

## **Analysis of formal and informal networks and the role of internal actors in organizations: a comparative study**

**Análise de redes formais e informais e o papel dos atores internos nas organizações: um estudo comparativo**

**Análisis de redes formales e Informales y el papel de los actores internos en las organizaciones: un estudio comparativo**

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### **Abstract**

This work aims to compare the formal and informal networks built in an organization and the role of internal actors involved in this process - employees, using the Social Network Analysis methodology - ARS, within an organization, in order to understand the types formal and informal relationships based on a matrix of quantitative data with the support of the UCINET software. A census survey was carried out of all employees in a company composed of 77 employees with 75 valid cases. Through the extracted quadratic matrix, both formal and informal, density, centrality, reciprocity, clustering and egonet were analyzed, including aspects related to gender and function. The results show differences between the formal and informal sociograms in both the identified variables and related aspects, suggesting that the formal and informal networks have different behaviors, and also suggest the contribution of using the analysis of social networks so that managers can understand the panorama strategic relationship between its employees both in professional involvement and in personal treatment.

**Keywords:** Social network analysis; Formal and informal networks; Sociogram; Role of internal actors in organizations.

### **Resumo**

Este trabalho tem como objetivo comparar as redes formais e informais construídas em uma organização e o papel dos atores internos envolvidos neste processo – os colaboradores, utilizando a metodologia da Análise das Redes Sociais – ARS, dentro de uma organização, de forma a compreender os tipos de relações formais e informais a partir de uma matriz de dados quantitativos com o apoio do software UCINET. Foi feito um levantamento censitário de todos os colaboradores de uma empresa composta por 77 colaboradores com 75 casos válidos. Através da matriz quadrática extraída, tanto formal como informal, analisou-se a densidade, centralidade, reciprocidade, clustering e egonet, incluindo aspectos relacionados ao gênero e função. Os resultados apresentam diferenças entre os sociogramas formal e informal tanto nas variáveis identificadas como pelos aspectos relacionados, sugerindo que as redes formais e informais possuem comportamentos distintos e, ainda, sugerem a contribuição do uso da análise das redes sociais para que gestores possam entender o panorama estratégico das relações entre seus colaboradores tanto no envolvimento profissional como no trato pessoal.

**Palavras-chave:** Análise de redes sociais; Redes formais e informais; Sociograma; Papel dos atores internos nas organizações.

### **Resumen**

Este trabajo tiene como objetivo comparar las redes formales e informales construidas en una organización y el rol de los actores internos involucrados en este proceso - empleados, utilizando la metodología de Análisis de Redes Sociales - ARS, dentro de una organización, con el fin de comprender los tipos de relaciones formales e informales basado en una matriz de datos cuantitativos con el apoyo del software UCINET. Se realizó una encuesta censal a todos los empleados de una empresa compuesta por 77 empleados con 75 casos válidos. A través de la matriz cuadrática extraída, tanto formal como informal, se analizaron la densidad, centralidad, reciprocidad, clustering y egonet, incluyendo aspectos relacionados con género y función. Los resultados muestran diferencias entre los sociogramas formales e informales tanto en las variables identificadas como en los aspectos relacionados, sugiriendo que las redes formales e informales tienen comportamientos diferentes, y también sugieren el aporte de utilizar el análisis de redes sociales para que los gerentes puedan entender la panorama estratégico de la relación entre sus empleados tanto en la implicación profesional como en el trato personal.

**Palabras clave:** Análisis de redes sociales; Redes formales e informales; Sociograma; Papel de los actores internos en las organizaciones.

## **1. Introduction**

Social networks take place from the mutual relationship between peers and take place within the scope of human relationships, with relationship patterns built by such interactions (Hanneman & Riddle, 2005). Within organizations, networks formed by technical and hierarchical aspects lead to complex formal relationships between internal actors - employees - who, from a strategic perspective, are encouraged to achieve the expected goals and objectives. Because it is human nature, informal relationships also arise from the interaction and coexistence of work, often influenced by the formal relationships themselves (Conde, & Farias Filho, 2016).

This work aims to compare the formal and informal networks built in an organization and the role of the internal actors involved in this process, using the Social Network Analysis (ARS) methodology, within an organization, in order to understand the types of formal relationships and informal, based on a matrix of quantitative data with the application of ARS in the company. (Amati, Lomi & Mira, 2018; Hanneman & Riddle, 2005; Rahman & Karim, 2016).

This approach becomes relevant in strategic studies due to the argumentation present in the literature that places the ARS as a broad analysis of multidisciplinary origin (Ferreira, 2011), they are fundamental in the exchange of information among its participants (Marteletto, 2001) as well as allowing greater understanding of relationships between actors in addition to building the general structure of existing networks in organizations (Brunetto, Xerri, Nelson & Farr-Wharton, 2016; Leonardo, Farina, Andreoli, & Lima, 2019, Rienties & Kinchin, 2014; Bastos & Viana Santos, 2007). The study's relevance also includes the importance of knowing the intrinsic relationships between the actors (Yousefi Nooraie, Marin, Hanneman, Lohfeld & Dobbins, 2017), as well as the inseparable relationship between the technical aspects and strategic objectives with the individual interests of these interconnections (Zhao & Cui, 2017).

The structure of this research is presented with its introduction; the approach of theoretical frameworks related to the analysis of social networks, the strategic comparison between formal and informal networks as well as the strategic role of actors in organizations by different classifications; the methodological procedures adopted; the analysis of the research results; final considerations and references.

## **2. Social Networks Analysis**

Social networks represent the interactions of mutual relationships between peers, resulting from the connections between people and companies through different types of interdependence (Rahman & Karim, 2016; Silva, Ramos, David & Vieira, 2021). As part of the approach to the study of human relations, the patterns identified in the mapped networks allow the

identification of information flows, interests, affinities, professional interactions, among other aspects through the study of their connections (Ferreira, 2011; Chung & Crawford, 2016).

The study of networks makes it possible to strategically observe organizational behavior through its interconnections as well as organizational changes and the impacts of both the internal environment and the influence of the external environment (Ferreira & Armagan, 2011). Still, the approach to management control through the use of social network analysis is widely discussed in the literature as presented by Duarte, Souza, Macêdo & Gomes (2020).

The concept of built relationships is complex and changeable, since human relationships have ties between actors from certain social systems (Silva, Fialho & Saragoça, 2013), whether they are organizations, groups, clubs, companies, projects or even other ventures.

In technical terms, Hanneman & Riddle (2005), Rahman & Karim (2016) and Amati, Lomi & Mira (2018) present explanations of the concepts associated with social networks, both in terms of interdependencies and in the groupings and measures of the networks. To extract a network, it is necessary to build the quadratic matrix that, after tabulation of the research data, allows crossing information related to the attributes of the network, characterized by its connections, between all the individuals of that network. In addition, it is possible to map with complementary information the so-called attributes of each of the individuals in the network in order to identify characteristics and patterns that lead to certain aspects presented in the network. The nodes represent each of the individuals present in the network.

Extracted from the quadratic matrix, the sociogram is observed, which represents the figure generated with all the connections present. There are several measures of networks observable in the results of the sociogram, and, according to Hanneman & Riddle (2005), for the purpose of this study, the measures as the focus of attention are:

- Centrality: the greater the centrality of the node, the more this individual is sought and important for the network;
- Density: it is the percentage of connections among the total possible connections, the higher this value, the better the relationships in the network;
- Reciprocity: verifies the differences between the total number of people who have the arrows pointed at both, where each one looks for the other, with those who just look for it, represented by the arrow directed only at one of the people in the connection;
- Cluster: means group, grouping or group, being able to observe the total number of possible connections for a given number and how much, in fact, the individual has connections;
- Egonet: although a given node has many connections, it is important to observe their density. The greater the egonet and its density, the greater the representativeness of the person within the network.

Still, it is possible to observe the exchanges and transfer of information between the nodes of the networks, since the relationships between individuals and their interactions constitute, in a dynamic way, the process of communication and exchange of information that is continuous and necessary for the achievement of the strategic objectives of the organizations. organizations, even comparing with aspects related to the survival of both groups and organizations (Marteleto, 2001).

### **3. Formal and Informal Networks and the Role of Internal Actors in Organizations**

Formal networks are characterized by professional interactions between internal actors of organizations, with a focus especially or even strictly focused on internal technical and procedural aspects. Informal networks cover relationships beyond professional aspects, including personal relationships, contacts that go beyond the work environment. , involving human nature interactions (Brunetto, Xerri, Nelson & Farr-Wharton, 2016; Conde & Farias Filho, 2016; Leonardo, Farina, Andreoli & Lima, 2019; Bastos & Viana Santos, 2007).

It is worth mentioning that the formal structure is the one that concentrates and directs the strategic efforts of organizations (Conde & Farias Filho, 2016), however, due to human relations, informal networks can influence or even change information flows, dynamics and even technical aspects, as these relationships are shaped (Rienties & Kinchin, 2014, Conde & Farias Filho, 2016; Leonardo, Farina, Andreoli & Lima, 2019, Yousefi Nooraie, Marin, Hanneman, Lohfeld & Dobbins, 2017).

Even in environments where the challenges are extreme, as described by Dapilah, Nielsen & Friis (2019) in poor rural communities or even groups apparently not formally structured, the resilience and comparison of formal and informal networks allows us to observe how such groups are behave in different ways depending on the aspect of their relationships. Although initially not formally established, they can, over time, organize themselves for mutual purposes and interests and, with this, make it possible to compare the different relationships between individuals or organizations.

The existing connections between individuals can even influence their decisions, such as the proximity between the nodes or even the intensity of the relationships (Yousefi Nooraie, Marin, Hanneman, Lohfeld & Dobbins, 2017), so that managers can use the analysis of networks social as a strategic complementary tool to map and better understand both the relationships between internal actors and their role within organizations, including the density of these relationships, cohesions or even conflicts (Bastos & Viana Santos, 2007).

Studying comparative aspects between formal and informal networks become relevant according to the literature since informal relationships can in fact lead to process improvements and overcoming relationship barriers with a focus on achieving strategic objectives (Conde & Farias Filho, 2016).

The Organization is a network of people at the service of a purpose and the manager is one of those responsible for improving the individual's performance and creating means to achieve the goals and reverse the efforts of the internal social network in expected strategic results (Silva, Fialho & Zaragoza, 2013). Networks are a fusion of individual, group and organizational interests, because the evolution of the company depends on the work and development of individuals and groups, making it impossible to disentangle the exclusively technical aspects of strategic objectives with human behavior (Zhao & Cui, 2017; Kolosque, Tizotte, Brizolla, Thesing & Baggio, 2020). Therefore, the Manager needs to be prepared for changes and continuous development, in view of the importance of team engagement.

Therefore, it is important to understand how individuals are imbued within the internal social network and the patterns of relationships involved, in order to deal with this context from a systemic view that allows the manager to evolve in internal development practices.

#### **4. Methodological Procedures**

The research uses the Social Network Analysis (ARS) methodology, applied to an organization through the collection of data elaborated using a form specific to the network analysis method and validated through a pre-test.

The organization chosen to apply the ARS was a company that manufactures curtains and blinds that serves retailers in the decoration industry. The company has 22 years in the market, under the corporate name of Easyblind Indústria e Comércio Eireli - located in Santana de Parnaíba in the State of São Paulo, it goes by the fancy name of Artesanart with a total of 77 employees in the research period including its owners.

The organization was chosen due to the ease of access to data and employees, without affecting the results due to the choice for convenience, since, unlike probabilistic methods, social network research uses the universe itself within the network delimited for study, thus, the choice of an organization, even if random, contributes to the observation of the phenomenon to be studied (Hanneman & Riddle, 2005).

The scope of the work is based on the census survey of all employees of the company, broadly serving the entire universe of the research object.

The research process began with the definition of the objective of the work and, following the theory of social networks supported by the theory of graphs, the research form was elaborated within the characteristics to obtain information from the quadratic matrix of both formal networks and networks informal within the studied organization (Amati, Lomi & Mira, 2018; Hanneman & Riddle, 2005; Rahman & Karim, 2016).

For analysis, formal networks are considered the connections between employees with a specific professional objective, whether in professional relationships, or in doubts and interactions related to work activity within the organization. For informal networks, on the other hand, strictly personal relationships are considered, not focused on doubts or work activities. Eventually people can be matched within social networks, but the tabulation follows separately Bastos & Viana Santos, 2007; Leonardo, Farina, Andreoli & Lima, 2019).

In addition, attributes were requested for analysis those allow greater understanding, namely: gender, length of service, function and age. For the function specifically, the form has three main fields: operational, administrative and managerial, delimiting in these dimensions the options of positions, and they are specified in the form. Following, two tabulations were presented to the respondents, one of the formal networks and the other of the informal networks (Hanneman & Riddle, 2005; Rahman & Karim, 2016).

The form also presented at the end the Informed Consent Term - TCLE, signed by each respondent, which offers greater robustness and reliability to the research process.

In order to maintain the confidentiality of the data, the names of the participants were presented on the form so that everyone could point out with whom they have relationships, and in the end, all names were replaced by random codes, preventing them from being identified and, thus, ensuring data confidentiality. The forms are available for eventual consultations to the database (Leonardo, Farina, Andreoli & Lima, 2019).

Still, the application went through the pre-test process, and the form was applied to a small sample of three respondents with no previous explanation and, after the application, they were asked about the doubts in the form. With that, it was possible at this point to identify small adjustments, thus validating the data collection instrument.

The research took place in an interval of two weeks and was applied under the supervision of one of the researchers, eliminating any doubts during the data collection process.

After collection, the data were tabulated in an Excel spreadsheet and generated three tables: the first called the attribute table containing the complementary data to the research and two other tables with the quadratic matrices containing the results of the participants' formal and informal relationship (Hanneman & Riddle, 2005).

From a total of 77 respondents, two individuals were excluded due to distortions in the results, totaling 75 elements for crossing the data.






The tabulated results were transformed into a UCINET 6.678 file version for reading the support software and, applying the data in the tool, the results obtained were extracted according to the described analysis (Hanneman & Riddle, 2005).

## 5. Data Analysis

The results of the analysis carried out using the UCINET Software present two sociograms, the first related to the formal network in Figure 2, that is, representing strictly professional relationships and the second related to the informal network in Figure 3, representing personal relationships or outside of the working environment. The sociogram's nodes were painted blue when the individual was male and pink for female individuals. A distinction was also made in the geometries of the nodes to classify the function in the company: when the node has the geometry of a circle it means that the individual has an operational function in the organization, the square nodes represent administrative functions and, finally, the managerial

positions, were represented in the shape of triangles, described in the legend of Figure 1.

**Figure 1.** Sociogram legend for nodes identification.

Pink – Female Gender	
Blue – Male Gender	
Circle – Operacional Function	
Square – Administrative Function	
Triangle – Managerial Function	

Source: Elaborated by the authors.

In relation to centrality, in Figure 2, which represents the formal network, it is possible to notice that the nodes located more centrally have a greater number of connections. It is also possible to see that, regardless of the function, there are individuals who concentrate representativeness in terms of network connections, since the individuals at the center of the extracted network generally have the largest number of connections. With regard to gender, it is possible to find female individuals both in the center of the image and in the regions most margin of the figure, which represents women with a lot of representativeness of network connections. The male gender is more evenly distributed in the image. In Figure 3, representing the informal network, it is observed that not all positions have extremely centralized elements, with predominance of a specific position, the operational one. There is an evident separation of informal groups between men and women, as shown by the sociogram. Table 1 shows that, in the formal network, individuals 13 and 28 are the most sought after, with "Outdeg" of 74% and individual 11 is the most sought after with "Indeg" of 47. In the informal network, individual 52 is the who looks for colleagues the most, with "Outdeg" of 71; and individual 64 is the most sought after with "Indeg" of 30. Although individual 04 does not present the highest numbers of centrality, in visual terms he presents himself as a central individual in both sociograms.

As for the density shown in Table 1, the formal network presents 34.6% of the total possible connections of the professional network, totaling 1922 connections, with an average of 25.6 professional connections per employee. The informal network shows a density of 21.2% of the total possible connections in the informal network, totaling 1176 connections, with an average of 15.7 informal connections per employee. The informal network is, therefore, less dense and has fewer connections, including the comparative visualization of sociograms related to this measure.

For the reciprocity measures also described in Table 1, the formal network is possible to see the values of the "Recip arcs" that represents the connections that both are looking for as a result of 1052 connections. "Unrecip arcs" represents those connections that only one of the individuals seeks the other and the result was 810. "Arc reciprocity" is the total percentage of situations that both are looking for, the higher, the more connected the network is. In the analyzed group, approximately 55% of situations in which both were sought were found. "All arcs" has been presented before, it is the total network connections highlighted here. As for the informal network, "Recip arcs", it had a result of 460 cases. "Unrecip arcs" that represents those connections that only one of the individuals seeks the other and the result was 716. "Arc reciprocity" which is the total percentage of situations that both are looking for, the higher, the more connected the network is, in the network informal was 0.391, approximately 15% less than in the formal network. All arcs, which is the total network connections highlighted here, was also lower than the formal network.

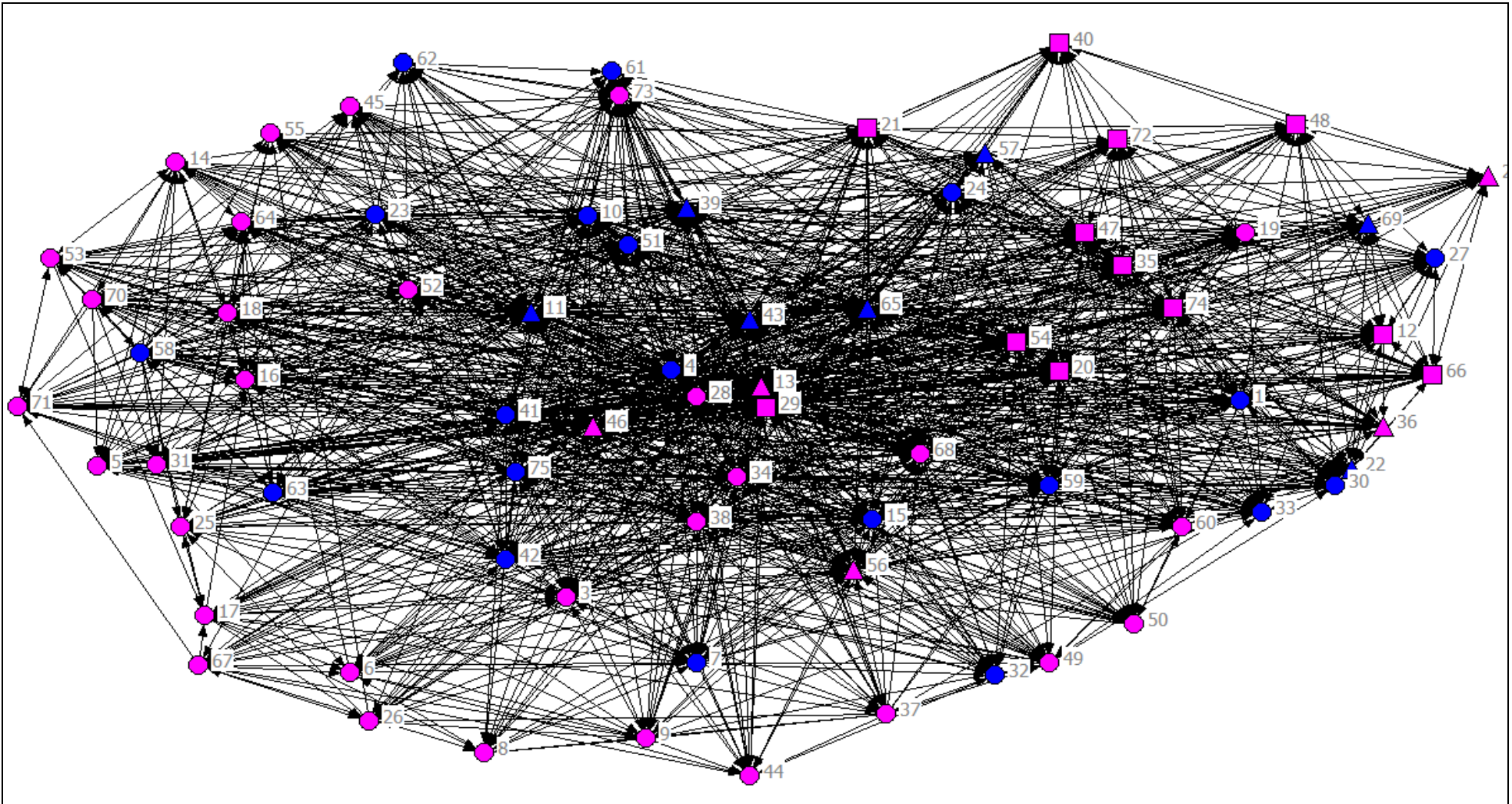


For the clustering measure, the “nPairs” of each participant was analyzed. The higher this number, the more connection possibilities the individual has. The "Clus Coef" represents how much, in fact, the individual has of the "nPairs", that is, the "nPairs" shows the possible connections of the individual and the "Clus Coef" shows what he really has. In the formal network, it is possible to observe the five largest "Clus coef" and the five largest "nPairs", respectively, realizing in the results that the largest "nPairs", do not coincide with the largest "Clus coef", which means that individuals with more possibility of connections are not the most connected in the formal network, similar phenomenon occurs in the informal network. Even so, the general coefficient of grouping presented in Table 1 of the formal network is higher than the informal network, with 55.1% against 46.4%, suggesting a greater grouping in professional relationships within the construction of the networks.

Regarding the egonet measure, the "size" represents the total number of connections that the individual has, both inbound and outbound. The individual may have many connections, but he needs to see the density of those connections, so the density analysis must be done (the values represent a percentage). The higher the EGO and its density, the greater the representativeness of the person within the network. The results presented in Table 1 of the five largest "sizes" of the formal network show that, despite high values, the density of these individuals does not follow the same relevance. Other individuals have a higher density even than the main five, but the egonet is very low. For the informal network, the results are even smaller.

Emphasizing the aspect of centrality, individual 13, who is part of the group of managerial functions as shown in Table 1, is in a prominent position in formal relationships, which is understandable when considering hierarchical issues, as well as other individuals of functions managerial and, in parallel, administrative functions that tend to concentrate information. The observation of individuals 28 and 4 in the formal network with high centrality is a relevant phenomenon since they are individuals with operational functions. Comparing with the sociogram in Figure 3, which primarily has individuals in operational functions in the centrality, it is inferred that human relationships in informal relationships, within the case studied, are superior to hierarchical relationships, different from what is expected in the formal relationships drawn in the sociogram of Figure 2.

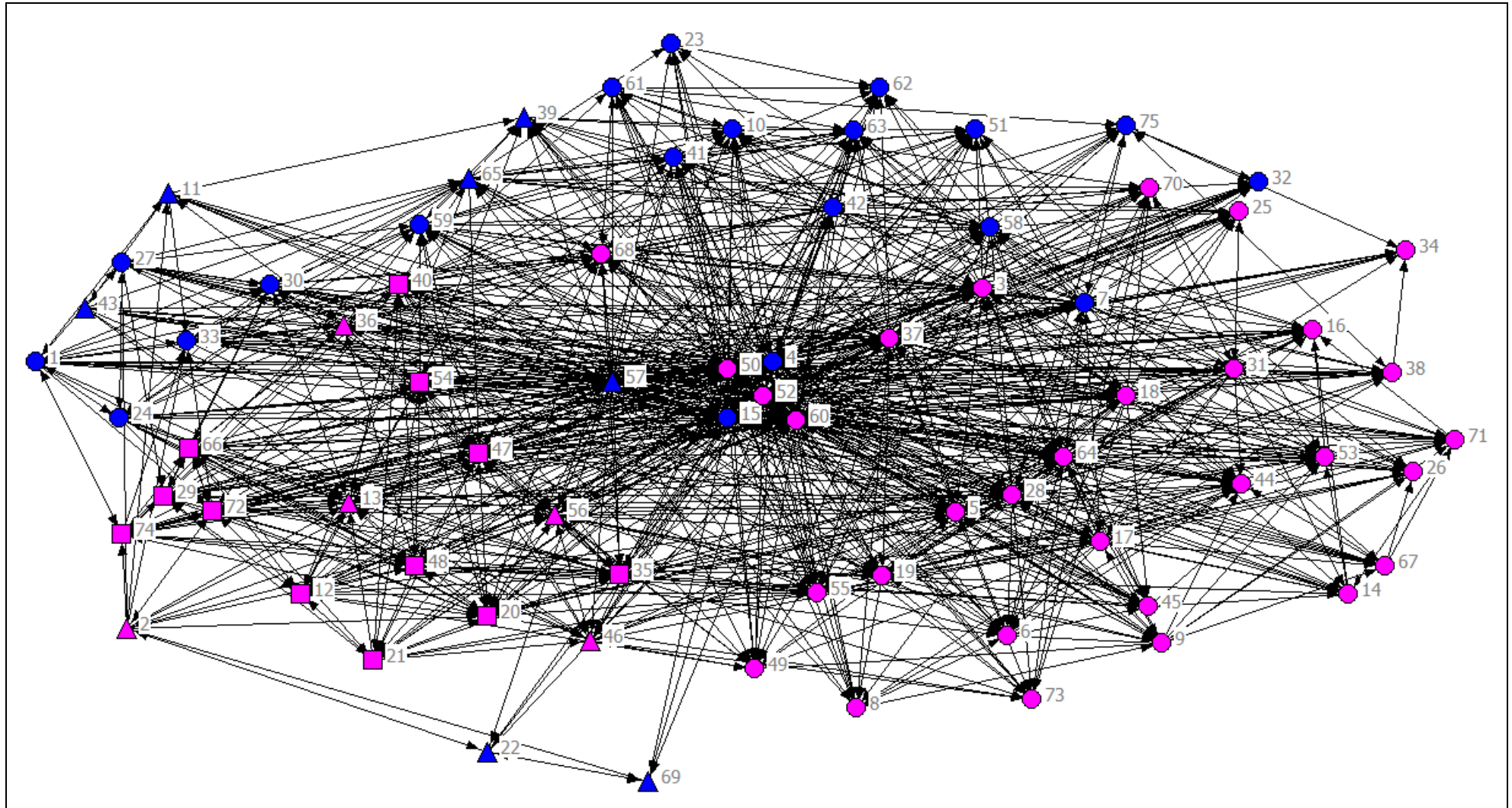
Figura 2. Formal network sociogram.



Source: Elaborated by the authors.



**Figura 3.** Informal network sociogram.



Source: Elaborated by the authors

**Table 1.** Main results of centrality, density, reciprocity, clustering and egonet extracted from maps of formal and informal networks using UCINET.

Results	Formal Network	Informal Network
Centrality (main individuals)	Individual - Indeg - Outdeg 13 – 74.000 – 36.000 28 – 74.000 – 17.000 11 – 39.000 – 47.000 04 – 72.000 – 30.000	Individual - Indeg - Outdeg 15 – 71.000 – 19.000 52 – 71.000 – 11.000 64 – 74.000 – 30.000 04 – 69.000 – 13.000
Density	Density 0,346, 1.992 Ties, Avg.Degree 25,627	Density 0,212, 1.176 Ties, Avg.Degree 15.680
Reciprocity	Recip Arcs -1052 Unrecip Arcs - 870 All Arcs - 1922 Arc Reciprocity - 0.547	Recip Arcs - 460 Unrecip Arcs - 716 All Arcs - 1176 Arc Reciprocity - 0.391
Clustering	Overall graph clustering coefficient 0.551  Main Clus Coef Individual - Clus Coef - nPairs 2 - 0.743 - 136.000 8 - 0.735 - 136.000 44 - 0.732 - 136.000 45 - 0.715 - 300.000 62 - 0.707 - 210.000  Main nPairs Individual - Clus Coef - nPairs 28 - 0.339 - 2.701.000 13 - 0.335 - 2.701.000 29 - 0.334 - 2.701.000 4 - 0.341 - 2.628.000 43 - 0.369 - 2.278.000	Overall graph clustering coefficient 0.464  Main Clus Coef Individual - Clus Coef - nPairs 34 - 0.733 - 45.000 23 - 0.708 - 36.000 32 - 0.674 - 66.000 8 - 0.659 - 91.000 62 - 0.632 - 91.000  Main nPairs Individual - Clus Coef - nPairs 52 - 0.208 - 2.485.000 15 - 0.206 - 2.485.000 60 - 0.209 - 2.415.000 4 - 0.215 - 2.346.000 50 - 0.228 - 2.145.000
Egonet	Greater results Individual – Size – Avg De g – Densit y 28 - 74.000 - 24.743 - 0,339 13 - 74.000 - 24.486 - 0,335 29 - 74.000 - 24.392 - 0,334 4 - 73.000 - 24.534 - 0,341 43 - 68.000 - 24.706 - 0,369	Greater results Individual – Size – Avg De g – Densit y 15 - 71.000 - 14.451 - 0.206 52 - 71.000 - 14.549 - 0.208 60 - 70.000 - 14.400 - 0.209 4 - 69.000 - 14.652 - 0.215 50 - 66.000 - 14.848 - 0.228

Source: Elaborated by the authors.

Thinking about the applied contribution of this study, the results consolidated in Table 1 show that the analysis of social networks allows managers to make decisions related to management and leadership in a more assertive way, since it is possible to map the influences of individuals in groups considering social networks built. The analysis of each network is

unique and, therefore, it becomes a contributing instrument for understanding the ecosystem of relationships built in each organization.

## 6. Final Considerations

The formal and informal sociograms extracted from the Analysis of Social Networks - ARS show the following differences: the professional network is more dense, with a homogeneous distribution of females and a notable concentration of males closer to the center of the map. It is still possible to observe that individuals with administrative and managerial functions are more at the center of the map, a region of greater density. When the informal network is verified, the female gender prevails in the center and individuals with operational functions that were more on the periphery of the professional sociogram appear in the center, like the elements 15; 50; 52 and 60.

In the density analysis, it is observed that in the formal networks there is a density of 34.6% while in the informal networks the results show 21.2%, which shows that the formal networks of this organization have greater connections.

As for centrality, individuals who are central in the formal network are not central in the informal network, with the exception of individual 4 who maintained centrality values very close in both situations.

In relation to reciprocity, it appears that there is a greater incidence of connections between individuals to which both communicate in informal networks. Individuals 12, 20 and 48 are among the ten with the greatest reciprocity in the two networks. The three are female and have an administrative role in the corporation.

Observing the clustering, it is verified that in the formal networks there is a higher incidence of crossings with a value of 0.551 against 0.464 in the informal one. Based on the analysis of egonet, individual 4 in the formal network coincides with the same position in the informal network.

The application of ARS in the company is positive because it gives the manager an overview of how formal and informal relationships take place in the organization, facilitating his work of strategic analysis, both from the professional interactions of the team and from the group's knowledge, from the perspective of image of relationships and how they happen. It is also possible to identify the role that individuals occupy in the internal network from the sociograms and observe the formal and informal connections that exist in them.

Attribute analysis were partially carried out, and it is possible to perform crosses considering gender and function. The other attributes such as time spent at home and age were not included in this study, being a recommendation for future analysis. It is also observed that, since it is a wide field of study, the application of ARS allows to evaluate other environments such as classrooms or even other organizations, being also a recommendation for future studies.

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