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THE INFLUENCE OF COOPERATION NETWORK AND EXTERNAL NETWORK BEHAVIOR ON COMPANY PERFORMANCE

A INFLUÊNCIA DA REDE DE COOPERAÇÃO E DO COMPORTAMENTO EXTERNO DE REDE NO DESEMPENHO DA EMPRESA

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Abstract

This article aims to analyze the influence of the cooperation network structure and external network behavior on the performance of biscuit manufacturing companies in the city of São Tiago. Social network analysis and structural equation modeling were used as a method. The results show that external network behavior influences both performance and network structure. This highlights the importance of social networks in business dynamics, suggesting that relationship building can impact performance. This research represents a relevant contribution to the understanding of relationship networks, as there are no prior studies on external network behavior published in Brazil.
Keywords: Social network analysis. External network behavior. Business performance. Cookie factories.

Resumo

Este artigo tem como objetivo analisar a influência da estrutura da rede de cooperação e do comportamento externo da rede no desempenho das empresas fabricantes de biscoitos da cidade de São Tiago. Como método, foram utilizadas a análise de redes sociais e a modelagem de equações estruturais. Os resultados mostram que o comportamento externo da rede influencia tanto o desempenho quanto a estrutura da rede. Isso ressalta a importância das redes sociais na dinâmica empresarial, sugerindo que a construção de relações pode impactar o desempenho. Esta pesquisa representa uma contribuição relevante para o entendimento das redes de relacionamento, uma vez que não há estudos anteriores sobre comportamento externo de rede publicados no Brasil.
Palavras-chave: Análise de redes sociais. Comportamento externo de rede. Desempenho empresarial. Fábricas de biscoito.

Introdução

Networks and their importance for the strategies and performance of micro and small enterprises (MSEs) and entrepreneurs have been investigated since the 1980s (Birley, 1986; Ostgaard & Birley, 1994; Larson, 1991; Grandori & Soda, 1995). The main reasons for using and/or forming networks are related to resource acquisition, reducing environmental uncertainties, seeking legitimacy, and cost reduction, among others (Oliver, 1990).

Network analyses have been conducted at both the dyadic and network levels to explore a variety of topics, such as knowledge transfer (Powell, 1998), patent issuance (Walker et al, 1997), capability acquisition (McEvily & Marcus, 2005), alliance formation (Gulati & Gargiulo, 1999), performance (Moran, 2005; Naudé et al., 2014; Wang et al., 2021), inter-firm cooperation (Gulati, 1995), governance forms of exchange relations (Larson, 1992; Uzzi, 1996), innovation (Ahuja, 2000; Moran, 2005), and survival (Watson, 2007), among others.

Social network analysis (SNA, hereinafter) has played a significant role in investigating business relationships (Burt, 1992; Kilduff & Tsai, 2008). To this end, several characteristics are examined, such as network density, the centrality of actors within these networks, their closeness, and brokerage. It is suggested that these characteristics, whether considered collectively or individually, may provide both benefits and constraints to firms. For example, in the case of density, where a network is more cohesive and its members are well-connected, this characteristic is proposed to foster trust among members, positively influencing business transactions (Coleman, 1988). On the other hand, less dense networks with higher clustering coefficients are considered more advantageous, as they enable the circulation of new, non-redundant information among members, leading to new opportunities (Burt, 1992).

Beyond SNA, it has been argued more recently that external networking behavior can influence the search for and formation of inter-organizational ties (Wolff & Moser, 2006; Ziani-Franclet, 2021). To the authors' knowledge, no publications in Brazil investigate external networking behavior, particularly concerning inter-organizational relationships and firm performance. This represents an important contribution to the present study, as it addresses a gap in the understanding of business networks in Brazil.

Considering this, this study aims to characterize and analyze the cooperation network among biscuit factory owners in São Tiago (MG), their external networking behavior, and firm performance. To achieve this objective, several specific goals must be pursued, including **i.** Characterizing the companies in size, founding date, and number of employees; **ii.** Developing the sociogram of the cooperation network; **iii.** Analyzing network variables such as centrality, betweenness, density, eigenvector, degree, and structural holes; **iv.** Examining the external networking behavior of the actors involved; **v.** Analyzing firm performance; and finally, **vi.** Investigating the impact of SNA indicators and external networking behavior on network structure, as well as the influence of both on firm performance.

This paper is presented in five sections, in addition to this introduction. The next section discusses the theoretical framework. In the second section, titled "Research Method," the methodological procedures are detailed. The third section presents the research results, consisting of the description and analysis of the findings. Concluding the paper, the fourth section presents the discussion and conclusions.

Theoretical Framework

Social Network Analysis (SNA) is widely used in the investigation of inter-organizational relationships and the performance of these organizations.

In an industrial cluster, specifically biscuit factories in São Tiago-MG, companies tend to present similar resources, cost structures, mental models, and competitive behaviors. However, they maintain unique and idiosyncratic network linkages, connecting to different actors, and as a result, they are exposed to new knowledge, ideas, opportunities, and constraints in a differentiated manner, creating sources of performance differences among the actors (McEvily & Zaheer, 1999).

The main concepts of Social Network Analysis (SNA) refer both to the position of the actor within the network – such as centrality, brokerage, and proximity – and the network as a whole – like density, for example – and have been fundamental in this analysis (Kilduff & Tsai, 2008).

Centrality refers to the position of an actor in the network and corresponds to the total number of direct connections an actor has with other actors in the network. This concept indicates whether a firm has quick and independent access to other firms through a few connections. The greater the number of connections an actor has, the higher their degree centrality and the greater the dependence of the other actors on that particular actor. This concept is also used in the analysis of structural holes (Hagedoorn & Duyster, 2002). The position of actors in the network is also important for the performance of companies (Powell et al., 1999).

It is argued that the centrality of an actor in the network can lead to higher returns because they have access to better information and opportunities than those who are more peripheral (Gulati et al, 2000; Naudé et al., 2014; Wanga et al., 2021; Seiler et al, 2020). However, there is empirical evidence showing that centrality is not an indicator that companies will have better performance or growth (Stam & Elfring, 2008; Bell, 2005; Powell et al, 1996) or be more innovative (Owen-Smith & Powell, 2004).

Even though firms may have similar positions in the network, they can have different performances, as they may exploit this position in diverse ways or exhibit different behaviors or interaction patterns (Zaheer & Bell, 2005; Gulati, 1999).

Later studies, however, identified a positive relationship between centrality and performance, with moderate to strong correlations between the actors, the subgroups formed by them, and their respective revenues and levels of centrality over the three years analyzed (Morgan et al, 2004; Bell, 2005; Ferreira et al., 2021). Furthermore, Wang et al. (2015) highlight that the impact of centrality on organizational innovation is more significant for small firms, while its influence on performance is more pronounced in large firms.

Moreover, just like centrality, access to structural holes proposed by Burt (1992) has a positive impact on performance (Naudé et al., 2014; Zaheer & Bell, 2005). Similarly, Zacharias et al (2023) found that firms occupying positions close to structural holes (gatekeeper positions) enhance performance. In the context of new ventures, structural holes in the network of entrepreneurs have a positive effect on the number of products of new firms but do not influence profit growth in the early stages of businesses (Batjargal, 2010b).

According to Burt et al (2013), individuals who connect through structural holes may have opportunities to coordinate other people who would otherwise be disconnected, granting them advantages by exposing them to different ideas, opinions, or practices. Acting as a 'bridge' between the nodes, they can reflect the diversity of information received by the firms (Zhang et al., 2023).

In addition to structural holes, denser networks have been associated with superior performance for firms (Zaheer & Bell, 2005). Interaction among network actors can also result in better performance for firms that interact more with other actors in the cluster (Quandt, 2012). On the other hand, in a corporate network of a firm, this position has a significant negative impact on strategic risk, although it does not influence its financial performance (Swiatowiec-Szczepanska & Stępie, 2022).

Furthermore, performance is associated with firms that have a higher degree centrality and exploit structural holes more effectively (Wang et al., 2021). In low-density networks, degree centrality and structural holes complement each other to increase firms' innovation performance, which does not occur in denser networks (Tan et al, 2014).

The external network behavior has been used both in the analysis between organizations and in the analysis of individuals. In addition to the characteristics of the network of the actors involved, the external network behavior of firms can also influence performance, as well as affect the structure of the actors' network itself. This behavior refers to the actors' conscious dispositions and efforts to use and/or alter the structure of the network in which they operate (Ford & Mouzas, 2013).

External network behavior can be described in three main aspects, as detailed in the Appendix: building contacts, which involves developing informal relationships with people outside the organization, such as attending association meetings or benefitting from business trips and training programs (items 1 to 3); maintaining contacts, which refers to sharing important information with acquaintances from other firms and using contacts to seek advice (items 4 to 6); and using contacts, which includes exchanging ideas and solutions to problems, as well as seeking updates on changes in acquaintances' businesses (items 7 to 9).

The behavior of actors in a network can influence both the network's configuration and performance, whether of individuals (as in career analyses, for example) or firms (Thornton et al, 2015; Naudé et al., 2014; Udimal et al, 2021; Wolff & Moser, 2006).

External network behavior can indeed have a significant impact on the formation of ties, the position of actors in the network, the creation of structural holes, the centrality of actors, and the size of the network, as argued by Ziani-Franclet (2021), Ebbers (2014), and Batjargal (2010a).

The relationship between behavior and the performance of firms and entrepreneurs is highly relevant, as this behavior not only affects the position of actors within the network but also organizational performance, as discussed by Thornton et al (2015), and Udimal et al (2021). Behavior can thus facilitate the creation of ties and directly impact the position of actors, as highlighted by Ebbers (2014).

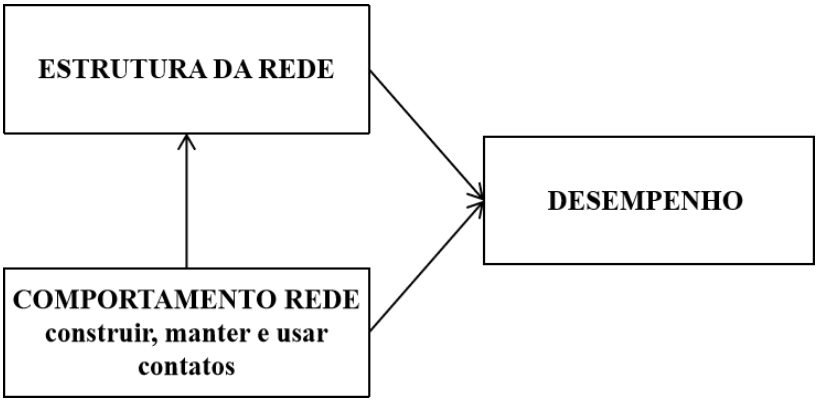
Moreover, when considering an actor's position in the network, it is important to analyze the company's characteristics, as innovative firms tend to achieve superior performance. Access to structural holes, as suggested by Zaheer and Bell (2005), is another relevant factor, as it significantly contributes to the improvement of firms' performance.

It is also important to consider the personal characteristics of business owners, as they may present barriers to the construction and maintenance of contacts. Some individuals may feel uncomfortable or intimidated when adopting external network behavior (Batjargal, 2010b). Furthermore, analyzing the formation of ties — a step that precedes the actor's position in the network — is essential to understanding the factors and individual characteristics that lead to centrality in the network, impacting performance and being especially relevant to entrepreneurs (Klein et al., 2004).

Based on the framework described thus far, a research model has been proposed in which the external network behavior of the actors influences the structure of the network, and both can influence performance.

The model is presented in Figure 1 below.

Figure 1 – Research model



Caption:
Estrutura da Rede – Network Structure
Comportamento Rede / construir, manter e usar contatos – External network behavior / building, maintaining and using contacts
Desempenho - Performance

The following presents the research method, including the measures of the variables to be analyzed, the research context, the sample, data collection, and the control variables.

Research Method

In this section, the research method, research context, sample, data collection, measures of the variables to be analyzed, and data analysis procedures are presented.
To achieve the proposed objectives and answer the guiding question, both qualitative and quantitative methods were adopted.

The qualitative method, based on interviews, was used to explore the research subject and establish initial contact with the universe to be investigated. To this end, six in-depth interviews were conducted using a semi-structured interview guide with leaders of the São-tiaguense Association of Biscuit Producers (ASSABISCOITO) and representatives from the companies in the FORTMAIS Group. The goal of these interviews was to obtain initial information for data collection from the biscuit manufacturers and to assess the clarity and understanding of the questionnaire through the reading and validation of the questions by the participants.

According to ASSABISCOITO, the city has 60 biscuit manufacturing companies, of which 14 are small (with more than 20 employees) and the remaining are microenterprises (with up to 20 employees). Given this scenario, the snowball sampling technique proved to be the most appropriate for data collection, as it is widely used in research involving small businesses, facilitating access to participants and enhancing the information-gathering process.

For the quantitative analysis, the UCINET 6.0 software (Borgatti et al, 2002) was used. This software, widely employed by researchers in SNA, allows not only the analysis of network variables but also the design of cooperation networks (sociogram).

To understand the impact of SNA indicators and the external network behavior on company performance, Structural Equation Modeling (SEM) was used, which combines multiple regression techniques and factor analysis into a single method. The modeling presents the results through a graph — the path diagram — and allows for evaluating the relationship between independent variables, the magnitude of their influence on the dependent variable, as well as the interaction between external

variables to the model and the independent variables. Therefore, this approach is particularly useful when a variable initially dependent becomes independent in subsequent dependency relationships (Pereira et al, 2019; Hair et al., 2005).

In addition, SEM can incorporate Latent Variables (LV) into the analysis, meaning theoretical concepts that are not observable and can be estimated through Observed Variables (OV) or measurable variables, corresponding to the values obtained from specific items or questions (Hair et al., 2005). In this study, the LV and OV are presented in Figure 2.

Figure 2: Latent Variables (LV) and Observed Variables (OV) of the Research Model

Latent Variables (LV)	Observed Variables (OV)
External Network Behavior	Build network relationship COMP1)
	Maintain network relationship (COMP2)
	Use network relationship (COMP3)
Network Structure	Degree (ESTR1)
	Betweenness (ESTR2)
	Eigenvector centrality (ESTR3)
	Effective Size (ESTR4)
	Constraint (ESTR5)
Performance	Overall Performance (DESEM1)
	Performance according to expectation (DESEM2)
	Performance compared to competition (DESEM3)

The first step in the SEM interpretation process was to evaluate the measurement model (relationships between indicators and constructs) using the Average Variance Extracted (AVEs), internal consistency (Cronbach's Alpha), Composite Reliability, and discriminant validity. Furthermore, to verify the non-collinearity between predictor constructs, the Variance Inflation Factor (VIF) was checked to ensure it was below 5.

In the second step, the structural model was analyzed through the evaluation of the Pearson determination coefficients (R2) and the values of the SEM correlations and linear regressions. To test the significance of the relationships indicated, the "Bootstrapping" module (a resampling technique) was used. Subsequently, the SEM correlation and linear regression values were analyzed to check for their significance between variables ($p \leq 0.05$). For correlation, the null hypothesis (H_0) is set as $R2 = 0$, and for regression, the path coefficient = 0. If the null hypothesis is accepted, the inclusion of LV or OV in the SEM should be reconsidered.

As a measure of residual adjustments, the Standardized Root Mean Square Residual (SRMR) was used, which evaluates the difference between the observed and the model-estimated correlations. In other words, it measures the discrepancy between sample correlations and the correlations estimated by the model. The SRMR value ranges from 0 to 1, and a value lower than 0.08 indicates a good model fit, while values between 0.08 and 0.1 indicate a reasonable fit (Hair et al., 2005).

For the discrepancy measure, the Unweighted Least Squares Discrepancy (d_ULS) and Geodesic Discrepancy (d_G) were used. To compare the developed model with the null or independence model, the Normed Fit Index (NFI) was applied, with values close to 1 being desirable. A value below 0.90 indicates an unsatisfactory fit. The SEM analysis was performed using the SmartPLS software.

2.1 Research Context

The choice to conduct this research in the city of São Tiago (MG), based on the guiding question "What is the configuration of the network of relationships of biscuit manufacturers in São Tiago (MG) and its influence on the performance of the companies?", is justified by São Tiago's proximity to São João del-Rei, which facilitates the execution of the study. Furthermore, the city is home to 60 biscuit factories, an association, and a Business Hub. São Tiago is nationally recognized as a producer of biscuits and sweets, holding a Geographical Indication granted by INPI – the National Institute of Industrial Property. The city is also the host of the *Festa do Café com Biscoito* (Coffee and Biscuit Festival), an event that began in 1999 and has gained significant proportions. The festival attracts around 100,000 tourists from all over Brazil, who come to taste over fifty thousand tons of biscuits, offered for sale and tasting in an open-air oven in the town square, accompanied by coffee – more than ten thousand liters. In addition to the biscuits, the event also showcases crafts, cachaças, and dairy products, such as cheeses and yogurts, all produced by local factories.

Abreu (2002, cited by Resende et al., 2012) states that São Tiago was "a stopping point for travelers on the so-called *'Caminho Novo'* (New Path), through which caravans, cattle herds, and troops coming from Rio de Janeiro headed towards the Triângulo Mineiro, Goiás, and vice-versa" (Abreu, 2002, p.123) and that in the past, the farms in the region would receive and feed travelers with sweets, becoming the main producers of confections in the entire region. This tradition of biscuit manufacturing continues to this day. Currently, São Tiago has about 60 formal and informal biscuit factories, with 14 small companies employing more than 20 workers, and the rest are micro-enterprises with up to 20 employees, according to information provided by the interviewees from the São-Tiaguense Association of Biscuit Producers (ASSABISCOITO).

2.2 Data Collection

As mentioned, São Tiago has 60 biscuit manufacturing companies. Since it is a small town, the snowball sampling technique is even more appropriate for data collection, as it allows almost 100% of the industries to be covered.

The snowball sampling technique is the most widely used in SNA for data collection (Hanneman & Riddle, 2005). When applying it, a small initial sample is defined for gathering data related to the network of cooperation among the interviewed actors. Then, based on the suggestions from the mentioned actors, new actors are included in the data collection process, and this continues until the names begin to repeat. This procedure is justified by the fact that obtaining data from the entire network of relationships can become an extremely costly and difficult task to execute (Hanneman & Riddle, 2005).

2.3 Sample

54 companies participated in the research. Among them, the majority – 45 companies (83.33%) – have been in operation for more than 10 years. All are micro and small enterprises (MSEs), with 41 microenterprises (75.93%), employing up to 20 people, and 13 small enterprises (24.07%), with 20 to 99 employees. It is noteworthy that fewer than half are members of ASSABISCOITO – 20 companies (37.04%). It is also important to note that 11 companies (20.37%) are part of the FortMais Group. These two factors indicate strong participation of members from the association and the business center in the research. Furthermore, it is important to highlight that 44.44% of the company owners (24) have over 15 years of experience in the sector.

2.4 Measures

2.4.1 Social Networks

In this study, cooperative relationships with competitors are analyzed, understood as those in which companies share information about business and market, participate in joint actions (such as marketing, and sales, among others), refer customers and suppliers, and make purchases of goods and services, among others. These relationships were based on Oliveira and Gonçalves (2014). The metrics proposed, widely used in Social Network Analysis (SNA), are as follows:

- Network Density: Proportion of the number of existing ties to the total number of possible ties.
- Clustering Coefficient: Introduced by Watts and Strogatz (1998), this concept indicates cohesion in networks. The clustering coefficient of a vertex is the ratio of the number of ties between its neighbors to the maximum number of ties possible between these neighbors. The general clustering coefficient is given by the average of the clustering coefficient of all nodes. It measures the degree to which nodes tend to cluster together.
- Geodesic Distance: Length of the shortest path that connects two nodes in a network, measured in terms of the number of ties.
- Network diameter: Measured by the longest distance between nodes in a network, i.e., the longest path among the shortest paths connecting the nodes, also known as the greatest geodesic distance in a graph.
- Degree Centrality: Total number of relationships (ties) of an actor in the network. In a directed network, both in-degree (arrows pointing in) and out-degree (arrows pointing out) of nodes can be considered.
- Structural Holes: The concept of effective size (Shipilov, 2009) was used. This measure not only considers the number of direct contacts of a company but also the ability to access other nodes in the network through its position in structural holes. The constraint (Burt, 2001, 2013; Burt & Sonja, 2024; Li & Liu, 2023) of the network was also used. Constraint measures how much a node's connections are restricted or limited by redundant ties within the network.
- Eigenvector Centrality: Reveals a central actor who is connected to others that are also well connected.
- Betweenness Centrality: Betweenness occurs when an actor serves as a bridge between two other actors who do not have a direct connection with each other (Spiro et al, 2013). It is understood at the actor level and refers to the actor's ability to mediate the relationship between the other two actors, and it is closely related to the concept of structural holes.

2.4.2 Performance

Regarding the performance of companies, both quantitative and subjective indicators were found in the literature reviewed. Quantitative indicators relate to production, patents, sales and profit, acquisition of capabilities, job growth, and innovation (Quandt, 2012; Zacharias et al, 2023; Ferreira et al., 2021; McEvily & Zaheer, 1999; Stam & Elfring, 2008). According to Edelman et al (2005), small businesses often do not formalize processes, routines, and decisions, which makes it difficult to collect secondary data such as revenue, among others. Additionally, Morgan et al (2004) and Dess and Robinson (1984) found a strong correlation between subjective and objective measures.

Thus, qualitative performance indicators were used. These indicators have been employed since at least 1984 (Dess & Robinson, 1984) and refer to satisfaction with the business, as well as the owner's perception of their control over the company (Gruber, 2007).

The definition of the indicators was done through surveys with the interviewees in the qualitative phase. During this phase, the interviewees stated that the questions were clear and would be easily understood by the factory owners. In this study, the following measures were used:

- Overall company performance in 2023 – 5-point Likert scale: very poor/excellent
- How was the company's overall performance concerning its expectations in 2023 – 5-point Likert scale: much worse than expected/much better than expected
- Considering the main competitors, with similar sales volume, how was your company's overall performance in 2023 – 5-point Likert scale: much worse/much better

These measures were based on Dess and Robinson (1984), Pelham and Wilson (1996), Quandt (2012), Naudé et al. (2014), Udimal et al (2021), and Olson et al (2005).

2.4.3 External Network Behavior

The external network behavior and its scales were originally developed by Wolff and Moser (2006), with a scale containing 60 items. In that same year, Wolff and Spurk (2006) created a new scale, composed of only 9 items. Several subsequent studies by Wolff and collaborators evaluated these scales (Wolff & Moser, 2009; Wolff & Moser, 2010).

The measures of external network behavior are entirely based on Wolff and Moser (2009, 2006, 2010), Wolff and Spurk (2019), and Naudé et al. (2014). According to Wolff and Moser (2006), external network behavior is a multidimensional construct encompassing building, maintaining, and using contacts, with three questions for each dimension. For all dimensions, a 5-point Likert scale was used – never/always (see Appendix).

2.4.4 Control Variables

The proposed control variables were the company size, measured by the number of employees, the founding year, and the company's association with ASSABISCOITO and/or the FORTMAIS GROUP. Company size was included as it is an important determinant of performance (Wincent, 2005), in addition to contributing to the increase in structural holes (Batjargal, 2010a).

Analysis And Results

In this section, descriptive statistics, network metrics and the structural model are presented.

3.1 Descriptive statistics

Below, in Table 1, are the descriptive statistics, with the means and standard deviation.

Table 1 – Descriptive Statistics

Constructs	M	DP
CHARACTERIZATION – Years		
Years of industry experience	10	8,40
Years of company existence	10	6,76
Number of employees in 2023	12	8,83
EXTERNAL NETWORK BEHAVIOR		
Build	2,56	1,35
Maintain	3,25	1,48
Use	3,30	1,43
NETWORK STRUCTURE		

Degree	4,037	3,302
Betweenness Centrality	0,015	0,029
Eigenvector Centrality	0,183	0,268
Constraint	0,404	0,318
Effective Size	3,182	2,602
PERFORMANCE - Likert 1-5		
Overall company performance in 2023	3,07	0,84
Relative to expectations	2,80	0,92
Relative to key competitors	3,07	0,64

It is observed that the owners of the companies have significant experience in the biscuit manufacturing sector (10 years), and the average age of the companies can also be considered high (10 years). As previously mentioned, the average number of employees is 12, indicating that most of the companies are classified as microenterprises (up to 20 employees).

The average for the indicator 'contacts from the external network behavior construct to seek business advice' (2.80) is the lowest among the three indicators for 'Building contacts.' Additionally, the average for the 'Building contacts' dimension (2.56), one of the three dimensions of external network behavior, is the lowest among the three dimensions (building, maintaining, and using).

Regarding the network structure indicators, it can be inferred that the average degree centrality is 4, indicating a relatively low number of connections, considering the total possible links. Betweenness Centrality, which indicates whether an actor acts as a bridge between other actors, shows a value of 0.015, which can also be considered low. The Eigenvector Centrality indicator reveals a central actor who is connected to others that are also well-connected. Since the value is 0.183, and this centrality measure depends on the number of neighboring nodes, it can be understood as low.

Burt's Constraint, with a value of 0.404, is higher when the ego has fewer related contacts, meaning more redundant ones. The higher this value, the fewer structural holes will exist in the network. Since the value of the constraint is 0.404, the connections are not entirely open to new opportunities, but they are also not completely closed, with the maximum value being 1. The effective Size is also low, with an average of 3.182, as the average number of contacts is 4.

The overall performance of the companies, with an average of 3.07, was considered good by the owners, according to the Likert scale. Regarding the entrepreneurs' expectations, the average of 2.80 is close to being considered positive, also according to the Likert scale. In relation to competitors, the managers evaluated the performance similarly.

3.2 Quantitative metrics for network analysis

Below is an analysis of the network metrics and the sociogram of the factories' relationship network.

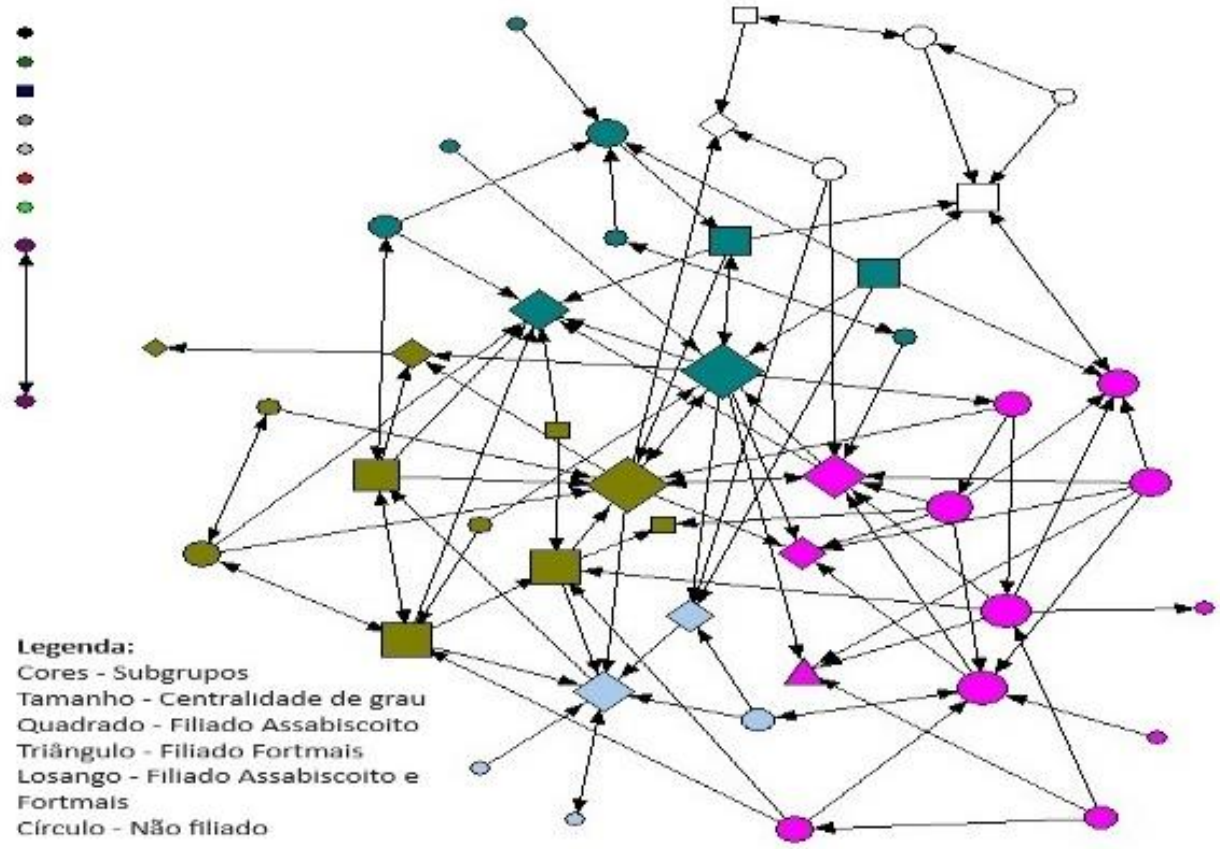
Table 2 – Network metrics

Indicators	Values
Network density	0,096
Average degree	4,22
Network diameter	6
Average path length	2,75
Communities	5
Clustering coefficient	0,203

Table 2 presents the network metrics of the biscuit factories in São Tiago. The network density is 0.096, indicating that the network is sparse, with a reduced number of connections between nodes concerning the total number of possible connections. The average degree of the network is 4.22, meaning that, on average, each node is connected to approximately four other nodes, which may contribute to the dissemination of information and collaboration. The network diameter is 6, representing the greatest distance between nodes within the network, while the average path length, of approximately 2.75, indicates that, on average, fewer than three connections are needed to reach any other node, promoting relatively efficient communication.

According to the modularity algorithm used in SNA, the presence of five communities (subgroups) suggests that the network is segmented into distinct groups, possibly with common characteristics or interests. The clustering coefficient, 0.203, indicates that the companies show some tendency to group nodes, reflecting the degree to which these factories tend to organize themselves into clusters. The network can be visualized in Figure 3.

Figure 3 - Sociogram of the relationship network



Caption:
Colors – Subgroups
Size – Degree centrality
Square – ASSABISCOITO affiliated
Triangle – Fortmais affiliated
Lozenge – ASSABISCOITO and Fortmais affiliated
Circle – Not affiliated

An initial observation concerns the presence of nine companies that are not connected to the rest of the network. Additionally, seven companies have only one contact in the network, which could function as either indegree (receiving nominations from other actors), outdegree (nominating other actors), or both (depending on the direction of the arrows). Among these seven actors, one is notably associated with both ASSABISCOITO and the Fortmais Group, which influences the low density of the network. It is also noticeable that the central factories are mostly associated with ASSABISCOITO and/or the Fortmais Group, while the non-associated ones tend to occupy peripheral positions in the network.

3.3. Structural Model

Upon conducting the first analysis with all latent variables, the observed variables ESTR1 were excluded due to high collinearity (VIF) with ESTR4, as well as the variables ESTR5 and DESEM3, due to non-significant external loadings. Subsequently, a second analysis was performed, and the results (Table 3) indicate that the constructs 'External Network Behavior,' 'Network Structure,' and 'Performance' maintained convergent validity for all external loadings, as well as internal consistency and discriminant validity.

Table 3 – Construct Validation

	Convergent Validity			Internal Consistency			Discriminant Validity
	External Loadings			AVE	Cronbach's Alpha (CA)	Composite Reliability (CR)	Cross Loading
Reference Criteria			p-values	> 0,5	> 0,6	> 0,7	Higher Factor Loadings in Respective Constructs
External Network Behavior	COMP1	0.853	0,000	0,688	0,780	0,869	Yes
	COMP2	0.827	0,000				
	COMP3	0.808	0,000				
Network Structure	ESTR2	0.906	0,000	0,777	0,857	0,912	Yes
	ESTR3	0.807	0,000				
	ESTR4	0.927	0,000				
Performance	DESEM1	0.934	0,000	0,808	0,769	0,894	Yes
	DESEM2	0.863	0,000				

Upon completing the assessment of the measurement model, the next step was to evaluate the structural model. The structural model was estimated based on the direct effects (Table 4), observing a strong and significant direct effect at 1% from 'External Network Behavior' on 'Performance' (0.481) and on 'Network Structure' (0.454), but a weak and non-significant direct effect from 'Network Structure' on 'Performance' (-0.148).

Table 4 – Path Coefficients (Direct Effects)

Constructs	Original Sample	Bootstrap Sample Mean	Standard Deviation	p-Values
External Network Behavior → Performance	0.481	0.498	0.158	0.002
External Network Behavior → Network Structure	0.454	0.471	0.121	0.000
Network Structure → Performance	-0.148	-0.137	0.158	0.348

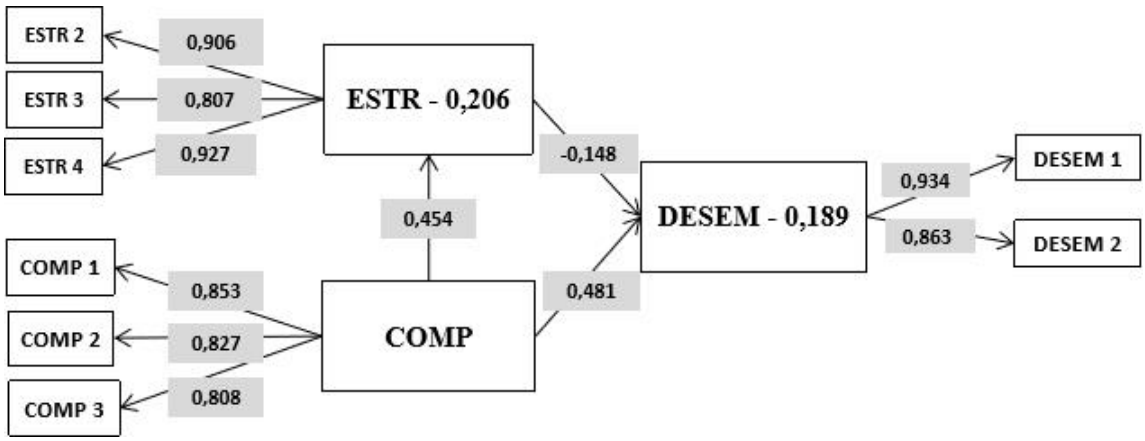
Regarding the total effect between constructs (Table 5), it is observed that the effect of External Network Behavior on Performance is weaker, but significant at 5%.

Table 5 – Total Effect

	Original Sample	Bootstrap Sample Mean	Standard Deviation	p-Values
Net. Behavior → Net. Structure → Performance	0.414	0.428	0.137	0.003

The Pearson determination coefficients (R^2) measure the proportion of variance in the endogenous variables explained by the structural model. Together, the exogenous constructs 'Network Behavior' and 'Network Structure' explain 18.9% of the variance in the endogenous construct Performance (R^2 = 0.189). Additionally, Network Behavior explains 20.6% of the variance in Network Structure (R^2 = 0.206), as illustrated in Figure 4.

Figure 4: Measurement of the Structural Model of External Network Behavior and Network Structure on Performance.



Caption:
ESTR – Structure
COMP – Behavior
DESEM – Performance

The VIF analysis indicated the absence of excessive collinearity between the constructs and indicators, reinforcing the non-redundancy of the components of the structural model. When examining the residual fit measure, an SRMR of 0.109 was observed, which, according to Hair et al. (2005), indicates a weak fit. The values of d_ULS (0.424) and d_G (0.243) fall within an intermediate range, not representing a perfect fit. The NFI, on the other hand, presented a value of 0.633, below the commonly accepted threshold of 0.90, suggesting the possibility of improvements in model fit.

In summary, the estimated model does not exhibit an ideal fit. While the values of SRMR, d_ULS, and d_G are acceptable, the NFI is relatively low, which represents a limitation of this study. However, the evidence that External Network Behavior influences both Network Structure and Performance emphasizes the role of cooperation among biscuit manufacturers in improving business performance.

Discussion and Conclusions

This study presented a research model to evaluate the impact of network structure and external network behavior on the performance of micro and small biscuit manufacturing companies. The aim was to broaden the understanding of the factors that influence performance, with an emphasis on

including external network behavior in the analyses.

The results showed that both the network structure and the companies' performance are impacted by external network behavior. This finding aligns with the evidence presented in the literature (Thornton et al, 2015; Naudé et al., 2014; Udimal et al, 2021), although the indicators of the full model did not prove robust. However, it is worth noting that the external network behavior construct test showed statistical consistency, which validates this conclusion. Therefore, its application is suggested in future research, both in small and large companies.

Contrary to expectations, the network structure did not prove to be relevant in explaining the performance of the companies. It is also worth noting that there are nine companies disconnected from the analyzed network. These companies, located in São Tiago, are part of the group of companies considered in the research, but they were not included in the structural model analysis or the other analyses presented earlier.

It is also important to highlight that three centrality metrics were included in the analysis model – degree centrality (ESTR1), betweenness centrality (ESTR2), and eigenvector centrality (ESTR3) – with only ESTR2 and ESTR3 remaining in the final analysis due to high collinearity (VIF) with ESTR4 (Effective Size). The inclusion of three metrics aimed to evaluate the main centrality measures to provide a more detailed investigation of the network structure. As previously presented, all measures were considered low.

There is also evidence that centrality does not necessarily indicate that companies will achieve better performance (Stam & Elfring, 2008; Bell, 2005; Powell et al, 1996). Additionally, there is evidence that centrality influences the performance of large companies. The network density is 0.096 (9.6%), indicating that the network is sparse, with a low number of connections between actors relative to the total possible connections. This indicator may have rendered the network structure irrelevant in explaining performance, given that in less dense networks, centrality tends to enhance performance in innovation (Tan et al, 2014) and, in small businesses, in organizational innovation (Wang et al., 2015). Finally, companies may exploit their position in the network in various ways or have distinct interaction patterns (Zaheer & Bell, 2005; Gulati, 1999).

It's also worth noting that the degree centrality and network density are very low, at 4 and 0.096, respectively. This fact may indicate a low interaction among the related actors. Therefore, the impact on performance was not confirmed, as greater interaction among actors can result in better performance (Quandt, 2012).

It is also important to consider that some intervening variables may influence behavior and, consequently, network structure, although they were not included in this study, which primarily focused on testing, it is reaffirmed, external network behavior. For example, as previously mentioned, the personal characteristics of business owners may impact both behavior and network structure. The average score for the "using contacts" indicator, within the external network behavior construct, for seeking business advice (2.80) is the lowest among the three indicators under "Building contacts." Among the surveyed companies, 27.78% reported never seeking business advice, and 18.50% do so rarely, totaling 46.30%. Additionally, the average score for the "Building contacts" dimension (2.56), one of the three dimensions of external network behavior, is the lowest among them (building, maintaining, and using contacts).

It may also be valid to assert that these personal characteristics, which include the fact that individuals may feel uncomfortable or intimidated when adopting an external network behavior (Batjargal, 2010b), could also explain this result. It is relevant to highlight that 50.01% of the companies have been in

existence for more than 10 years, and 59.26% of the owners have over 10 years of experience in the sector. Since these companies have been established in the city for a long time and their owners are experienced, a higher number of connections within the local network was expected, especially considering the existence of an industry association with only 20 members. These factors suggest that owners' characteristics may have influenced these results. It is also important to note that external network behavior precedes the formation of ties and the positioning of actors within the network.

4.1 Theoretical Contribution

The main theoretical contribution of this study lies in the use of external network behavior to assess network structure and firm performance, given that, as mentioned, there are no studies in Brazil that address this construct. Furthermore, it is asserted that studying external network behavior is important for investigating the formation of ties and, consequently, the positioning of actors within the network and their performance (Ebbers, 2014).

4.2 Managerial Contribution

Based on the findings of this study, particularly the impact of external network behavior on firm performance, it may be relevant to encourage managers to build and utilize contacts/ties, leveraging the benefits of being connected. If this occurs, it is advisable to establish connections with central actors, as these actors possess valuable information and opportunities (Wang et al., 2021; Seiler et al, 2020) that can be leveraged by firms, influencing their performance.

Additionally, companies are encouraged to participate in industry associations, as observed in the sociogram presented, where central firms are affiliated with ASSABISCOITO and/or FortMais Group.

4.3. Future Research and Limitations

Considering that this study analyzes external network behavior— a topic that, as mentioned, lacks published research in Brazil— an effort was made to test this construct in combination with network structure and performance. Future research could include other variables that may influence the constructs analyzed in this study. For instance, Brass et al. (2004) and Watts et al (2006) suggest that business owners' social characteristics, such as education level, local origin, and years of experience, may impact firm performance.

Additionally, Naudé et al. (2004) propose that emotional intelligence can influence both behavior and network structure. It is also argued that individual personal characteristics affect actors' central positions (Klein et al., 2004). Moreover, business owners may feel constrained, uncomfortable, or intimidated when adopting external network behavior (Batjargal, 2010b), which could result in external network behavior and structure that do not necessarily lead to superior performance.

Finally, it would be important to assess how external network behavior influences vertical ties— both upstream and downstream— with suppliers and customers, as there is evidence that these connections impact performance (Baum et al, 2000).

Furthermore, the use of resources acquired through the network may be influenced by absorptive capacity (Cohen & Levinthal, 1990), which refers to the ability to assimilate information and knowledge and apply them internally, as well as by the resources held by firms and their relational capabilities (Dyer & Singh, 1998).

Despite the precautions taken in conducting this research, some limitations must be acknowledged. This study focused exclusively on testing external network behavior, network structure, and performance. This decision was made due to the lack of publications in Brazil assessing the suitability

of external network behavior scales, although a preliminary evaluation was conducted with six research participants to ensure the clarity and comprehension of the questionnaire items. While the reliability of the scales used was assessed, this is the first time they have been applied in Brazil. Future research could examine their suitability in other contexts, further testing the reliability of these constructs.

Additionally, as 25 of the surveyed companies have two or more partners (46.30%), and only one partner was interviewed per company, the study reflects only one partner's perception of external network behavior and business performance.

These limitations, therefore, provide opportunities for further research and expansion in future studies, which could contribute to a more comprehensive and detailed understanding of external network behavior and its impact on business performance across different contexts and organizational configurations.

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Appendix – Measures of External Network Behavior

ITEMS	1	2	3	4	5
Building Contacts					
1. I develop informal contacts with people outside the organization, creating personal connections beyond the company.					
2. I participate in association meetings (e.g., unions, associations, etc.).					
3. I use business trips or training programs to build new contacts.					
Maintaining Contacts					
4. When I obtain informal information that could be important for acquaintances from other companies, I pass it on to them.					
5. I use my contacts outside my company to seek business					
6. For business purposes, I maintain contact with former colleagues.					
Using Contacts					
7. If I meet acquaintances from other companies, I reach out to them to learn about updates and changes in their businesses.					
8. I exchange tips and suggestions with acquaintances from other organizations.					
9. When I can't solve a work-related problem, I call acquaintances from other organizations and ask for advice					

Source: based on Wolff and Moser (2009, 2006, 2010), Wolff and Spurk (2019), and Naudé et al (2014)

Caption:
1. Never
2. Rarely
3. Sometimes
4. Often
5. Always