Identification of Irregularities in public procurement using SAS tools.

José Alexsandre Fonseca da Silva
alex@tce.ce.gov.br
Court of Audit of the State of Ceará (TCE-Ceará)

ABSTRACT

150 million dollars. This is the volume of financial resources that the Court of Audit of the State of Ceará (Brazil) identified, in the period of January 2016 to March 2018, as possible irregularities with the implementation of the data analysis and analytical intelligence project to identify irregularities (fraud) in purchases using SAS® tools. The Court of Audit of the State of Ceará (TCE-Ceará) is the public institution responsible for the control of public assets and resources of the State of Ceará, promoting ethics in public management in order to guarantee the full exercise of citizenship of the population of Ceará. It can be observed that companies organize themselves in an improper way, such as the creation of cartels, for example, to increase their profit margins, circumventing legislation and implementing illegal methods to win bids. This work presents the methodology, procedures and techniques applied with the SAS Guide software, SAS Enterprise Miner and SAS Social Network Analysis, which allow the crossing of data, application of sophisticated algorithms and creation of networks of relationships between companies and people, which are making it possible to identify around 600 million reais in public tenders with signs of irregularities, contributing to the reduction of corruption in the state of Ceará (Brazil).

INTRODUCTION

The Court of Audit of the State of Ceará (TCE-Ceará) is the public institution responsible for controlling public assets and resources of the State of Ceará, promoting ethics in public management in order to guarantee the full exercise of citizenship of the population of Ceará. It has the constitutional competence to supervise and judge the good and regular application of public resources by administrators and other officials, assisting the State Legislative Assembly in the exercise of external control.

THE BUSINESS PROBLEM

The procurement is a formal administrative procedure in which the Public Administration calls, by means of conditions established in its own act (notice or invitation), companies interested in submitting proposals for the offer of goods and services.

Therefore, it aims to ensure compliance with the constitutional principle of isonomy and to select the most advantageous proposal for the Administration, in order to ensure equal opportunity for all interested parties and to enable attendance at the contest of the largest possible number of participants.

However, the public administration in the execution of its bidding processes may be victim of agreements made by participants to set prices, divide markets, establish quotas or restrict production, which damages the provision of public services to society.

Thus, the present article aims to identify evidence of collusion practices among bidders in public acquisitions designed to obstruct their competitive character.

In order to achieve the stated objective, the following audit question was formulated:
Are there, in the biddings practiced by public entities subject to the jurisdiction of the Court of Audit of the State of Ceará (TCE-Ceará), companies acting in collusion frustrating the competitive process required by law in public procurement?

HOW TO IDENTIFY THIS TYPE OF FRAUD

For the identification of possible indications of irregularities in municipal bidding, the following bases were used: Municipal Information System (SIM); Municipal Tender Portal, Registration of Individuals, Lawyers, Members and Accountants of the Federal Revenue Service of Brazil, Annual Report of Social Information (RAIS) and payroll of municipal public servers.

SAS TECHNOLOGIES USED

The Court of Audit of the State of Ceará made the acquisition in august, 2016 of the SAS Fraud Framework for Government solution and through the SAS tool Enterprise Guide, SAS Enterprise Miner and SAS Social Network Analysis, of the Guide all the investigations were developed to identify possible irregularities in public tenders of the State of Ceará.

The methodology used to reach the results observed the following steps:

1ª) Study of the theme (literature review);

In order to better address the problem of possible irregularities in public tenders of the State of Ceará, a study was made of: i) the national and state legislation pertinent to the topic; ii) of jurisprudence in the Judiciary and in the other Courts of Account in Brazil; iii) of the understanding within the scope of this Court of Accounts. Finally, in order to align the work with the TCE-CE Audit Unit responsible for continuing the fieldwork, a number of dialogues took place with the TCE-EC Bid development.

2ª) Definition, collection, reception and organization of databases;

After the study of the theme and the definition of the best approach to the problem, the data necessary to carry out the work was defined, as well as who were the holders of this information. Once the Jurisdiction was notified to submit the information (an inherent power of the Account Cuts), a computerized environment was prepared to receive and organize the presented data.

3ª) ETL (Extract, Transform, Load) of the databases (Figure 1);

Given the heterogeneity of the sources of this information, each database underwent an extensive ETL process (70% of effort), which aimed to: improve information quality, standardize formats, standardize fields, exclude duplicities, etc., taking caution to minimize the loss of information.

Figure 1 - Example of ETL in databases
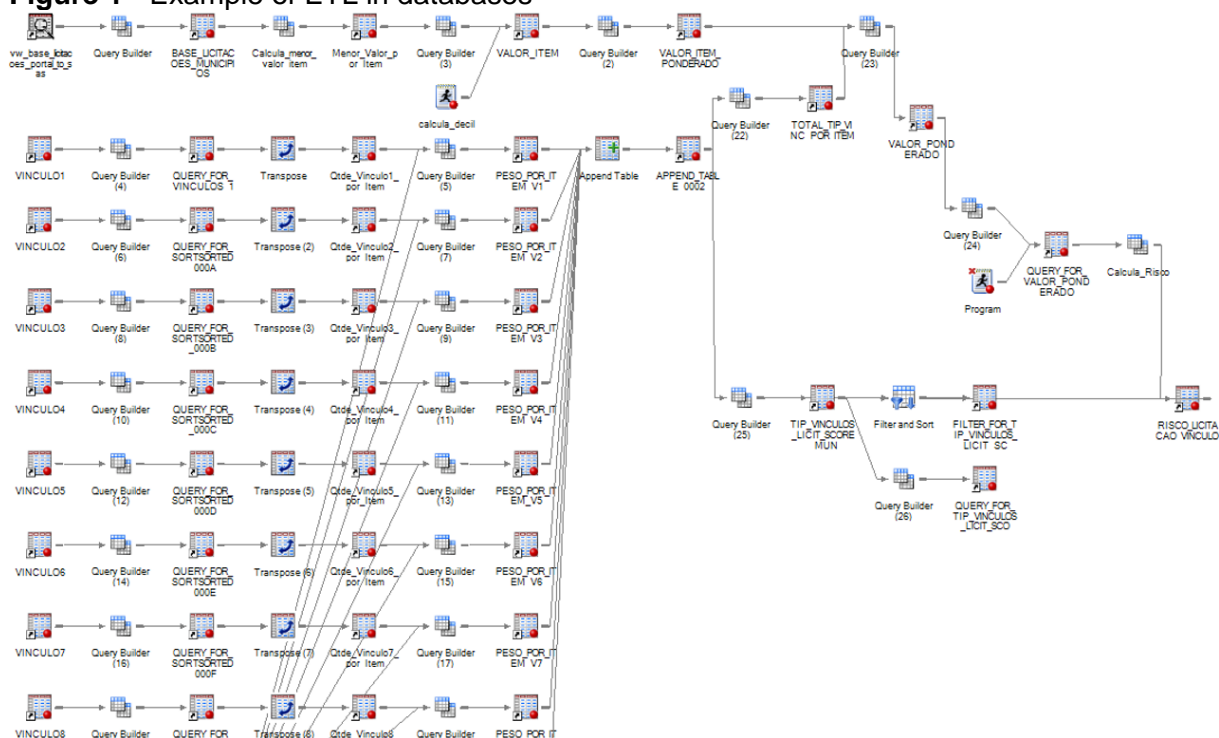
Source: Prepared by the author.

4) Development of the risk factors inherent to the biddings

Considering a large number of bids, 20,000 only in 2017, a risk matrix was created as a strategy for ranking bids with higher rates of irregularities.

In order to elaborate a ranking of tenders with greater risk of presenting irregularities, several aspects were considered involving bidders, bidding committee and their relations.

The relationship was divided into 3 parts:
• Types of Legal Person
• Typologies of Links between involved parties in the bidding process
• Market Basket Analysis

After calculating these typologies a score was defined for each bid and the ranking was set up which could be visualized through SAS Social Network Analysis. The Score adopted the maximum value of 1,000 points which was calculated by the following formula:

> **Score = Typologies of legal person + Typologies of links + Market Basket Analysis**

The detail of the elaboration of the risk matrix is specified below:

1) Typologies of Legal Person

This risk factor is related to the knowledge process of each company involved in the bidding processes. That is, in this factor the companies were submitted to 54 typologies, which represent characteristics or indications of irregularities, in which it was possible to have a broader risk view of each one of the participating companies. This risk factor had a maximum score of 400 points.

It is important to note that the severity of each typology was extensively discussed with the specialized areas of the TCE-CE and had their points worked as follows:

A) For each company that participated in the bidding process, 54 typologies were tested, where the company received a value of 0 for unverified typologies and 1 for typologies.

B) The company receives a calculated value as follows:
    1. If the company was the winner of the bid and fell into some critical typology, it received the maximum score for the "Type of Legal Entity".
    2. Otherwise, the legal entity received the sum of the typologies observed.

C) The bid was the same score as the legal entity that received the highest score among its participants, even if it didn't win.

D) The results of the bids were divided into deciles and the bids received from 40 to 400 points, according to Table 1 below:

Table 1 - Scores the bids based on the typology of Legal Entity

Decil	Value
1º	40
2º	80
3º	12
4º	160
5º	200
6º	240
7º	280
8º	320
9º	360
10º	400

Source: Prepared by the author.

2) Typology of Ties

This risk factor was aimed at proving ties among the companies participating in the same bidding item, in which they were proven by means of rules aimed at identifying corporate relations between companies, kinship relationship between the partners of the companies, corporate relationship between the partners and the members of the bidding committee and relationship of kinship between the members of the commission of procurement, among others.

By doing so, it was possible to identify that the companies that participated in the same bidding item maintained links between them. This risk factor had a maximum score of 400 points and the severity of each possible link was widely discussed with the specialized areas of the TCE-CE.

These bond typologies had their points worked as follows:

A) For each item of the bid, the number of times the typology occurred was verified, being assigned this number to the item.

B) Then, we performed the weighted sum of the typologies for each item, according to didactic examples shown in Table 2 below.

Table 2 - Weighted sum of the typologies per item

		Typology 1	Tipology 2	...	Tipology n		TOTAL
	Item 1	(3 x 80)	(1 x 60)	...	(3 x 100)	=	800
	Item 2	(2 x 80)	(4 x 60)	...	(2 x 100)	=	600
Bidding X	.	.	.		.		
	.	.	.		.		
	.	.	.		.		
	Item n	(5 x 80)	(2 x 60)	...	(2 x 100)	=	1200

Source: Prepared by the author.

The weights of each link typology are listed in Table 3 below:

Table 3 - Types of links between bidders

CODE	Description of typology	Score
Link_1	Link between corporate bidders through related business associates	80
Link_2	Procurement committee member is the business partner of a participating company	100
Link_3	A bidder, business associate of a member of the procurement in a corporation.	80
Link_4	Link between corporate bidders through common legal entity association	50
Link_5	Bidding companies with common employees	60
Link_6	Partner of bidding company employed by other bidder	80
Link_7	Relationship of kinship between partners of companies participating in bid	60
Link_8	Member of the bidding committee relative of the bidding partner	80
Link_9	Bidder related to a member of the commission	80

Source: Prepared by the author.

It is important to emphasize that the weight of each type of link was widely discussed with the specialized areas of the TCE-CE.

C) Each item also receives a value according to its materiality, as shown in Table 4 below:

Table 4 - Weight of the bidding item according to materiality

Decil	Value
1º	0,1
2º	0,2
3º	0,3
4º	0,4
5º	0,5
6º	0,6
7º	0,7
8º	0,8
9º	0,9
10º	1

Source: Prepared by the author.

D) The materiality weights determined in item C were multiplied by the value of each item received for the "Bond Typologies", as calculated in item B.

E) The bid received the value of the item that obtained the highest score weighted by materiality (calculated in item D).

F) Finally, the 400 points were distributed among all procurement using the decile.

Figure 2 shows the result of this stage of the project developed in SAS Guide.

3) MARKET_BASKET association rules

This risk factor had as its objective the identification of patterns of associations between the companies participating in public tenders. It received as its maximum score 200 points and the SAS Guide and the SAS Enterprise Miner were used for its development, for which the following rules were adopted.

A) Considering that a bid can have one or more items and a company can participate in one or more items, it was established that the associations would be verified only for the companies that were competing in the same bidding item. That way, the Market Basket was generated using as an association node the compound key NUMBER OF BIDDING + ITEM.

B) Market Basket was generated considering the following associations: two companies, [A] implying [B]; and three companies, [A] implying [B & C] or [A & B] implying [C];

C) Associations were considered only when the SUPPORT and the LIFT is greater than 80.

The following figures show the development of associations between two and three companies.

Figure 2- Preparation of Market Basket base - 2 companies
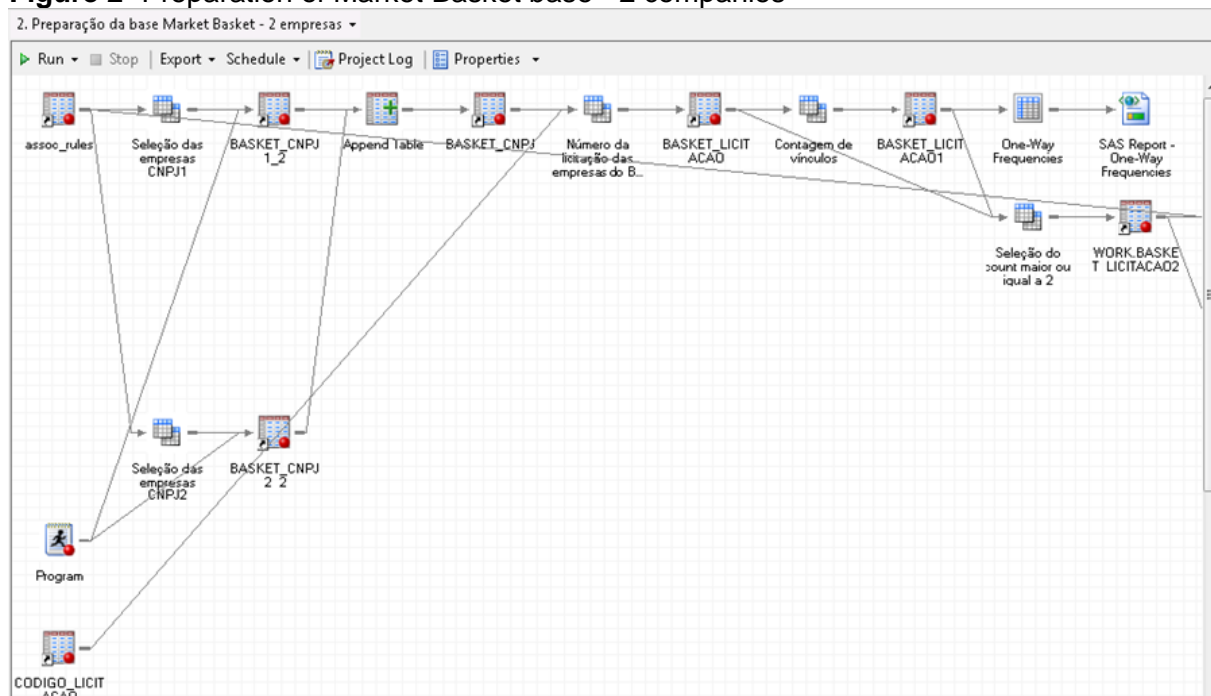
Source: Prepared by the author.

Figure 3 - Market basket preparation - 3 companies
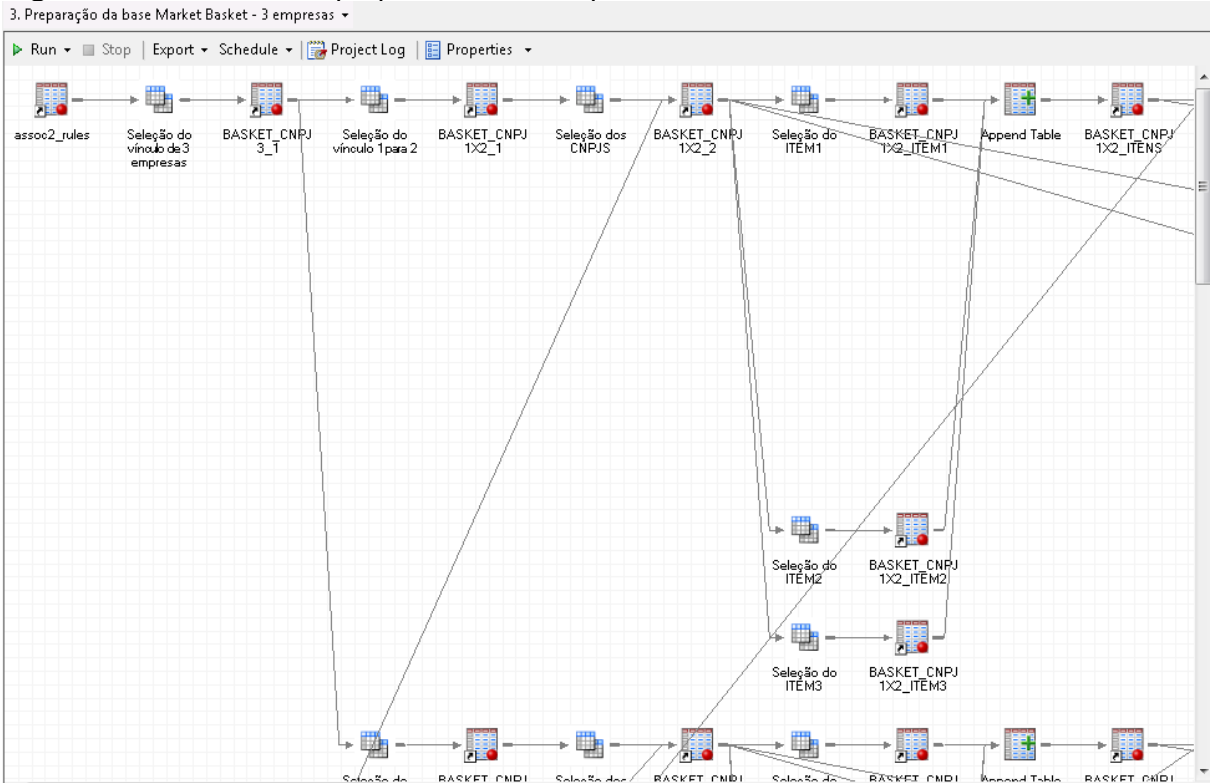
Source: Prepared by the author.

Once the associations between two and three companies were developed, as demonstrated in the two previous figures, the consolidation of these associations was made possible, creating the details of the Market Basket, as can be seen in figures 4 and 5 below.

Figure 4 - Market Basket Details Screen Preparation
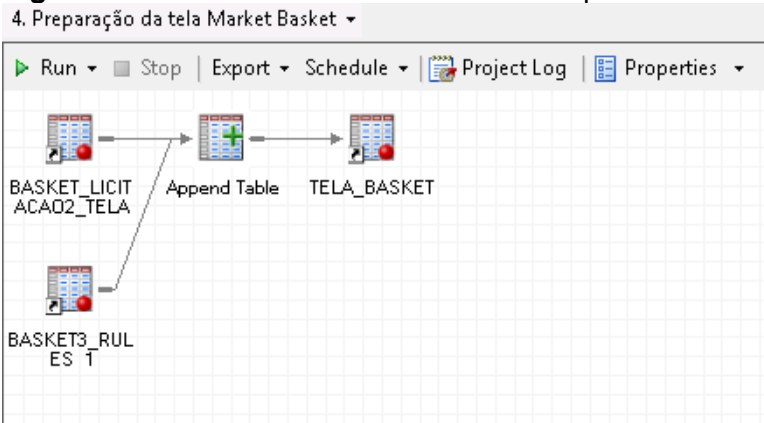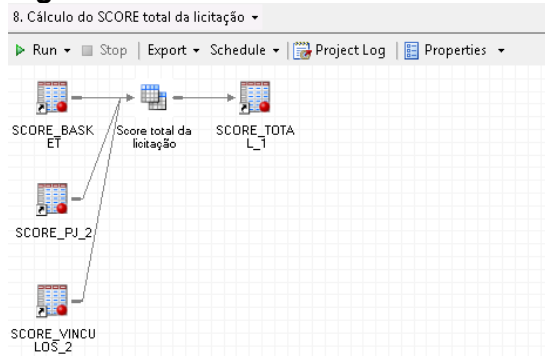

Source: Prepared by the author.

Figure 5 - Market Basket Details Screen

Confiança (%)	Suporte (%)	Lift	Regra de associação
100	1,166	77,2	23456021000111 & 03117440000111 ==> 04802280000102
100	1,166	85,778	03117440000111 ==> 23456021000111
100	1,166	85,778	03117440000111 ==> 23456021000111 & 04802280000102
100	1,166	85,778	04802280000102 & 03117440000111 ==> 23456021000111
100	1,166	85,778	23456021000111 & 04802280000102 ==> 03117440000111
100	1,166	85,778	23456021000111 ==> 03117440000111
100	1,166	85,778	23456021000111 ==> 04802280000102 & 03117440000111

1 - 7 de 7 resultados

Source: Prepared by the author.

After the three risk factors were developed, the accounting was performed, so that the final score for each bidding process was reached, making it possible to rank them based on risk. Figure 6 shows the stage that made the consolidation of the risk factors adopted for the project.

Figure 6 - Calculation of total bid SCORE

Source: Prepared by the author.

After completing all these steps, the Bid Panel was developed in SAS Social Network Analysis, which will be described below.

5) Development of the bid risk panel

The risk panel had as objective to present the tenders ranked based on the risks adopted in this project. In addition, through the use of filters, the identification of specific bids and the reasons for its classification allowed a more assertive targeting for the analysis of the TCE-CE area responsible for audits of the public bids of the State of Ceará.

Figure 7 - SNA home screen

Source: Prepared by the author.

Figure 7 shows the initial screen of the SNA, as you can see, the bids are listed with their respective risk scores.

The initial screen consists of the following fields: Bid Code, Administrative File Number, Bidding Number, Year, City, Mode, Status, Bid Value (R$), Number of Companies, Number

of Items, Market Basket and Score.). More than one bid can be selected if the analyst wishes.

In the left corner you can make several filters (Bid Code, Year, Municipality, Mode, Situation, Bid Value (R$), Market Basket and Score).

In addition, in the upper bar a free filter can be made, in which it makes the consultation more specific and fast.

Once the selection is made, the user is directed to the SNA Details screen as shown in Figure 8 below.

Figure 8 - SNA Details screen

Source: Prepared by the author

In this environment presented in Figure 8, the user has access to several information that make it possible, in addition to the identifications of registration information of the bidding and the participating companies, the different typologies that were verified giving an understanding to the TCE-CE analyst of the signs of irregularity during this public bidding process.

Each part in this SNA Details screen will be explained in more detail later.

Figure 9 - SNA Details screen

Source: Prepared by the author

The Details screen, Figure 9, the user has access to registration data of the selected bidding through the following information: Bidding number, City, Type, Year, Quantity of companies, Quantity of items, Category, CPF(Social Security Number) of the responsible and CPF(Social Security Number) of the competent authority.

Figure 10 - SNA SCORECARD screen

Scorecard	Notas	
ScoreCard		
Tipologia	**Descrição da regra**	**Score**
VINCULO_1	VÍNCULO ENTRE LICITANTES PJ POR MEIO DE SÓCIO PF EM COMUM	80
VINCULO_6	SÓCIO DE EMPRESA LICITANTE EMPREGADO DE OUTRA LICITANTE	80
VINCULO_7	VÍNCULO DE PARENTESCO ENTRE OS SÓCIOS DAS PJS LICITANTES	60
CREDOR_PJ_02_01	PJ COM UM EMPREGADO NA RAIS	80
CREDOR_PJ_02_02	PJ SEM EMPREGADOS NA RAIS	100
1 - 18 de 18 resultados		‹ 1 › 18 ▾

Source: Prepared by the author

Figure 10 has the function to present to the user all the typologies that were identified in the analyzed bid. Three pieces of information are presented: Typology, Rule Description and Score.

Figure 11 - SNA Companies Screen

CNPJ	Razão social	Nome da empresa	Endereço	Município	Estado	Data de abertura	CPF do responsável	Nome do responsável	Capital social (R$)	Código do item	Valor da proposta (R$)	Venc
21443731000181	CLINITI CARIRI LTDA - ME	ORTOFISIO	RUA EDMUNDO DE SA SAMPAIO 260 CENTRO	BARBALHA	CE	2018-04-10	00697054373	JOSE ALEX SARAIVA DE SA BARRETO	100.000	781561	50.000	SIM
05465299000173	ASSOCIACAO PESTALOZZI DE BARBALHA	CENTRO DE AEE E CLINICO MINERVA DIAZ DE SA BARRETO	AVENIDA JOSE BERNARDINO S/N BURITI	BARBALHA	CE	2018-04-10	14002035387	MARIA CILANIA PARENTE DE SA BARRETO	0	781561	57.500	SIM
21892178000164	TERESA SILVANA NOGUEIRA DA SILVA - ME	ESPACO ATIVO	AVENIDA MINISTRO COSTA CAVALCANTE 392 CENTRO	BARBALHA	CE	2018-04-10	83827676304	TERESA SILVANA NOGUEIRA DA SILVA	10.000	781561	70.000	SIM
1 - 18 de 18 resultados											‹ 1 ›	18 ▾

Source: Prepared by the author

Figure 11 contains the information about the companies that participated in the selected bidding, where the user can view the following information: CNPJ (Legal entity Resgistration Number), Corporate name, Company name, Address, City, State, Date of opening CPF of the responsible, Share Capital (R$), Item code and Winner (Yes or No).

Figure 12- SNA Items Screen

Empresas	Itens	
Código do item	**Descrição dos itens**	
781561	Contratação de instituições privadas com ou sem fins lucrativos de assistência à saúde, interessadas em prestar serviços de forma complementar ao Sistema Único de Saúde (SUS) no Município de Barbalha - CE nos seguintes Sub-grupos, Formas de Organização e procedimentos da Tabela Unificada do Sistema Único de Saúde.	
1 - 1 de 1 resultados		‹ 1 › 1 ▾

Source: Prepared by the author

Figure 12 shows the description of the bidding items, this screen is formed by the fields Item code and Item description.

Figure 13 - SNA Network Screen
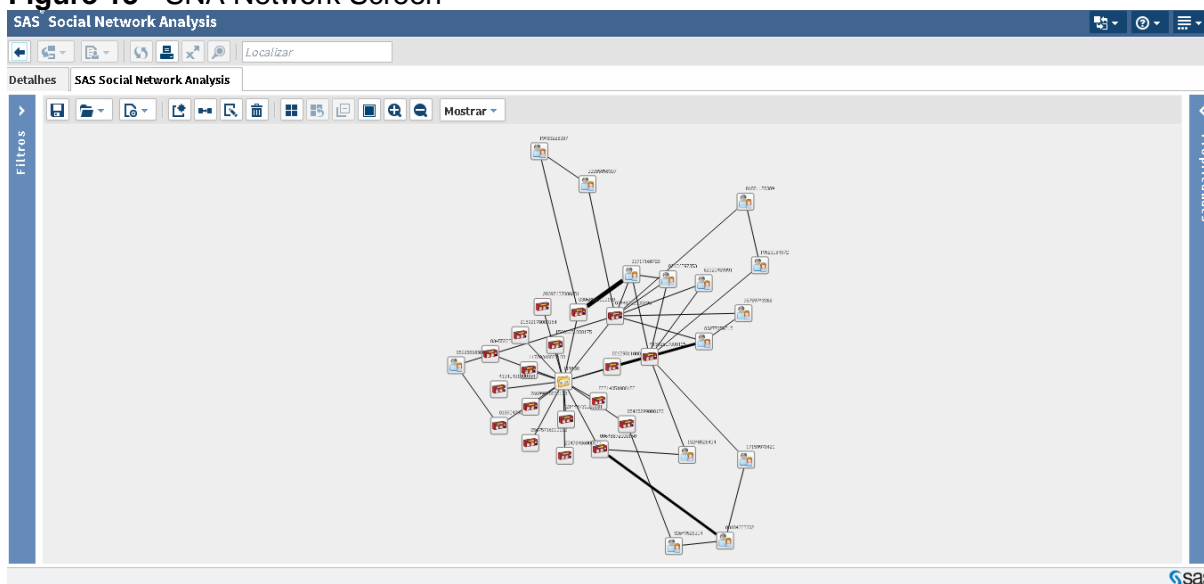
Source: Prepared by the author

The development of the social network in SNA, Figure 13, aimed to graphically demonstrate the understanding of the relationship patterns among those involved (companies, partners, family, bidding committee) in a bidding process of public administration.

For this, the 9 types of linkages, already presented in Table 3, were adopted, and the number of the selected bidding as the central node.

The following are some results observed by the TCE-CE through the application of rich criteria for public tenders in the state of Ceará.

6ª) Results achieved

This topic presents some results that could be observed through the development of the risk panel aimed at identifying evidence of irregularities in the bidding processes carried out by public administration, in the scope of the State of Ceará by the TCE-CE.

Table 5 below presents the universe of bids made by the public administration of the State of Ceará from January 2016 to March 2018.

Table 5 - Execution of bids by the Public Administration

Year	#_of_Bids	#_of_Items
2016	12,795	88,125
2017	18,414	137,693
2018	5,393	36,145
Grand total	**36,602**	**238,753**

Source: Prepared by the author

One can see from Table 5 the great challenge in developing control work in a concomitant way, aimed at identifying evidence of irregularities in the acquisitions of the State of Ceará, since in less than three years there were more than 36 thousand bids representing a volume of 19,5 billion reais.

Table 6 below shows what could be identified as evidence of irregularities in the universe of bids made in the period here presented.

Table 6 - Tenders with indications of irregularities

Year	#_of_Bids_with_Indications_of_Irregularities	#_of_Items	Total_ Bid
2016	866	3,707	241,835,628.55
2017	1,021	5,379	301,865,020.45
2018	219	830	69,366,405.26
Grand total	**2,106**	**9,916**	**613,067,054.26**

Source: Prepared by the author

Table 6 shows an amount of over 2,106 bids with indications of irregularities. It is important to note that these irregularities involve an amount of more than 613 million reais.

In addition, it was possible to identify that during the several bidding processes presented previously, there were the participation of 15.352 companies and that 2.210 presented some evidence of irregularity, that is, 14.4% of the companies participating in bids.

It is important to emphasize that the various analyses carried out by the TCE-CE bidding risk portal are initiated after the announcement of the result of the bid, that is, before the signing of the contract. This is of great value to the public administration, as the TCE-CE within its legal attributions, perceiving signs of irregularities, may act in a preventive manner preventing the signing of the contract, as well as the cancellation of the bidding process.

Referral to the specialized Audit Department of the Court of Auditors

The results of the present study were sent to the "Procurement Audit Management" of TCE-Ceará, a competent sector with the expertise to continue the audit with the fieldwork.

CONCLUSION

This work presented the results of the application of the SAS Fraud Framework in the Court of Accounts of the State of Ceará in Brazil. The information presented by the tender risks panel for the period of January 2016 to March 2018 was extremely relevant, mainly for its ability to evaluate a large number of bids, 36,602, in which it is possible to identify 2,106 bids with indications of irregularities representing a financial volume of approximately 150 million dollars.

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