Heliyon

Analysis of organizational power networks through a holistic approach using consensus strategies

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Abstract

Power is one of the most complex organizational attributes to understand due to the multiple related variables and dimensions in which it appears. The ownership and use and of power are reflected in the interpersonal relationships within an organization, as a result, modeling its structure and interactions can lead to knowledge about the power networks that shape it. The objective of this study was to identify the behavior of organizational networks based on existing sources of power, using a consensual analysis of the different topologies present in these networks. The study was carried out in a private production company in Ecuador, which has representation at a domestic level. To this end, a 12-question personalized questionnaire was designed with the aim of identifying specific networks and was applied to 1190 workers in the company. The results were obtained using organizational network analysis and a consensus strategy to integrate the centralities found in multiple networks into one. This study can serve as a reference to organizations, so they can know the relationships between

people within it, as part of their management process. In this way, the identification of people within power networks is useful for knowing the "key" actors in the promotion of organizational changes, as well as for the development of career plans based on the position that people occupy in the organizational system.

1. Introduction

Power can be defined in multiple ways, depending on specific epistemological and philosophical frameworks. Dahl (1957) defined power as the process in which: A has power over B in the sense that he/she can get B to do something which B would otherwise not do. This definition, which is useful in demonstrating the power of this organizational attribute on interpersonal relationships, shows only one of the possible dimensions of power. Lukes (2007) recognized three dimensions of power, identified by Gaventa (2006) as visible, hidden and invisible, depending on their form of action in the organization.

People within organizations use power to achieve their goals, as the ultimate way to resolve their conflicts and impose their self interests (Lukes, 2007). Since power is associated with certain roles in organizations, its understanding is useful for any of the agents, since it allows the understanding of the interpersonal relationships which constitute it, among other areas (Mariño-Arévalo, 2014).

1.1. Power

Power is a complex element, because it implies a quality of the relationships. Enz (1989) stated that power can be demonstrated when it refers to actions that have already occurred, or potential, when it refers to existing capacities that can lead to this power being manifested (Enz, 1989). Other authors mention a distinction between power when it cames to a potentiality and influence when the power is manifested (Meliá et al., 1993). One of the main references in relation to power is Weber, who relates it to legitimacy, a concept in itself that forces us to question what would be legitimate for someone in the context of the relationships established (Kelly, 2007). In this sense, there are concepts that are necessarily related with power which are trust and knowledge (Bordum, 2004; Meyer and Ward, 2009), which are also expressed within the organizational context.

According to Kelly (2007), the way in which power is exercised in an organization, especially if this exercise of power is legitimized in some way by the organization itself, can increase the levels of confidence. In this system, knowledge is a way to legitimize power (Kelly, 2007), although there may be others such as rationality, tradition or charisma (Guzzini, 2015). Bordum (2004) also explained the

relationship between power and trust through the influence of knowledge, as proposed by Luhman, who has shown the need to identify whether this trust is rational or irrational. In this way, knowledge could help to rationalize or not the levels of trust gained, which would at the same time contribute to increase or decrease the existing levels of power (Bordum, 2004).

For Baporikar (2008), power is a form of relationship between individuals or groups of individuals that allows understanding differences between them, generating important changes in these context of analysis, knowing the ways in which organizations operate and how decisions are made. It is defined as the way in which a person or group can get another person or group to do something that they would not do otherwise (Baporikar, 2008; Guzzini, 2015). Although power has been used as a synonym of control, influence or authority, Baporikar (2008) shares Weber's concept where power is expressed as a potential for people to act in a certain way.

1.2. Sources of power in organizations

Sources that give a person the ability to influence and change the behavior of others are known as bases or sources of power which are nothing more than concrete formulas adopted to influence a social relationship (Ansari and Kapoor, 1987). There is no consensus as to what the sources of power within an organization are. For Mintzberg et al. (1997) these can be: (1) the control of a resource, (2) of a technical skill, (3) of a body of knowledge, (4) of legal prerogatives, (5) access to those agents that enjoy one of the other sources. With Morgan (1996) there are 14 sources of power and which includes the control of informal groups and sex.

For French and Raven (1959) and Raven (1993), there are six bases of power: (1) legitimate power derived from the official position of a person in an organization, (2) coercive power given by the ability of a person to instill fear in another individual, (3) power derived from providing rewards, that is opposite to coercive power because it derives from the ability to grant rewards for obeying the boss's wishes, (4) the power of someone considered an expert, derived from the perception or belief of the subordinate that the expert possesses a remarkable ability or knowledge and expertise in certain areas, (5) reference power that is based on the identification of an individual with a leader who is held in high esteem, which is admired and frequently imitated by his/her subordinates, and (6) informational power based on the belief that an agent is more informed than a subordinate or individual, where the information may be explicit or implied (French and Raven, 1959; Raven, 1993). These sources of power are related to types of power in organizations.

1.3. Types of power in organizations

Sources of power are related to those elements of the organization from which the power comes, which in turn can be developed (Pfeffer, 1992). On the other hand, types of power refer to the behaviors that people of the organization use to gain power (Patterson et al., 2018), so they can be derived from the use of power sources previously mentioned. For Peiró and Meliá (2003) power is, ultimately, bifactorial: formal or informal. In the first case, it is given by the structure, that is, by the position of power in a legitimized way in an organization; in the second case, it is given by relationships, which they also call personal power (Peiró and Meliá, 2003).

1.3.1. Formal power

According to Patterson et al. (2018), coercive power is a form of formal power that can be manifested in behaviors related to resistance or humiliation techniques. Another form of formal power is linked to structural power, given by the position the person occupies in the hierarchy or the formal structure of the organization, which refers to a legitimate power (Meliá et al., 1993; Patterson et al., 2018). Meliá et al. (1993) also mentioned reward and coercive power as a form of formal power. However, Patterson et al. (2018) said that people can also have formal power legitimized from their relationships within the network in which they are located.

1.3.2. Informal power

Informal power is closely related to informal structure (Barchiesi et al., 2008; Cross et al., 2002), however, it can also be linked to formal structure (Patterson et al., 2018). This is due to the relationships that people establish from the position they occupy within the formal structure of the organization. In this case, power given by the information is a form of informal power within a formal structure (Patterson et al., 2018). Other informal powers are expert power and referent power (Meliá et al., 1993; Patterson et al., 2018). Both forms of formal and informal power can be analyzed considering relationships between people within organizations, through studies of networks, which can be called formal or informal networks depending on the type of power considered.

1.4. Social network analysis to study power relationships

The analysis of power in organizations has been widely studied and defined over the years (e.g., Ansari and Kapoor, 1987; Baporikar, 2008; French and Raven, 2014; Hanscome, 2000; Hershey, 1979; Madero and Rivera, 2012; Moskvina, 2016; Pfeffer, 1992; Tworoger and Preziosi, 2005). In order to identify and model the structure and scope of some of the forms of power in an organization, one can analyze the networks that comprise it. To be more specific, Social Network Analysis

(SNA) is a technique of quantitative research for social networks, based on the pillars of graph theory, which allows the attainment of a technical-methodological approximation to explore the relationships and interdependent actions among the different members of a social system. SNA can be used to investigate the structure of organizations, as well as to describe formal and informal relationships among individuals in the organization (Grassi et al., 2010). As a technique, SNA employs the use of actor-network representations to understand social phenomena. Compared to other analytical techniques, SNA has a marked relational character and focuses on understanding the interactions between the actors of a network, as well as the structure of the network itself. SNA treats interactions between elements in terms of network theory, which are generated from nodes and links to indicate their connectivity and structure through the use of mathematical and computational models (Blanchet and James, 2012; Jusdado, 2014). It is, therefore, a field that mixes sociology and mathematics, in which there are actors or entities that interact, and actions are represented on a graph.

Several authors referred the concept of "healthy organizations" when considering the role of the SNA to diagnose organizational relationships, considering how formal and informal networks are structured (Allee, 2008; Cross et al., 2002; NMAC LINC, 2018). By doing this, researchers can evaluate the performance of the organizations and the effectiveness of the implementation of changes at the operational or strategic level (Cross et al., 2002).

1.5. Organizational network analysis as a type of SNA methods

Among SNA's methods, Organizational Network Analysis (ONA) is extensively applied because it is a methodology that deals with issues of interest in the field of analysis and organizational behavior. According to Anklam et al. (2005), ONA has become the standard used for the study of networks in organizations, making more specific the use of SNA. It allows us to analyze organizational aspects, as well as to identify the skills and shortcomings of the different work teams and to visualize in a more precise manner the influence and interconnectivity. Results obtained from ONA can be applied, for example, to redesign the structure of work groups, processes and workflows and to identify groups of individuals that have arisen due to the performance of their functions (Jusdado, 2014). In addition, adopting a network vision can lead to a deeper understanding of the differences in the results of a company. Currently, ONA has become a popular methodology for a wide variety of applications, but one of the main challenges facing researchers is to try to generate measurable and reproducible networks with practical and positive results in the organization (Hunter and Wolf, 2015; Moskvina, 2016; Omondiagbe et al., 2017; Reynolds et al., 2014).

1.6. Network analysis indexes

Network analysis also allows for the incorporation of attributes to relationships and actors that compose it, which extend analytical possibilities. Each organization has people, nodes, that serve links that are critical for the exchange of ideas and information. In this way, the actors are not simply connected nodes, but have properties or characteristics.

Depending on the objective of network studies, different authors have made their proposals of indexes that allow them to measure the characteristics of the relations between nodes. Barchiesi et al. (2008) proposed the *informality degree of organizations* index to assess the level of the informality of a network within an organization. This index includes the measurement of the physical distance, the psychological distance and the perceived frequency of interaction between the agents of a network (Barchiesi et al., 2008). Authors such as Brass (1984) also defined the importance of a person in a network considering their distances with the rest of the network members, creating the *access measure index*. Additionally, Brass (1984) also proposed the *critical index*, which considers alternative routes to direct access between nodes, which can be used to measure distances.

One of the most important and significant properties is centrality or number of connections (degree-based), which are individual indicators (Brass, 1984; Omondiagbe et al., 2017; Pasqualino et al., 2013). This also provides information on the importance of actors within the network. It allows for the measuring of an actor's "power" in the network (for example, by the number of contacts that he/she has in the network) and also implies control over the acquisition of resources by others, it therefore, presents several indicators that determine the degree of prestige or power an actor has in the network. In turn, centrality has several measurements such as *degree centrality, closeness centrality, eigenvector centrality* and *betweeness centrality,* which is well defined for analysis, depending on characteristics within the network (Grassi et al., 2010; Wasserman and Faust, 1994).

However, the solutions given to the network analysis generally allow us to understand the behaviors of people within the network but do not offer a solution that combines all the described indices. From the management area, these solutions that use a strategy derived from a certain degree of agreement between all the parties are known as consensus strategies (González-Benito et al., 2012; Homburg et al., 1999; Teuber, 1973). The consensus is a type of decision-making process and is defined as that basis that several elements have in common that do not necessarily benefit everyone equally, but functions as the least common denominator among all (Hassani, 2016). Based on this logic, the use of *consensus* methods does not imply the selection of several options for the solution of a problem but is based

on the existence of a single decision that is acknowledged as the best one for the whole group (Butler, 1991; Chong and Benli, 2005).

In response to this background, the present study aimed to identify the behavior of organizational networks from existing sources of power, using a consensus analysis of the different topologies present in these networks.

2. Methodology

The study was carried out in a large private construction company in Ecuador that employs more than 1000 employees working as part of the system of production, using a mixed, qualitative and quantitative approach.

First, intentional sampling was used for data collection. Using the qualitiave method, this sampling allows the selection of people or groups of people according to their characteristics and the contributions they can make to the attainment of information related to the investigation (Coyne, 1997). Following this logic, five interviews were conducted with authorities in charge from the four national headquarters, located in Quito, Guayaquil, Cuenca and Lasso. The actors interviewed were selected taking cognizance of their knowledge regarding relationships in the company and the forms of conflict resolution commonly applied.

A masked questionnaire, authorized by the company's upper management, was used for the interviews in order to obtain exploratory information to understand the main sources of power used in the company and the factors related to their use. These initial interviews with senior executives of the company was aimed to obtain the predominant sources of power perceived by influential workers. The questions addressed everyday work issues and it was the researchers who, through the coding and categorization described, identified the preliminary categories.

Subsequently, a questionnaire was applied through personal interviews with a random sample of workers, from a total population of 1190 workers: 90.3% men and 9.7% women. The characteristics of the sample are presented in Table 1.

2.1. Procedure

The investigation had the support of the organization in providing the availability of people's time to participate in the interviews, as well as the authorization given to the investigators to enter the facilities and with respect to the organization of the work. The research team was composed of organization culture specialists and business management consultants.

Information was collected through individual interviews and direct observation. The interviews aimed to identify the perception associated with power and to understand

Table 1. Description of the sample of participating workers.

Sociodemographic characteristics		Numer of participants
Sex	Male	1074
	Female	116
Province	Quito	290
	Guayaquil	316
	Cuenca	6
	Lasso	598
Location	Office	147
	Production plant	1043
Work Area	Presidency/General Management	3
	Production	672
	Supply chain	190
	Maintenance	163
	Human Resources	59
	Finance/Auditing	48
	Marketing/Commercial/Sustainability	55

and characterize company power networks. Direct observation allowed the identification of visible elements of organization members' behavior and of the structure thereof. To be specific, those who make decisions (formal or informal authority), in certain areas (technical, technological, use of time, use of resources, problem-solving, peer support, etc.) and how problems are resolved (by agreement or imposition). In the case that decisions are imposed, it was necessary to know how they were imposed (through hierarchical authority, the use of strong voice tones, appealing to friendship, to gender relationship, etc.). Although question and observation guides were developed for the interviews, information related to other aspects that came up was also collected.

Information collected from interviews and direct observations was submitted to a content analysis through categorization from more specific aspects to more general ones. This type of information processing is used within a qualitative approach focused on language characteristics and the use of explicit and/or implicit concepts (Hsieh and Shannon, 2005).

2.2. Data analysis

A preliminary analysis of word frequency in employee responses was made using the information collected from the first five interviews (first sample group). NVIVO10 (Castleberry, 2014) was used to calculate the frequency and to graph correlated categories and subcategories. The content of the interviews with the workers helped to understand what is happening in the organizationa and to identify the power dimension. As an example of formal power, there were affirmations during the interviews such as "we follow the established line of command" (Interviewee 1, 2017), or that a certain plant "is a fiefdom, because there is too much concentration

of power in the managements of the plant" (Interviewee 3, 2017), and that "the operators skip the lines of command" (Interviewee 2, 2017).

Other example related to informal power, linking experience with knowledge, is the affirmation that " workers take their lesson, putting them to the test" (Interviewee 1, 2017). Other type of informal power was regarding relationships, which appeared in affirmations such as "each area and each plant resembles its leader" (Interviewee 5, 2017), and that the "resistance to change generates suspicion of fraud" (Interviewee 4, 2017). The categories obtained, from the codes found in the qualitative information of the interviews, were summarized in six sources of power, measured through 12 questions that were used in the survey applied to all of the company employees described in the Sample on Table 1. These questions were validated in terms of content with a group of experts of the organization, considering its comprehension (Twycross and Shields, 2005). According to this, there were no changes to the original questions.

Once the questions were applied, the results were processed in order to identify the power networks corresponding to each question and the consensus of the networks. For this purpose, the 12 directed networks derived from each question were analyzed. In each network "j" several centrality indexes were calculated for each node "i", specifically: *in-degree (D_i^j), clustering coefficient (CC_i^j)* and *neighborhood connectivity (NC_i^j)*. The consensus strategy used to combine the different scores obtained in each independent network and to obtain a standardized ranking. We will explain the procedure, for simplicity, only with in-degree (D_i^j) but the same strategy apply for other centrality indexes. In this way:

1) The D_i^j index was standardized between 0 and 1 in each of the networks (DN_i^j). It is important because the network topology could change in each type of questions and therefore the centrality (i.e. node degree) could also change accordingly. However, by normalizing, we will be measuring the centrality according to the node with maximal connectivity. This normalization process leads us to a rank based scale of nodes between 0 to and 1. The use of rankings had also been considered by Adalat et al. (2018) and this normalizacion strategy had also been used in comparing different ranking lists like in López-Cortés et al. (2018) and Tejera et al. (2017).

2) The final consensus index (D_i) was calculated as: $D_i = \frac{1}{N}\sum_j^N DN\cdot_i^j$ where N is the total number of networks. This concensus is basically the average normalized ranking. With this consensus strategy, it is possible to integrate the centralities of the same individual that were obtained in several networks.

This formula is basically the average of the standardized indexes in all the networks. The standardization is needed for actual comparison. The standard (dD_i) deviation was also calculated, in which high dD_i values indicate that the individual centrality

fluctuates across the networks while lower dD_i values imply that the individual remains with a more less constant centrality (low or high) in all the networks.

A factorial analysis applying Varimax as a rotation method was also carried out using the obtained DN_i^j values. The Cytoscape program (Shannon et al., 2003) was used to visualize or obtain graphs from networks. The individuals from each of the four locations of the company being analyzed were assigned a specific color within each network in order to analyze connectivity and dispersion; these were: green for Quito, red for Guayaquil, yellow for Cuenca, and blue for Lasso.

3. Results

A first analysis of the information revealed word frequency obtained from the interviews and direct observation carried out. This allowed an initial understanding of what power descriptors could be expected, while at the same time orienting categorization. Fig. 1 represents the frequency graph obtained. A word was considered to be frequent if it was it appeared at least 10 times in the analyzed resources. According to the results obtained, it was possible to infer that the most frequently mentioned elements were related to characteristics that describe the organization (frequency of the words production, plant, area, company, personnel, process, operators, and managers). In the second place, were words associated with how people feel about the organization (confidence, lack, resistance). In the last place were words that express what the organization does or should do based on its function and the function of various people (communication, equipment, objectives, bosses, leadership). Once results were available, a qualitative-quantitative study was carried forward with power sources having been identified.

The six power sources identified by the five employees that were interviewed were:

(1) Power based on collaborative work and confidence in the group.
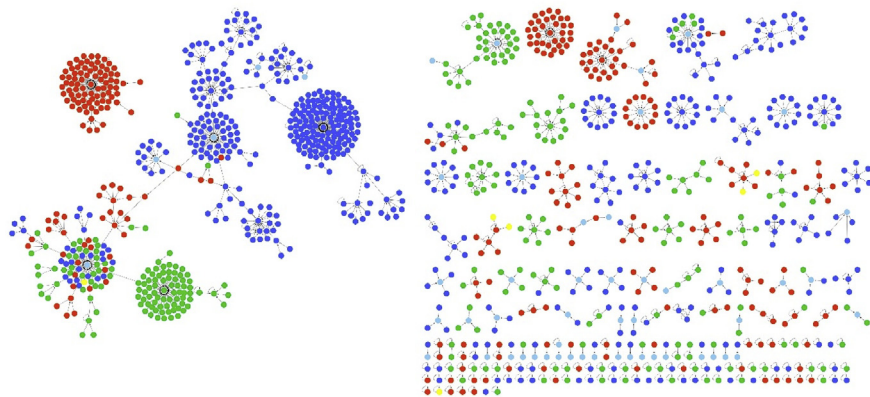
Fig. 1. Results of network 1 regarding, "Who makes the decisions about what happens on a day-to-day basis in your area?" Obtained using the Cytoscape program. The individuals in each one of the four company sites analyzed were color coded, Quito being green, Guayaquil red, Cuenca yellow, and Lasso blue.

(2) Power generated through the use of information, communication, and knowledge.

(3) Formal power based on hierarchy,

(4) Power based on a role as a mediator.

(5) Power sustained by culture and the environment projected by the organization.

(6) Power based on the capacity of control.

In addition, five key aspects that accompany power and should be considered in subsequent studies for this type of production company were identified, these being: the key actor (Line Chiefs), asymmetry of power between the production plants, changes, presumption of corruption, lack of plant worker proactivity, and lack of respect for the job.

Upon having identified the sources of power, the following questions (Q) were devised to be used when carrying out personalized interviews with all of the company employees:

Q1: Who makes the decisions about what happens on a daily basis in your work area?

Q2: Who do you call to solve normal problems during your shift or working day?

Q3: Who is the person that helps you to solve personal problems?

Q4: Who you do you call when you need information?

Q5: In the face of a very complicated problem, who would go to in the company?

Q6: What is the name of the boss who makes the decisions in your area?

Q7: Which of your co-workers do you consider to be the most supportive?

Q8: Which of your coworkers do you consider to have the most experience?

Q9: Who is the co-worker with whom you interact the most?

Q10: If your boss needs help to solve a problem, in which of his/her co-workers would he/she be able to rely on? (You can include your name or that of one of your co-workers)

Q11: In the face of a conflict between two employees, who is the person who would help resolve the conflict in your area?

Q12: In the face of a conflict between two employees, who is the person who would help resolve the conflict in your plant?

The statistical results obtained from the analysis of each of the variables (Q1-Q12) with respect to the elements that were considered for comparison are shown in Table 2.

We can see that the most critical aspects are indicated in rows (A) percentage of those who are isolated and/or reference themselves, (B) percentage of self-

Table 2. Statistical analysis of the questions applied.

Parameter*	Questions											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
A	7.01	1.86	3.29	0.34	0.00	0.34	0.42	0.17	0.00	11.15	1.60	0.08
B	14.95	4.31	4.48	0.76	017	2.28	0.68	1.35	0.34	29.90	5.41	1.35
C	5.22	7.69	23.14	20.35	3.15	1.28	15.12	8.37	12.71	9.83	11.31	10.91
D	0.08	1.24	6.86	11.16	10.74	0.00	0.07	0.00	0.00	0.00	2.65	29.45

Note. *The parameters considered were: (A) percent of isolated subject and/or who referenced themselves, (B) percent of subject who self-referenced, (C) percent of NA (did not indicate anyone) on each network and (D) Percent of those whoe referenced "Human Resources". All the percents were calculated with respect of total nuber of nodes in each network.

referencing persons, (F) percentage of NAs (do not indicate anyone) in each network and (H) percentage who referenced "Human Resources".

Additionally, upon analyzing the columns or questions, you can see that for Q10, "If your boss needs help to solve a problem, which of his colleagues could he rely on?" 11% of the workers indicate that he/she could count on the worker themselves and almost 10% of the employees did not know on whom he/she could rely. Our attention was also drawn to the fact that for certain questions there were a large number of people who did not respond or did not indicate any of the employees, including themselves. Such is the case, for example, of questions 3 (Personal Problems) and 4 (Needs Information), where 23 and 20% of the employees, respectively, do not know or did not mention anyone in their responses. In contrast, in question 6, "What is the name of the boss who makes decisions in your area?" only 1.28% of the employees did not mention anyone. This suggests that the immediate boss is not the figure that workers always go to when they have problems of a personal nature or even to seek information. The creation of the "Human Resources" category originated because, in questions related to personal problems or problems between employees, 30% of the workers answered "Human Resources", but not one or several specific individuals.

Networks derived from each question; where it could be seen that different topologies and conglomerate forms were presented, depending on the network, were later obtained. For a better understanding, we will model the results obtained from four of the networks (1, 3, 4 and 12), which are the ones that best illustrate the differences in connectivity between individuals or groups depending on the question asked. Additionally, a number of small images will be shown for the purpose of observing general topology.

The network derived from question 1 — "Who makes the decisions about what happens on a daily basis in your work area?" shows that only a few people have a high degree of connectivity. In general, these individuals were senior managers while the small islands corresponded to leaders of small groups or people to whom in general

very few employees resorted to (Fig. 1). One can see that Lasso (blue), Quito (green) and Guayaquil (red) demonstrate a better connectivity distribution, even though there are approximately 14.95% of people that refer to themselves and about 5.22% that did not indicate any other subject (multicolor island).

The network derived from question 3 (Personal Problems) slightly resembles Network 1, although it contains fewer scattered islands (Fig. 2). In this network not only were the people with the greatest connectivity different, but they could appreciate 3 majority islands (green belonging to Quito, blue belonging to Lasso and multicolor). The multicolor one corresponded to those people who did not know what to respond (approximately 23% of the people did not indicate any other subject in this type of question).

Network 4's "Needs Information" topology varied considerably in comparison to the preceding ones (Fig. 3). In this case, no individuals with a high centrality were identified; and there was a percentage of workers who referred to "Human Resources˙" (about 10%) and more than 20% did not indicate anyone. These two scenarios, Human Resources and Nobody, are the two majority islands that we identified in the multicolored network (which indicates that this occurs in any of the plants).

On the other hand, network 12, "in the face of a conflict between two employees, who is the person who would help resolve the conflict in your plant?", reflects that the number of nodes or people who resort to "Human Resources" has increased (about 30%, in the multicolored network) as well as approximately 11% of the people who did not know who to refer to (Fig. 4). The names and network centrality change in this network, therefore, the values of connectivity will also change.

The DN_i^j (normalized index in-degrees *in each network "j"*) and its grouping in factors was determined by the factorial analysis (Table 3).
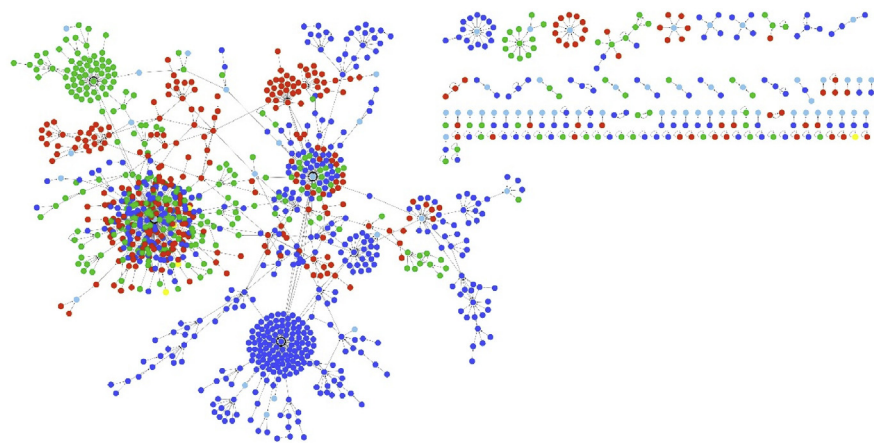
Fig. 2. Network 3 results referring to "Personal Problems" obtained using the Cytoscape program. The individuals analyzed in each of the four company sites are color-coded: Quito - green, Guayaquil - red, Cuenca - yellow, and Lasso - blue.
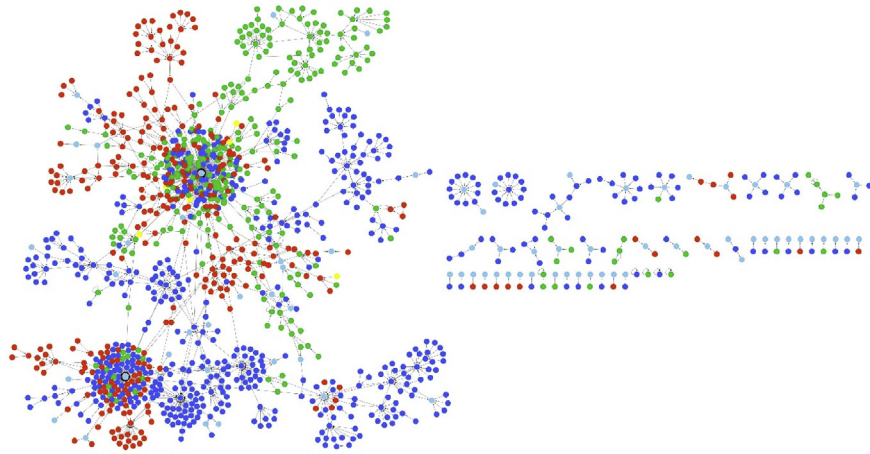
Fig. 3. Network 4 results referring to "Need Information" obtained using the Cytoscape program. The individuals analyzed in each of the four company sites are color-coded: Quito green, Guayaquil red, Cuenca Yellow, and Lasso Blue.
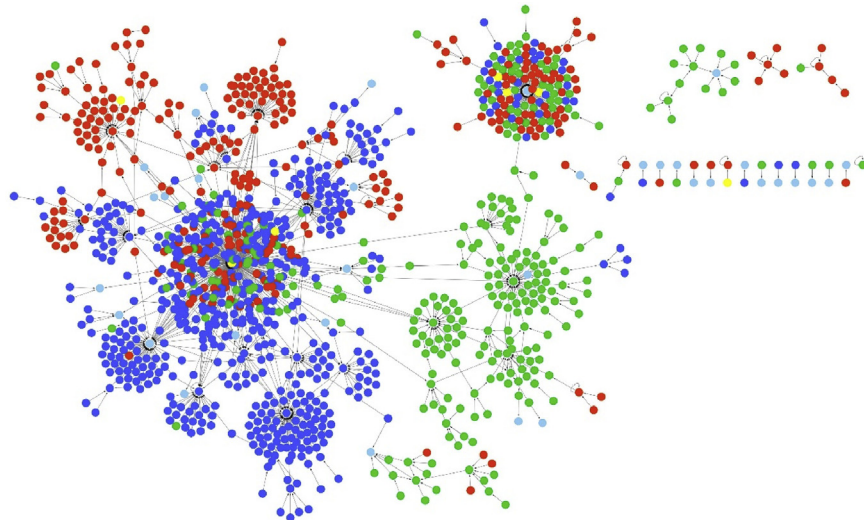
Fig. 4. Network 12 results referring to, "in the face of a conflict between two employees, who is the person who would help resolve the conflict in your plant?" obtained using the Cytoscape program. The individuals analyzed in each of the four company sites are color-coded: Quito green, Guayaquil red, Cuenca Yellow, and Lasso Blue.

As can be seen, standardized scores or values allow networks to be grouped into three factors. The first factor is considered to be the Formal Power, referring to formal and frequent power channels (networks 1, 2, 5, 6, 11, 12). The second factor is considered the Informal Power, which in this case is a kind of minor derivation of the Formal Power (Networks 7, 8, 9, 10). Finally, the third factor is the most complex to associate and is clearly related to personal relationships and conflicts that they generate (Networks 3, 4).

Table 3. Analysis of main components for networks, distributed according to a Varimax rotation with a Kaiser normalization.

Networks	Factors		
	1	**2**	**3**
$DN^{j}_{i}11$	.946		
$DN^{j}_{i}1$	.933		
$DN^{j}_{i}2$	.854		
$DN^{j}_{i}5$	.826		
$DN^{j}_{i}6$	.761		
$DN^{j}_{i}12$	.645		
$DN^{j}_{i}8$		.778	
$DN^{j}_{i}7$		.773	
$DN^{j}_{i}10$		.773	
$DN^{j}_{i}9$		.747	
$DN^{j}_{i}3$			.948
$DN^{j}_{i}4$			.788

Note. DN^{j}_{i} is the standard in-degree index between 0 and 1 in each of the networks in order to be integrated into a single indicator, where N pertains to the question that was converted into a network. The distribution in three factors corresponds to a 75.69% explained variance. The highest values of saturization were considered in order to identify the networks that form a part of each factor. The rotation was convergent in five interactions.

It was possible to identify the connectivity of individuals and how they were grouped according to a factor by using the In-Degree medium and considering only the period belonging to each factor (Table 4). The medium coefficient clustering (Cluster-Coeff), which is another indicator of centrality (especially for clustering), and gives a measure of how "essential" an individual is on a network is also represented in the table. In other words, this index measures the characteristics of individuals who are

Table 4. Analysis of the average In-Degree, considering only the people who are part of each factor.

	Factor 1	**Factor 2**	**Factor 3**
Average connectivity	26.12	4.65	15.92
Average grouping coefficient	0.004	0.031	0.005
Media neighbor connectivity	3.97	34.34	5.58

connected to a particular individual. For example, let us suppose individual X is connected to 4 individuals; if these 4 individuals are also connected to each other, then the clustering coefficient will be greater than if these 4 individuals were not connected to each other. The Neighborhood Connectivity average, which is the average of neighbors ' connectivity that connects a node, was also calculated. This index is important when we are dealing with networks in which one can identify many "islands".

Thus Factor 1 groups people who have a high connectivity, but a low grouping value, indicating that the individuals connected to them are not very connected to each other (we would say that they have a high indispensability). Likewise, the people connected to them do not have a high connectivity either, being that there are many employees that depend on them. This group would be the formal leaders of the institution.

Factor 2 groups those people who have low connectivity and a high grouping coefficient, this means that they reach their position as leaders due to their relationships with others, probably because of their experience and for their connection with the formal leaders (high value of neighbor connectivity). However, these individuals are more indispensable because many of the people that they are connected with, also have a lot of connections between themselves.

Finally, Factor 3 also indicated a solid position of power, at least in relevant matters, that would be more related to employee personal matters, as well as their need for information, possibly interpreted as information related to working conditions and related matters. These people have a position as solid as those in Factor 1 (some
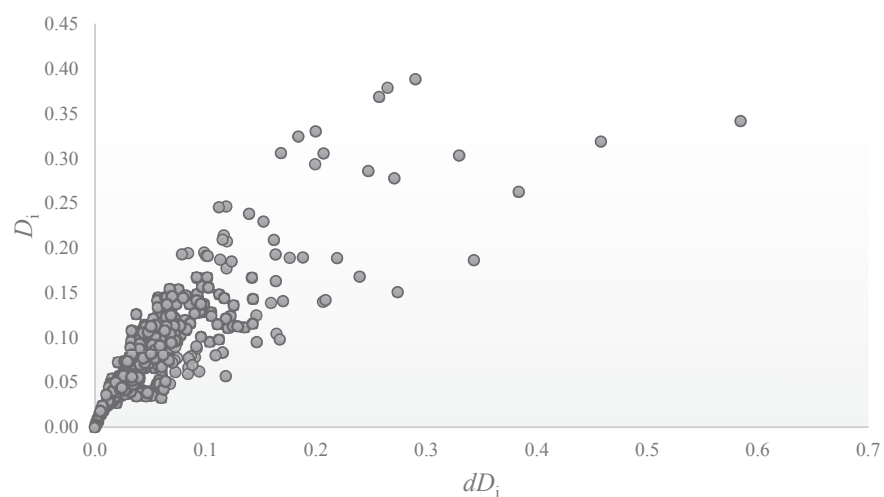
Fig. 5. Results of the analysis of the consensus strategy that integrates the centralities of the same individual obtained in several networks. D_i being *the general index* ($D_i = \frac{1}{N}\sum_j^N DN \cdot {}_i^j$) where N is the total number of questions that were converted into networks and dD_i the standard deviation.

of the members are even repeated) since they have high values of connectivity and low values of grouping coefficient and connectivity with neighbors.

Finally, with the results obtained we proceeded to develop the consensus strategy to integrate the centralities of the same individual obtained in several networks, derived from the average and deviation standard (dD_i) of the In-Degree (Fig. 5). In this graph you can see that there are groups of individuals with a lot of connections and low variability, but in turn there are others that have a low connectivity and high variability, and therefore are the ones that exert the least power in the company.

4. Discussion

The goal of this research was to use the results obtained, using a qualitative-quantitative approach, to contribute to the understanding of the role of individuals within organizational power networks. The strategy used was one in which individual interviews and direct observation were combined to identify the sources of power within the organization, with a network approach and topological analysis of networks using graphics based on centrality measures, and then to finally conclude with a consensus strategy in order to obtain a standardized ranking. What is proposed is a model that captures the main features of organizational power in a company, delineates its organizational hierarchy and includes a consensus strategy that allows the rapid identification of individuals relevant to the organization.

The representation of power relations as a network allowed the researchers to analyze and visualize how employees are connected to each other within the organizational structure. By using this network, it was possible to analyze the structure of power relationships within the company. In addition, centrality measures allowed the defining of the distribution of power in the organization due its ability to detect the most influential positions within each network (Liu and Moskvina, 2016). The differences between individuals with respect to their relationship can be extremely important to understand their attributes and behavior within an organization. Highly connected people can be more influential and more influenced by others (Justado, 2014). That is, those individuals who have more connectivity indicate that they are the most relevant to the company in terms of decision making, as many employees have these few within their operational range. Likewise, the differences in connections can tell us a little about the order of stratification of the individuals.

Based on the information provided to the company, it was able to identify the people suitable for influencing decision-making and governance in their organization. In this way, it made it easier for the company to evaluate the distribution of people within their workflow, and identify redundancy of roles, inaccurate roles or fragmented functions within a network. In other words, the information obtained

allowed the organization to analyze whether its members were functioning optimally and to raise possibilities of reorganization in cases where the results were not those expected.

The consensus strategy employed allowed the integration of all the networks analyzed, so that it transcended the individual approaches of the networks in terms of the significance of individual standardized scores. This is a methodology recently described for the integration of ranked genes across different prioritization tools (Cruz-Monteaqudo et al., 2016; López-Cortés et al., 2018; Tejera et al., 2017), but this constitutes the first report of application and validity in studies related to social sciences. The idea of normalizing to explore a ranked node centrality had also being recently explored in communication networks but not as a direct comparison measure across networks (Adalat et al., 2018). Moreover our results in factorial analysis showed that normalized centralities are very well correlated between networks; it is a property of centrality indexes already identified in Valente et al. (2008). Having an adequate consensus strategy in the context of organizational power networks, can provide the capacity to classify individuals relevant to the organization within a long list, simultaneously taking into account different sources of power in which the same individual may or might not be equally relevant. This directly reduces the cost of experimental validation and allows for better decision-making and distribution of staff within the organization. Our results can be significant both theoretically and from a practical point of view in helping managers shape strategic positions in their organizations.

5. Conclusions

This investigation presents two fundamental contributions. First, there is the use of organizational networks, specifically in the context of the description of power networks, to know the dynamics within organizations. Power as a key element in this study broadens the field of leadership studies, once interpersonal relationships will depend on these forms of influence. In this sense, the results obtained allow the organization where the study was applied to have a reference when carrying out its management through the knowledge of its informal structure and the organizational changes within it according to certain power dynamics described.

On the other hand, the present study proposed a new approach at the methodological level considering organizational network analysis, where not only it can describe, but analyze its behavior based on finding patterns that allow a better understanding of it. By applying a logic that has not been used within the field of social sciences, as is the case of the use of consensus strategies in the network analysis process, we are incorporating new aspects to its development, which allows extending the field of research on networks in organizations.

5.1. Study limitations

As part of the limitations of this research, especially in terms of being able to replicate it, we can indicate that collaboration is always required by the organization where the research is carried out, once there is a need for the responses of all the population that works as an object of study. This research does not use a representative sample of the population. Another of the key elements in the case of this study, was the lack of homogeneity at the time of indicating the names of the people who were selected according to the questions asked, which led to delays in the analysis and the repetition of calculation processes. Also, the identification of sources of power from a qualitative analysis of the interviews could fail to have other aspects to consider that were not mentioned during this process. In this case, the studies that are carried out in the future can consider quantitative tools for identification of these said sources of power, which serve as the basis for the construction of specific questions that generate the networks. On the other hand, we only considered direct influences in the network analysis. Futures studies can benefit for the use of indexes based on indirect infuences as well.

Declarations

Author contribution statement

Valentina Ramos: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Antonio Franco-Crespo, Yasel Guerra, Carlos Ramos-Galarza: Analyzed and interpreted the data.

Lien González-Pérez: Analyzed and interpreted the data; Wrote the paper.

Pablo Pazmiño: Contributed reagents, materials, analysis tools or data.

Eduardo Tejera: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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The authors declare no conflict of interest.

Additional information

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References

Adalat, M., Niazi, M.A., Vasilakos, A.V., 2018. Variations in power of opinion leaders in online communication networks. Roy. Soc. Open Sci. 5 (10), 180642.

Allee, V., 2008. Value network analysis and value conversion of tangible and intangible assets. J. Intellect. Cap. 9 (1), 5–24.

Anklam, P., Cross, R., Gulas, V., 2005. Expanding the field of vision. Learn. Organ. 12 (6), 539–551.

Ansari, M.A., Kapoor, A., 1987. Organizational context and upward influence tactics. Organ. Behav. Hum. Decis. Process. 40 (1), 39–49.

Baporikar, N., 2008. Power in organizations. J. Hosp. Appl. Res. 3 (1), 74–81.

Barchiesi, M.A., Battistoni, E., Iacobone, F.A., La Bella, A., 2008. Leveraging on informal networks for organizational change. In: IEMC-Europe 2008–2008 IEEE International Engineering Management Conference, Europe. Managing Engineering, Technology and Innovation for Growth, pp. 1–5.

Blanchet, K., James, P., 2012. How to do (or not to do) ... a social network analysis in health systems research. Health Policy Plan. 27 (5), 438–446.

Bordum, A., 2004. Trust as a Critical Concept (No. 4). Frederiksberg.

Brass, D.J., 1984. Being in the right place: a structural analysis of individual influence in an organization. Adm. Sci. Q. 29 (4), 518.

Butler, C.T.L., 1991. In: On Conflict and Consensus: a Handbook on Formal Consensus Decision Making, second ed. Foot Not Bombs, Portland.

Castleberry, A., 2014. NVivo 10 [software program]. Version 10. QSR International; 2012. Am. J. Pharmaceut. Educ. 78 (1), 25.

Chong, P.S.-., Benli, Ö.S., 2005. Consensus in team decision making involving resource allocation. Manag. Decis. 43 (9), 1147–1160.

Coyne, I.T., 1997. Sampling in qualitative research. Purposeful and theoretical sampling; Merging or clear boundaries? J. Adv. Nurs. 26 (3), 623–630.

Cross, R., Borgatti, S.P., Parker, A., 2002. Making invisible work visible: using social network analysis to support strategic collaboration. California Rev. Manag. 44 (2), 2546.

Cruz-Monteagudo, M., Borges, F., Paz-y-Miño, C., Cordeiro, M.N.D.S., Rebelo, I., Perez- Castillo, Y., Tejera, E., 2016. Efficient and biologically relevant consensus strategy for Parkensoń́s disease gene prioritization. BMC Med. Genomics 9, 12.

Dahl, R.A., 1957. The concept of power. Behav. Sci. 3 (3).

Enz, C.A., 1989. The measurement of perceived intraorganizational power: a multi-respondent perspective. Organ. Stud. 10 (2), 241−251.

French, J.R.P., Raven, B., 1959. Chapter 9: the bases of social power. In: Cartwright, D. (Ed.), Studies in Social Power (Vol. Research Center for Group Dynamics Series. Publication. Research Center for Group Dynamics, Institute for Social Research, University of Michigan, Ann Arbor, pp. 150−167.

French, J.R.P., Raven, B., 2014. The bases of social power. In: Leadership and Influence Process, pp. 151−164.

Gaventa, J., 2006. Finding the spaces for change: a power analysis. IDS Bull. 37 (6), 23−33.

González-Benito, J., Aguinis, H., Boyd, B.K., Suárez-González, I., 2012. Coming to consensus on strategic consensus: a mediated moderation model of consensus and performance. J. Manag. 38 (6), 1685−1714.

Grassi, R., Stefani, S., Torriero, A., 2010. Centrality in organizational networks. Int. J. Intell. Syst. 23 (3), 253−265.

Guzzini, S., 2015. El poder en Max Weber. Relac. Int. 30, 97−116.

Hanscome, M.L., 2000. Influence of Gender and Power Relationships Among Human Resource Development Managers. University of Georgia.

Hassani, B.K., 2016. The consensus approach. In: Scenario Analysis in Risk Management: Theory and Practice in Finance. Springer Internatinal Publishing, Cham, pp. 39−50.

Hershey, 1979. Power Perception Profile Self Instrument. John Wiley & Sons, Incorporated.

Homburg, C., Krohmer, H., Workman, J.P., 1999. Strategic consensus and performance: the role of strategy type and market-related dynamism. Strat. Manag. J. 20 (4), 339−357.

Hsieh, H.-F., Shannon, S.E., 2005. Three approaches to qualitative content analysis. Qual. Health Res. 15 (9), 1277−1288.

Hunter, K.O., Wolf, E.M., 2015. Cracking the code of process safety culture with organizational network analysis. Process Saf. Prog.

Interviewee 1, October, 2017. Interviews with Managers in the Company.

Interviewee 2, October, 2017. Interviews with Managers in the Company.

Interviewee 3, October, 2017. Interviews with Managers in the Company.

Interviewee 4, October, 2017. Interviews with Managers in the Company.

Interviewee 5, October, 2017. Interviews with Managers in the Company.

Justado, A., 2014. Organigrama informal: Análisis de redes organizativas y so-ciales, 86. Observatorio de Recursos Humanos, pp. 47−51.

Kelly, C., 2007. Managing the relationship between knowledge and power in orga-nisations. Aslib Proc.: New Inf. Perspect. 59 (2), 125−138.

Liu, J., Moskvina, A., 2016. Hierarchies, ties and power in organizational networks: model and analysis. Soc. Netw. Anal. Min. 6 (1), 106.

López-Cortés, A., Paz-y-Miño, C., Cabrera-Andrade, A., Barigye, S.J., Munteanu, C.R., González-Díaz, H., Tejera, E., 2018. Gene prioritization, commu-nality analysis, networking and metabolic integrated pathway to better understand breast cancer pathogenesis. Sci. Rep. 8 (1), 16679.

Lukes, S., 2007. El Poder: Un Enforque Radical. Siglo XXI, Madrid.

Madero, S.M., Rivera, H., 2012. Análisis de los procesos de recursos humanos y su influencia en los bonos y prestaciones. Cuad. Adm. 28 (48), 25−36.

Mariño-Arévalo, A., 2014. Las relaciones de poder y la comunicación en las organ-izaciones: una fuente de cambio. AD-minister, pp. 119−141.

Meliá, J.L., Oliver, A., Tomás, J.M., 1993. El poder en las organizaciones y su medición, el cuestionario de poder formal e informal. Rev. Latinoam. Psicol. 25 (2), 139−155.

Meyer, S., Ward, P.R., 2009. Reworking the sociology of trust: making a semantic distinction between trust and dependence. Future Sociol. 1−16.

Mintzberg, H., Quinn, J.B., Voyer, J., 1997. In: El proceso estratégico: conceptos, contextos y casos (P. Educación Ed.). Prentice Hall.

Morgan, G., 1996. Imágenes de la organización. Alfaomega.

Moskvina, A., 2016. Power and Network Integration: Structural and Algorithmic Analysis of Organizational Networks. Auckland University of Technology.

NMAC LINC, 2018. Organizational Effectiveness Series: Building Healthy Orga-nizations. NMAC, Washington.

Omondiagbe, H.A., Towns, D.R., Wood, J.K., Bollard-Breen, B., 2017. Stakeholders and social networks identify potential roles of communities in sustainable management of invasive species. Biol. Invasions 19 (10), 3037−3049.

Pasqualino, P., Barchiesi, M.A., Battistoni, E., Murgia, G., 2013. Key-roles in VLEs: a metric based on social network analysis. Towards Learning and Instruction in Web 3.0. Adv. Cognit. Educ. Psychol., (Celda) 173−191.

Patterson, E., Branch, S., Barker, M., Ramsay, S., 2018. Qualitative research in organizations and management : an article information . Qual. Res. Org. Manag.: Int. J. 13 (1), 32−52.

Peiró, J.M., Meliá, J.L., 2003. Formal and Informal Interpersonal Power in Organisations: Testing a Bifacto. University of Warwick eResources, 52(1), pp. 14−35.

Pfeffer, J., 1992. Understanding power in organizations. In: Managing with Power, pp. 29−50.

Raven, B.H., 1993. The bases of power: origins and recent developments. J. Soc. Issues 49 (4), 227−251.

Reynolds, H.W., Curran, J., Thomas, J.C., 2014. Organizational Network Analysis: MEASURE Evaluation's Experience, 2010-2014, (August).

Shannon, P., Markiel, A., Ozier, O., Baliga, N.S., Wang, J.T., Ramage, D., Ideker, T., 2003. Cytoscape: a software environment for integrated models of biomolecular interaction networks. Genome Res. 13 (11), 2498−2504.

Tejera, E., Cruz-Monteagudo, M., Burgos, G., Sánchez, M.-E., Sánchez-Rodríguez, A., Pérez-Castillo, Y., Rebelo, I., 2017. Consensus strategy in genes prioritization and combined bioinformatics analysis for preeclampsia pathogenesis. BMC Med. Genomics 10 (1), 50.

Teuber, E.B., 1973. Emergence and change of human relations Groups : the nature of human. Am. Behav. Sci. 16 (3), 378.

Tworoger, T., Preziosi, R., 2005. An examination of successful leadership power base perceptions. J. Bus. Leadersh.: Res. Pract. Teach. (2005-2012) 1 (1).

Twycross, A., Shields, L., 2005. Validity and reliability − what's it all about? Part 3 issues relating to qualitative studies. Paediatr. Care 17 (1), 36−36.

Valente, T.W., Coronges, K., Lakon, C., Costenbader, E., 2008. How correlated are network centrality measures? Connections (Toronto, Ont.) 28 (1), 16−26.

Wasserman, S., Faust, K., 1994. Social Network Analysis: Methods and Applications (Vol. Volume 8 of Structural Analysius in the Social Sciences). Cambridge University Press.