by year. SNA has also been applied to the determination of criteria weights in multicriteria decision making [10], [11].

Focusing on people networks, the present paper explores three social networks: a company project collaboration from the private sector, a collaboration among politicians (city council members) during decision-making about local government issues, and a collaboration among members of an NGO. The similarities in number of members and collaborative structure made it possible to compare these networks.

The rest of the paper is structured as follows. Section 2 briefly outlines SNA methodology. In section 3, the three networks are described, both, verbally and in graphical form. Section 4 presents the results of SNA for all three networks. In section 5, the main differences among the social networks and their structures are discussed and interpreted. Finally, section 6 includes conclusions and proposals for future work.

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2. Methodology: Social Network Analysis

Social network analysis is a complex methodology involving the following steps (adapted from [1]):

1. Research goal definition
2. Research plan creation
    a. Research scope definition
    b. Research form and content definition
    c. Research level and methods definition
3. Data collection
4. Social network(s) analysis
5. Conclusions and discussion.

The goals of the present research are as follows:

- to present and analyse three social networks from three distinct areas (private sector, politics and non-governmental sector);
- to discuss the differences between social network structures; and
- to interpret those differences.

Research scope definition specifies the members of the network to be included in the analysis. In the present case, the research plan specified that the analysis should include all members of the private company in question who participated in the project collaboration, all the politicians who participated in the local government unit's decision making (members of the city council) and all those who participated in the NGO's project activities.

The relationships between network members may be informed by sociability, superiority, competition, conflict, cooperation or solidarity. The content of those relationships can be based on communication, economics, sentiment, family or transactions, among others. Levels of analysis may include egocentric networks (observing one member and its relationships), dyadic networks (analysis of pairs in the network), triadic networks (analysis of triplets in the network) and complete network analysis [1]. In the present case, the form of all three networks was cooperative; the content was communication-related, and the level of analysis was the complete network.

The method involved the calculation of centrality measures and the investigation of substructures, as defined in [1], [12], where

- g is the number of nodes in the network.
- L is the number of lines (ties, connections) in the network.
- The density of the network is the ratio of number of lines in the graph to the maximum possible number Δ. This is calculated by the formula

$$\Delta = \frac{2L}{g(g-1)}.$$

- Geodesic distance, $d(N_i, N_j)$, denotes the number of lines in the geodesic linking actors i and j.
- Average geodesic distance is the arithmetic mean of all geodesic distances between each two nodes.
- Actor degree centrality (nodal degree or degree of a node) is the number of lines incident (or number of nodes adjacent to) an actor in the unweighted graph. This is calculated by the formula

$$C_D(N_i) = \sum_{j=1}^{N} x_{ij}, (i \neq j),$$

where variable x_{ij} relates to the cell in the matrix of incidence.

- Actor closeness centrality measures how close an actor is to other actors in the network. This relates to geodesic distances (shortest path between two nodes) in the unweighted graph and is calculated by the formula

$$C_C(N_i) = \frac{1}{\sum_{j=1}^{N} d(N_i, N_j)} (i \neq j),$$

- Actor betweenness centrality refers to how a certain actor controls communication between other actors in the network; it is calculated by the following formula:

$$C_B(N_i) = \sum_{j<k} \frac{g_{jk}(N_i)}{g_{jk}},$$

where g_{jk} denotes the number of geodesic paths between j and k, and $g_{jk}(N_i)$ denotes the number of geodesic paths between j and k that include node N_i.

- Cliques are a maximal complete subgraph of three or more nodes, all of which are connected to each other; n-cliques is a maximal subgraph in which the largest geodesic distance between any two nodes is no greater than n. Additionally, there are n-clans, n-clubs, k- cores and k-plexes.
- A cutpoint is a node in the graph that causes the number of components to be higher when it is deleted.
- A bridge is a line in which the graph containing the line has fewer components than the subgraph obtained after the line is removed.

- Clusters and blockmodels are substructures incorporating nodes that have something in common (e.g. structural equivalence) or that result from a mapping.

SNA also includes many other methods that can be applied in light of the basic characteristics of the network (e.g. directed or undirected, weighted (valued) or unweighted) and the goals of the research. In the present case, the analysis of networks was completed with the assistance of Pajek software [13].

The third step in SNA is data collection, which can involve four main methods: interview, questionnaire, observation and archive analysis. For present purposes, as one of the authors had an opportunity to participate in the networks and to observe all collaborations and information flows, the main methods of data collection were observation and interview. An appropriate data collection form was prepared for each of the three case studies, with fields to input connections between network members, notes, dates and other information. The process of data collection lasted about a month for each network. One limitation of this research relates to the possibility that the inputted data may not be correct in every case because of the specifics of collection strategies and collaboration intensities. The results of the analysis of all networks following data collection will be described below.

3. Three case studies

The first social network relates to a private TV and Internet media company in Croatia. The network represents collaboration on a project initiated by a higher education institution (HEI), which proposed the collaboration. The proposal required the company to promote HEI studies through video commercials as part of one its daily TV shows. Benefits for the company included: (1) an opportunity to demonstrate corporate social responsibility; (2) selection of a young scholar to be awarded a full scholarship for HEI undergraduate study (sponsored by the HEI) and (3) increasing viewership and quality of TV programming. The TV company had to make a tactical decision about whether or not to accept the proposal. Before making that decision, the company had to undertake a deeper analysis of costs and benefits, involving 13 employees from several departments: marketing (actors 1, 2 and 3); accounting (actors 12 and 5); legal administration (actor 13); public relations (actors 10 and 11); TV programme and Internet portal managers (actors 4 and 6); and IT (actors 7, 8 and 9). A further participant (actor 14) was a coordinator from the HEI. Cooperation, collaboration and information flow between employees are presented in Figure 1. as relationships (connections, ties) in a social network.

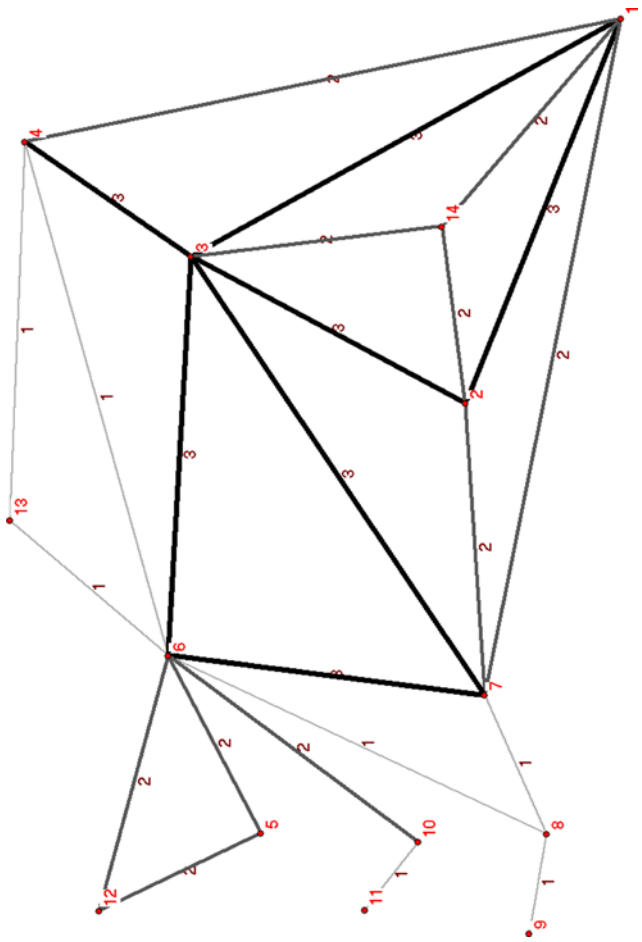

Figure 1. Social network: private company

The second social network relates to collaboration among city council members during meetings at a number of local government units in Croatia. City councils are the holders of legislative power for local administration. In this case, there were 15 city council members, who were also members of political parties. The city council majority comprised eight members (actors $Lx, x \in \{1,2,3,4,5,6,7,8\}$), and the remaining seven members were the opposition (actors $Dx, x \in \{1,2,3,4,5,6,7\}$). All meeting documents were prepared by four city administration employees ($GU1, GU2, GU3, GU4$) before each meeting, and each city council member can propose a topic. The political environment in Croatia is such that members of opposing parties do not collaborate during preparation of meeting documents, as can be seen in Figure 2.

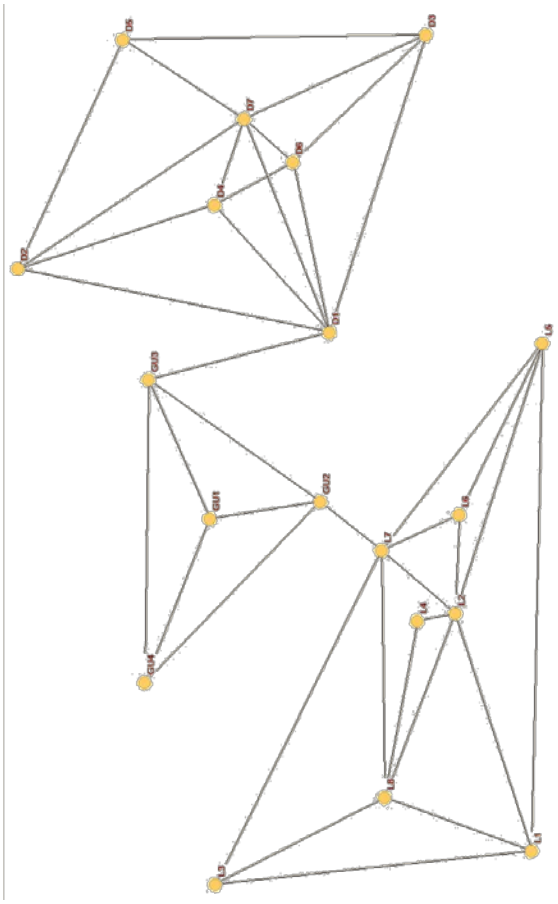

Figure 2. Social network: LGU

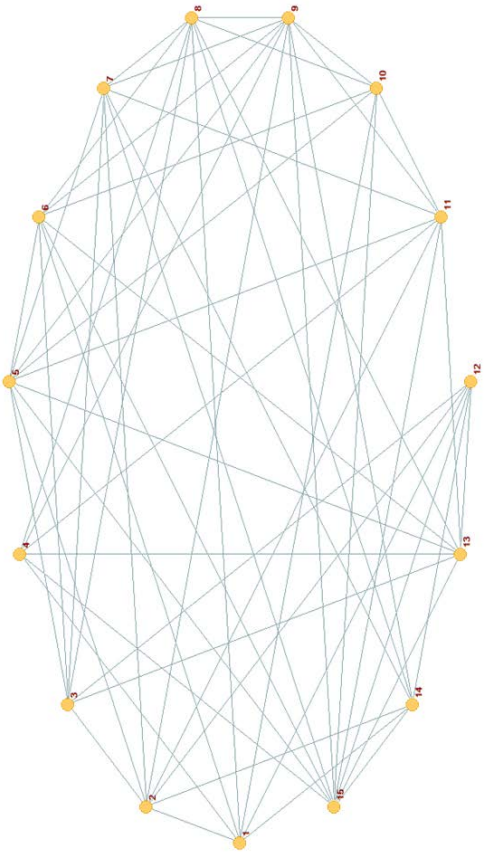

Figure 3. Social network: NGO

The third social network relates to collaboration and information exchange during implementation of an NGO project in a small village in Croatia. The network comprised 15 actors. Co-funded by the EU, the project sought to establish social activities in the village and lasted for three months. Actors in the network were the main organisers of project activities. None of the actors was employed by the NGO, and all activities were voluntary, motivated by a desire to enhance the quality of life in the village, especially for children and young people.

4. Results

The results of the SNA are presented in Tables 1., 2. and 3.

Table 1. Analysis of TV company network

Network size g	14 actors
Number of connections L	24 lines
Network type	Weighted undirected
Density of network Δ	0.26
Average geodesic distance	2.11
Centrality degree	Highest: actor 3 Lowest: actors 11 and 9 Average degree: 3.42
Closeness centrality	Highest: actors 3, 6 and 7 Lowest: actors 11 and 9
Betweenness centrality	Highest: actors 3 and 6 Lowest: actors 5, 9, 11, 12, 13, 14
Cliques, *n*-cliques	Clique of size 4: 1-2-3-14 (actor 14 is from HEI) Two cliques of size 3: (1-2-3) and (3-6-7) 2-clique of size 5: 1-2-3-6-7
Cutpoints and bridges	Significant cutpoint: Actor 6 No significant bridge
Clusters and blockmodels	Two blockmodels: 4-7-9-11-12-14 and 1-2-3-5-6-8-10-13

The first network consists of 14 nodes and 24 lines. It is a weighted undirected network, with three weights describing the intensity of communication between actors. The density of the network is low, and average geodesic distance is also low, indicating that collaboration in the network is very well planned. Actors 3, 6 and 7 all have high centrality values; these actors have to create a cost-benefit study, and actor 6 will make the final decision. The three make a strong clique of size 3. A second strong clique is 1-2-3, which is the team responsible for collaboration with the HEI representative (actor 14). The 2-clique 1-2-3-6-7 includes members who do

most of the work; the significant cutpoint is actor 6 because if he leaves, the decision will not be made. Actors 8 and 10 are also cutpoints, but if they do not come to work, their job will be taken over by actors 9 and 11 (and new lines will appear in the network). A similar interpretation applies to bridges 10-6 and 8-6. Different options for clustering and blockmodelling resulted in various subsets of actors, as shown in Table 1. The first group includes mostly marginal members of the network; the second group are the most important for decision making.

Table 2. Analysis of politicians' network (LGU)

Network size g	19 actors
Number of connections L	41 lines
Network type	Unweighted undirected
Density of network Δ	0.23
Average geodesic distance	7.5
Centrality degree	Highest: L2; L7 and D1 Lowest: L4, L3 and D5 Average degree: 4.3
Closeness centrality	Highest: GU2 and GU3 (0.43) Lowest: L3, D5
Betweenness centrality	Highest: GU2, GU3, L7 and D1 Lowest: L3 and D5
Cliques, n**-cliques**	One clique of size 4: GU1-GU2-GU3-GU4 Two clans: actors with label "D" and actors with label "L"
Cutpoints and bridges	Cutpoints: D1, L7, GU2 and GU3 Bridges: D1-GU3 and GU2-L7
Clusters and blockmodels	Clusters that fit clique and two clans

The network consists of 19 actors: 4 are representatives of city administration, 8 are members of the majority (governing), and 7 are members of the minority (opposition). D1 is president of the minority political party; L7 is president of the majority political party, and L2 is president of the city council. The density of the network is low, mainly because of the lack of communication between members of the majority and members of the minority. It follows that the city council is deeply divided into two parts, and this is confirmed by the high average geodesic distance. Geodesic distances between members of the three groups (majority, minority, city administration) are low, but in terms of the overall network, distances between majority and minority members are very high. The maximum centrality degree values relate to the most active minority and majority members (president of the city council, leaders of minority and majority political parties). The lowest centrality degree values relate to the most inactive minority and majority members. In many cases, they show a lack of interest in collaborating or of the knowledge needed to communicate; their main involvement is simply to support whatever is said by members of their own party. In regard to betweenness and closeness centrality, members of the city administration (together with the presidents of minority and majority political parties) achieve high values. Members of the city administration also form a clique of size 4. They work together to prepare documents for city council meetings and must ensure that all documents are prepared in keeping with existing laws. Members of the two political parties form two clans. Although there are four cutpoints, GU2 and GU3 will not in reality be cutpoints because other members of the city administration will take their place and re-establish a connection between the two political parties. On the other hand, D1 and L7 are cutpoints; when one of them retreats, the network is broken into two components. At one city council meeting, D1 became angry, and all the minority members left the meeting.

Table 3. Analysis of NGO network

Network size g	15 actors
Number of connections L	60 lines
Network type	Unweighted undirected
Density of network, Δ	0.57
Average geodesic distance	1.3
Centrality degree	Average degree: 8 All actors have high centrality degrees.
Closeness centrality	All actors have high values.
Betweenness centrality	All actors have low values.
Cliques, n**-cliques**	Several cliques of sizes 3 and 4, but the whole network is one 2-clique.
Cutpoints and bridges	No cutpoints and no bridges
Clusters and blockmodels	Network as a cluster

Fifteen members of NGO collaborated on the project. They are strongly connected, with 60 connections. The network density is very high (0.57) and geodesic distance is very low (1.3). This is a characteristic of the network, highlighting communication between all members. All members have high values of both centrality degree and closeness centrality and low values of betweenness centrality. This means that all members can access all

other members very quickly; they are familiar with ongoing events and happenings, and none of them has a privileged position in the network with a strong impact on others. In other words, they function as a team. The leader of the project (actor 15) encourages democratic decision making and motivates all members to participate in the project. This explains the cutpoints or bridges in the network. However, project meetings are time-consuming and exhausting.

5. Parallel analysis and discussion

Table 4. provides a parallel presentation of SNA results for the three social networks.

- The networks are similar in number of actors.
- The number of connections differs among the networks; the number is lowest in the private company and highest in the NGO. This is to be expected, given the organisational structures and the personal characteristics of the members. While those in charge of the private company have specific knowledge about their professional area, NGO members often lack the requisite knowledge to perform their roles in the project. As they need help, they collaborate with others. In contrast, if a private company employee asked for help too often, he would probably be fired. This illustrates the differing organisational climates in the two types of organisation. In the NGO, the working atmosphere is more relaxed, with less pressure and stress and fewer deadlines.
- In the political network, the number of connections is average (when compared to the other two networks), but the structure reveals some problems in terms of density and average geodesic distance. The low density and very high average geodesic distance indicate that actors are strongly connected in subnetworks but very weakly connected at the global level.
- Average centrality degrees are highest in the NGO and the lowest in the private company.
- In the private company and the political network, there are actors with low and high closeness centrality; in the NGO network, however, all members exhibit high closeness centrality values. In the private company and the political network, there are actors with low and high closeness centrality values, but all members of the NGO network have low

Table 4. Parallel analysis of three social networks

	Private company	**Political network**	**NGO**
Network size, g	14 actors	19 actors	15 actors
Number of connections, L	24 lines	41 lines	60 lines
Network type	Weighted undirected network	Unweighted and undirected network	Unweighted and undirected network
Density of network, Δ	0.26	0.23	0.57
Average geodesic distance	2.11	7.5	1.3
Centrality degree	Highest: actor 3 Lowest: actors 11 and 9 Average degree: 3.42	Highest: L2; L7 and D1 Lowest: L4, L3 and D5 Average degree: 4.3	All actors have high centrality degrees Average degree: 8
Closeness centrality	Highest: actors 3, 6 and 7 Lowest: actors 11 and 9	Highest: GU2 and GU3 (0.43) Lowest: L3, D5	All actors have high values.
Betweenness centrality	Highest: actors 3 and 6 Lowest: actors 5, 9, 11, 12, 13, 14	Highest: GU2, GU3, L7 and D1 Lowest: L3 and D5	All actors have low values.
Cliques, n**-cliques**	Clique of size 4: 1-2-3-14 (actor 14 is from HEI) Two cliques of size 3: (1-2-3) and (3-6-7) 2-clique of size 5: 1-2-3-6-7	One clique sized 4: GU1-GU2-GU3-GU4 2 clans: actors with label "D" (7 members) and actors with label "L" (8 members)	There are several cliques of sizes 3 and 4, but the whole network is one 2-clique (15 members)
Cutpoints and bridges	Significant cutpoint: Actor 6 No significant bridge	Cutpoints: D1, L7, GU2 and GU3 Bridges: D1-GU3 and GU2-L7	No cutpoints and no bridges
Clusters and blockmodels	2 blockmodels: 4-7-9-11-12-14 and 1-2-3-5-6-8-10-13	Clusters that fit clique and 2 clans	Network as a cluster

closeness centrality values. This means that NGO members are highly (and equally) connected to each other. In the private company, project responsibilities are different. In the political network, responsibilities are equal, but the politicians refuse to cooperate.

- While the NGO acts as one big clique, the political network includes three substructures, one clique and two big clans. In the private company, there are two cliques of size 3, with no time and money for unnecessary collaboration. Cliques with a larger number of members may indicate to the employer that too many people are working on the same assignments. In the political network and the NGO, members are not limited by time when they attend meetings.
- Actors with high betweenness centrality are also cutpoints.

6. Conclusion

This paper described three social networks from organisations of different types: a private company, a non-governmental organisation and a political network (city council). All three were similar in terms of number of members and type of network (project collaboration). In all three cases, project complexity was similar (tactical level).

Differences in the three social network structures become apparent in the differing network measures, centrality measures and substructures. In conclusion, we can identify two main reasons for those differences: (1) general motivation or reason for establishing the network and (2) characteristics of network members.

In the private company, the main motivation for a network's existence is profit. At the same time, employees must be professional and committed to the company. The company therefore employs highly professional people who know their job, and this directly influences the network's number of connections, density and clique size (all of which are low). Nevertheless, employees are strongly connected.

In the NGO, the main motivation for a network's existence is the project's benefits for the community. However, the NGO members are not professionals in their roles, and the network's number of connections, density and clique size is high.

Finally, in the political network, the main motivation for the network is the project's benefits for the community. However, it is often the case that members of city council are not professionals, and they are often more committed to their political party than to the local government unit.

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