IMPACT OF TECHNOLOGY ON AUDIT ACTIVITY: EQUATING BOTTLENECKS

IN UNION PASSES TO SUBNATIONAL ENTITIES

1.INTRODUCTION

The control is one of the basic functions of management since this science is constituted as a science (Wren, Bedeian, Hoffman, & Murphy, 2009; Wren, Bedeian, & Breeze, 1975; Otley, 1999) . In the Public Administration framework, this function gains even greater proportions (Bresser-Pereira, 1998; Bresser-Pereira, 2008) , since it also involves a republican perspective in its scope, in which society has the right to ask every agent for account public by its administration (Nascimento , 2015 ; Filgueiras, 2018), as established in the 1988 Federal Constitution, which stipulates that anyone who uses, collects, stores, manages or administers public money, goods or values must be accountable (Abrucio & Loureiro, 2018).

In this context, new information technologies are an important instrument for the exercise of government control and internal audit activity . According to Parker, Jacobs & Schmitz (2018) , q he more innovative the technology, in May or the prospect of what the auditors propose new paradigms for the operation of the business and to the decision-making of the manager.

This work aims to analyze how the integration of technology with internal audit can be useful in the internal controls of the Administration. To this end, the case of a system implemented in the Federal Government to control the agreements signed with the government will be studied. These transfers are made through voluntary transfers from the Federal Government , either to subnational entities or directly to private non-profit entities. And hese t ransferências are intermediated by the System Covenants of the Federal Government (SICONV). From this perspective, we analyze the case of the " *Malha Fina de Convênios* " system, an innovative technological approach involving the Federal Comptroller General and the Ministry of Economy.

To this end, this work is developed in five more sections, in addition to this Introduction. In the first, a contextualization about the processing of voluntary transfers through Siconv is carried out , in addition to a brief presentation about the system itself. In the following section, the problem to be solved with the implementation of the system is exposed. That done, the proposed intervention is presented, ie, it is explained how the system would be implemented so that, in the next section, the results of the simulations performed are presented. Finally, the main technological and social contributions expected from such implementation are described.

2. CONTEXTUALIZATION OF THE PROBLEM SITUATION

The Union's Voluntary Transfers process handled more than R $ 100 billion between 2008 and 2018 by means of over 140 thousand instruments among the entities of the Federation, according to SICONV data. In February 2019, SICONV had 142,666 thousand instruments signed (Ministry of Economy, 2019).

However, the granting of voluntary transfers by government agencies and entities constitutes a major challenge for public administrators, both with regard to the desired smoothness, as well as the agile and effective operationalization of the thousands of instruments destined to the implementation of public policies in Brazilian States and Municipalities (Neto & Simonassi , 2013) . This challenge occurs due to the number of agents and the multiplicity of objects present in the concession agreement (Soares & Melo, 2016) .

Among the public policies that have received resources through federal transfers in the last 10 years are: Planning, management and urban development (R $ 11.3 billion), support to tourism (R $ 9.3 billion); specialized health care (R $ 7.5 billion), family farming (R $ 5.5 billion), water resources (R $ 4.3 billion), public security (R $ 4.3 billion), indigenous policies (R $ 4.2 billion), sports Major Events (R $ R $ 3.7 billion); sports and leisure (R $ 2.8 billion) and Agriculture and livestock (R $ 2.7 billion).

In spite of the deficiencies notably recognized in SICONV, this system has been improved over the last decade and today it allows meeting fundamental requirements of good public governance, which requires transparency as a fundamental pillar. In turn, the process of voluntary transfers is still excessively slow, inefficient and effective (CGU, 2018). According to data from the CGU audit report (CGU, 2018) , the average lifecycle time of a federal money transfer process at SICONV reaches more than 5 years. In addition, CGU detected a major imbalance between the operating capacity of the granting agencies and the volume of work expended to analyze the rendering of accounts of the transfers made. The number of transfers made would require an analysis effort much higher than the available analysis capacity of the transferring agencies.

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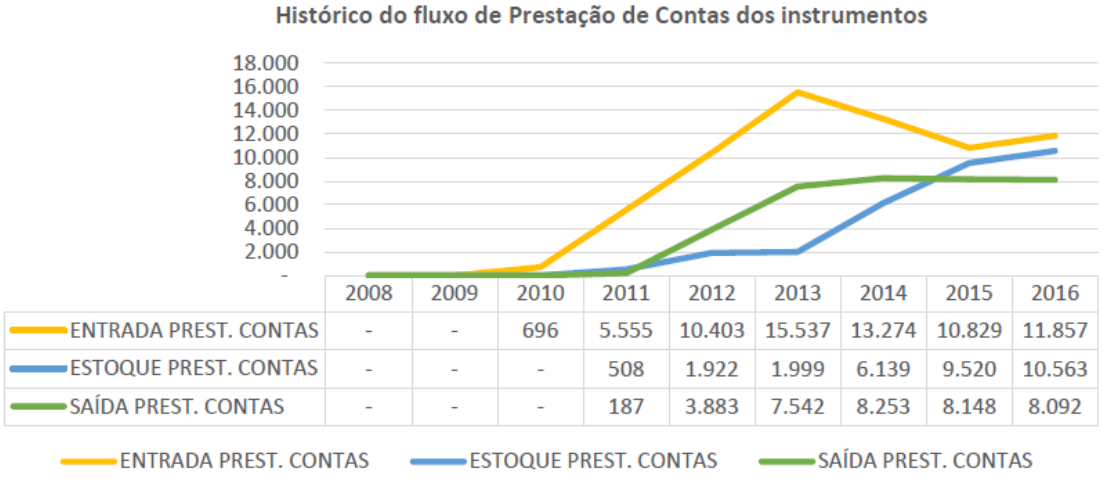

	2008	2009	2010	2011	2012	2013	2014	2015	2016
ENTRADA PREST. CONTAS	-	-	696	5.555	10.403	15.537	13.274	10.829	11.857
ESTOQUE PREST. CONTAS	-	-	-	508	1.922	1.999	6.139	9.520	10.563
SAÍDA PREST. CONTAS	-	-	-	187	3.883	7.542	8.253	8.148	8.092

Figura 1 - **Flow of the relationship between inflow, outflow and the resulting stock related to the accountability phase of voluntary transfers. Update for 2017 and 2018. Source: CGU based on SICONV data.**

In view of this operational bottleneck, the problem of stock of accountability pending analysis by the forwarding agencies emerges. The criticality of the problem is characterized by the continued growth of this stock. From the perspective of government auditing, there are two lines of action (IIA, 2012; Olivieri , 2011; CGU, 2017) for the situation illustrated in Figure 1 .

The first line is the independent and objective evaluation of the operation process of voluntary transfers in order to improve risk management, internal controls and governance (Al- qudah , Baniahmad, & Al-fawaerah, 2013; COSO, 2013; Monteiro, 2015; CGU, 2017). The immediate result of acting in this approach would be some recommendations whose content would demand that the resources transferring agencies make efforts to carry out the accountability analysis, or if they do not have the analysis capacity, refrain from promoting new transfers. These are relevant and useful recommendations, but obvious, they are just the same (Power 2003a; Power, 2003b) .

On the other hand, the second line of action consists of consultancy, in which the audit provides advisory and advisory services in strategic matters (CGU, 2017) of the process of voluntary transfers from the union. The result of the consultancy is usually a product or a solution built jointly with the manager (Kim, Mannino and Nieschwietz (2009) . In the case at

hand, the consultancy produced a solution for the stock of accountability of onlending accounts pending analysis .

After the completion of the performance of the internal audit following the precepts of the way of acting in consulting, a system was delivered that allows to solve the flagrant imbalance between the operational capacity of the granting agencies and the volume of work required to analyze the rendering of accounts. This imbalance generated a liability of more than 15 thousand instruments pending analysis, representing almost R $ 17 billion pending analysis. This system was called Fine Mesh of Covenants and consists of the use of artificial intelligence.

Based on the characteristics of each agreement or transfer agreement, the tool recognizes standards and allows to predict, with a high degree of precision, the result of the account analysis, in the case of manual evaluation by employees of the granting federal agencies. In practice, the application of the "Fine Mesh of Agreements" checks the instruments signed in Siconv , uses algorithms and provides a risk note to measure the probability of approval or disapproval of the accounts. The methodology also combines the issuing of alerts generated in the audit trails applied by CGU, in search of predefined patterns of indications of improprieties or irregularities.

3.PROPOSED INTERVENTION

3.1.The System "Malha Fina de Convênios"

The system "Malha Fina de Convênios" is a predictive model created by CGU that allows indicating, with a certain degree of certainty, the result of the analysis of the rendering of accounts of the covenants when their accounts are presented by the covenants (subnational entities receiving funds) to the grantors (organs of the Union that transfer funds). In other words, Malha Fina allows to infer whether the accounts of the agreements will be approved or rejected.

This is possible because this system uses a machine learning algorithm based on the characteristics of the agreements whose accounts have already been analyzed. Between September 2008 and December 2017, more than 61,000 agreements (Ministry of Economy, 2019) had their accounts analyzed by the grantors , providing a satisfactory amount of data for the learning of the algorithm to provide accurate results. 104 variables from each agreement were used in the learning algorithm.

The application of the algorithm results in the constitution of an individual note for each agreement, varying between 0 and 1. The closer to 0 the note is, the greater the chance that the agreement will have its accounts disapproved. Alternatively, the closer to 1, the greater the chances that the agreement will have its accounts rejected. Consequently, the rejection of the accounts of an agreement entitles the grantor to take the appropriate measures to recover the damage to the Treasury, such as, for example, the establishment of a Special Accountability (ECA).

The value calculated for each agreement is compared to the "cut-off value" established by the area manager, which also varies from 0 to 1. Thus, all agreements whose score calculated by the algorithm was above this limit, would be considered "objectionable" , requiring a conventional analysis.

Thus, for the operation of the algorithm, it is enough that the agency stipulates a minimum score before which all agreements classified below it are approved. As an example, if a specific

agency stipulates a score of 0.8 as its threshold, it means that 79.4% of its agreements may be subject to tacit approval, of which 4.62% would be inadvertently approved (Figure 2) . It should be noted that the decision on the note line, by granting body , reflects the risk appetite of the manager.

3.2.Validating the Program's assertiveness

In order to verify the assertiveness of the notes attributed by the algorithm to the agreements, CGU proceeded with a verification, comparing the notes with the result of the analysis of the accounts rendered by the grantors . On 12/31/2017, as shown in Table 1 , there were 13,992 agreements awaiting accountability analysis, configuring a stock with a liability of more than R $ 15.3 billion.

The algorithm was executed so that it could learn from the history of the SICONV base until the deadline of 12/31/2017. Thus, the algorithm assigned a note to all 13,992 inventory agreements, as shown in Table 2 , the result of which is shown in Table 3 .

Grade Group Interval Assigned by Algorithm	**Start**	**End**
I3	>= 0,0	< 0,4
I4	>= 0,4	< 0,5
I5	>= 0,5	< 0,6
I6	>= 0,6	< 0,7
I7	>= 0,7	< 0,8
I8	>= 0,8	< 0,9
I9	>= 0,9	<= 1,0

Table 1 - Definition of the Notes Intervals attributed by the algorithm of the Fine Mesh System of Agreements

Situação do Convênio	**I3**	**I4**	**I5**	**I6**	**I7**	**I8**	**I9**	Total
Accountability under Analysis	102	209	310	645	910	797	1348	4321
Complementary Accountability	135	115	173	261	353	389	408	1834
Accountability sent for Analysis	505	866	1017	1453	1732	1095	700	7368
Accountability initiated by anticipation	124	113	89	76	62	5		469
Grand Total	**866**	**1303**	**1589**	**2435**	**3057**	**2286**	**2456**	13992

Tabela 2 - Distribution of the score attributed by the algorithm to the 13,992 agreements awaiting analysis of accountability on 12/31/2017.

The CGU verification technique was to wait for the time elapsing until the rendering of accounts of some inventory agreements were analyzed by the granting agencies. The comparison between the score attributed by the algorithm and the actual result of the analysis of the accounts would be compared. Thus, on April 18, 2018, 1,948 agreements had their accountability analyzed:

- Approved Accountability: 1,305 agreements
- Accountability Approved with Provisions: 336 agreements

- Rejected Accountability: 307 agreements

Concedente – Órgão Superior	Total de Convênios	Valor Total dos Convênios
MINISTERIO DO TURISMO	2245	R$ 1.125.672.602,56
MINISTERIO DA SAUDE	1534	R$ 1.688.015.614,45
MINISTERIO DO ESPORTE	1335	R$ 1.221.149.270,10
MINISTERIO DA JUSTICA	1154	R$ 1.248.929.609,17
MINISTERIO DA INTEGRACAO NACIONAL	1055	R$ 964.877.853,50
MINISTERIO DA EDUCACAO	1013	R$ 1.360.257.686,33
MINISTÉRIO DA AGRICULTURA, PECUARIA E ABASTECIMENTO	813	R$ 598.888.074,09
MINISTERIO DA CULTURA	799	R$ 556.884.127,81
MINISTERIO DO DESENVOLVIMENTO SOCIAL	643	R$ 2.793.503.462,56
PRESIDENCIA DA REPÚBLICA	629	R$ 315.130.127,01
MINISTERIO DAS CIDADES	590	R$ 295.855.034,26
MINISTERIO DOS DIREITOS HUMANOS	509	R$ 351.912.866,19
SECRETARIA DE AGRICULTURA FAMILIAR E DO DESENVOLVIMENTO AGRARIO	433	R$ 624.652.594,87
MINISTERIO DO DESENVOLVIMENTO AGRARIO	322	R$ 473.696.914,28
MINISTERIO DO TRABALHO E EMPREGO	271	R$ 545.836.212,74
MINISTERIO DA DEFESA	235	R$ 237.247.698,91
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES	199	R$ 608.145.941,46
MINISTERIO DO DESENVOLVIMENTO, INDÚSTRIA E COMERCIO EXTERIOR	92	R$ 148.763.218,21
MINISTERIO DO TRABALHO E PREVIDENCIA SOCIAL	60	R$ 113.247.482,61
MINISTERIO DO MEIO AMBIENTE	46	R$ 34.297.066,37
MINISTERIO DE MINAS E ENERGIA	12	R$ 11.256.083,04
MINISTERIO DO PLANEJAMENTO, DESENVOLVIMENTO E GESTAO	1	R$ 777.825,00
JUSTICA ELEITORAL	1	R$ 514.460,65
MINISTERIO DOS TRANSPORTES	1	R$ 1.430.704,88
Total Geral	**13992**	**R$ 15.320.942.531,05**

Tabela 3 - Liabilities of agreements awaiting analysis by the grantor in the rendering of accounts on 12/31/2017. Values in Brazilian Currency R$ Reais.

The reliability of the algorithm was measured by comparing the score attributed to the agreements whose accountability was evaluated by the granting agencies between 01/01/2018 and 04/18/2018 (1,948). Naturally, it was observed that the algorithm is not infallible and assigns scores relatively close to 0 for failing accountability agreements.

Situation of the Agreement	**I3**	**I4**	**I5**	**I6**	**I7**	**I8**	**I9**	**Total**
Approved Accountability	201	235	203	203	170	180	113	**1,305**
Accountability Approved with Provisions	9	12	23	40	78	102	72	**336**
Accountability Rejected		1	5	6th	10	68	217	**307**
Total	**210**	**248**	**231**	**249**	**258**	**350**	**402**	**1,948**

Table 4 - Distribution of the score attributed by the "Fine Mesh of Agreements" system algorithm to the agreements analyzed between 01/01/2018 and 04/18/2018.

However, this inadvertent classification of disapproved agreements occurs at a low rate, as noted in Table 4 . Of the 307 agreements with rejected accountability, only 12 are classified with a score up to the interval 0.7 (I6), that is, the remaining 295 whose accounts were disapproved are classified with a score above 0.7, intervals I7, I8 and I9. More than 70% of the disapproved agreements were classified by the algorithm with a score above 0.9, interval I9.

According to the data shown in Table 6 and the illustration in Figure 2 , the “Malha Fina” system of covenants would allow to assist the work of analyzing the rendering of covenant accounts in the granting agencies.

Situation of the Agreement	**IA3**	**IA4**	**IA5**	**IA6**	**IA7**	**IA8**	**IA9**
Approved Accountability	201	436	639	842	1,012	1,192	1,305
Accountability Approved with Provisions	9	21	44	84	162	264	336
Accountability Rejected		1	6th	12	22	90	307
Total	**210**	**458**	**689**	**938**	**1,196**	**1,546**	**1,948**

Table 6 - Distribution of the accumulated range of grades awarded by the "Fine Mesh of Covenants" of the covenants analyzed between 01/01/2018 and 04/18/2018.

According to the curves in Figure 2 , the greater the risk appetite, the higher the threshold score and the greater the chances of tacitly approving reprehensible agreements. In turn, the data obtained on the disapproval rates of covenant accounts presented by the covenants, was restricted to a period of less than 4 months, with repercussions between 01/01/2018 and 04/18/2018.

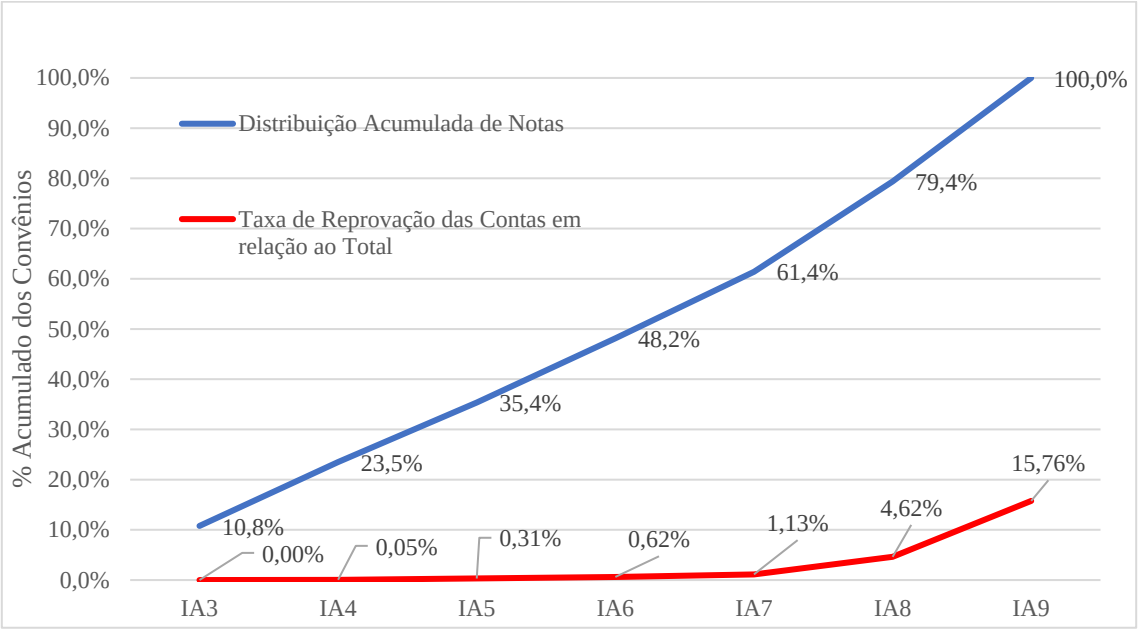

Figure 2 - Graph of cumulative distribution of the grades attributed by "Malha Fina de Convênios" of the agreements analyzed between 01/01/2018 and 04/18/2018 and their respective disapproval rate.

The algorithm learned to classify the agreements based on all those with analyzed accounts (approved, approved with reservation or rejected) from the beginning of data registration in the SICONV database between September 2008 until 12/31/2017.

After validating the algorithm, the question becomes to what extent the adoption of the system could be carried out without the need for conventional evaluation by a public servant of the granting agency. As seen, in cases of evaluation carried out automatically by the system, there is an inherent rate of probability of "diagnostic errors", that is, disapproved agreements, but classified with a score below the threshold stipulated for tacit approval.

To analyze such a proposition, hypotheses must be raised so that the knowledge of the algorithm is improved. In this work, two hypotheses are presented, both related to the volume of data used to train the learning of the algorithm:

Hypothesis 1: the accuracy of classifying the machine learning algorithm increases as there is more data in the learning universe.

Hypothesis 2: is it possible to predict the existence of a saturation point in which the amount of data is no longer relevant for the machine learning algorithm to classify covenants?

3.3.Data Training

The construct " *Size of data training" (* Table 8) was established in order to ascertain the impact that the volumetry of the training series has on the results generated by the algorithm.

In April 2019, SICONV had 142,968 registered agreements. Of these, 64,535 completed their life cycle (Ministry of Economy , 2019) , that is, the resources transferring body evaluated the accountability presented by the agreement definitively, approving it, approving it with

reservations, or rejecting it. The essence of evaluating this construct is the verification of the accuracy behavior of the risk notes generated by the fine mesh system of covenants.

It is intended to ascertain the impact that the volumetry of the data training sequence generates on the Artificial Intelligence algorithm in the results produced. The heart of the proposed intervention is the verification of the accuracy behavior of the risk notes generated by the fine mesh system of covenants by different algorithms, which were generated by incremental training sequences, segmented by year of signing the covenants. The behavior of the results of the algorithms will be analyzed as more agreements serve as input for machine learning.

Year	**Number of Covenants**	**Number of Agreements with accountability analyzed**
2015	97,932	39,093
2016	110,896	46,983
2017	127,532	55,009
2018	142,876	61,884

Table 9 - Accumulated quantity of number of agreements and accountability between 2015 and 2018. Source: SICONV. Base date April 2019.

In this way, the algorithm will be trained with different data segments according to the year in which the agreement was signed, allowing, therefore, 9 different data series between the years 2008 to 2016. These series will be analyzed specifically regarding the behavior of the risk notes assigned by the algorithm.

Additionally, it is important to define that the training sequence of the algorithm must correspond only to agreements whose life cycle has ended, that is, it has passed through the phases of celebration, execution and accountability. Consequently, this requires a reliable and stable source of the SICONV database, which reflects the continuity of the situations of the agreements. To the extent that the process of voluntary transfers from the union is inherently volatile (Brollo & Nannicini, 201 2) , changes in the situations of the agreements may occur, especially in those recently concluded. Therefore, the year 2017 was adopted as the cut-off point for the population of health plans to be used as a training sequence. The Table 10 shows the quantity of this sample agreements, depending on the targeted year.

Year of Covenant Celebration	*Number of Life Cycle Agreements*	*Accumulated Number of Agreements with the closed life cycle*
2008	1141	1141
2009	12850	13991
2010	11541	25532
2011	6825	32357
2012	5303	37660
2013	6324	43984
2014	3761	47745
2015	1306	49051
2016	737	49788
2017	10	49798

Table 10 - Number of agreements with the rendering of accounts closed according to the year of celebration. Source: SICONV. Base date December 2017.

However, by observing Table 10 , it is clear that the 10 agreements signed in 2017, whose life cycles are closed, have no significance for the training sequence. This fact led to the delimitation of the scope in 9 series between the years 2008 and 2016, excluding the 2017 series.

The Figure 5 shows the process performed to determine various artificial intelligence algorithms with gradual increase of training sequences. The 9 series used as a training sequence produced 9 distinct algorithms, capable of classifying any SICONV agreement regarding the probability of the accounts being approved or rejected. In turn, the 9 algorithms generated were tested by comparing the risk score assigned by him with the result of the analysis of the accountability of the agreement.

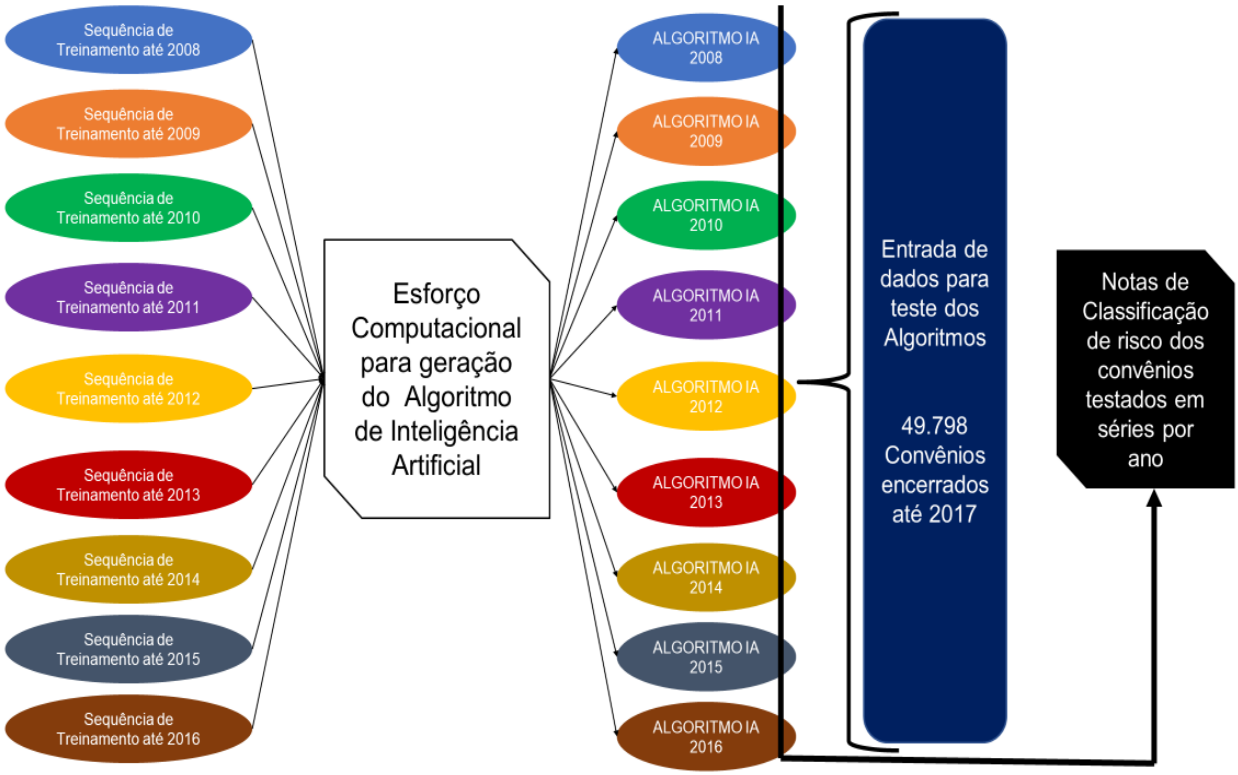

Figure 5 - Methodology for testing to verify the impact of the training sequence volume on the accuracy of the artificial intelligence algorithm. Prepared by the author.

Consequently, the testing of the algorithms could only be performed with agreements whose life cycle has ended, similarly to the population used for the training sequence. Now, the most assertive way to test the reliability of the risk classification generated by the algorithm is to compare it with the real result of the agreement. Likewise, the algorithm learns from closed agreements, that is, from the variables that led them to have their accounts rejected or closed. Thus, the test of the 9 algorithms consisted in classifying the completeness of the agreements in Table 10 , whose breakdown of the situation in which they were closed is found in Table 11 .

Situation of the Agreement	Amount
Approved Accountability	41391
Accountability Approved with Provisions	6578
Accountability Rejected	1405

Completed Accountability	350
Accountability under Analysis	40
Complementary Accountability	14
Accountability Proven in Analysis	9
Accountability sent for Analysis	5
Canceled Agreement	4
Canceled	2
Grand total	**49798**

Table 11 - Details of the population of health insurance companies submitted to the 9 AI algorithms for checking between accuracy and training volume.

4. RESULTS

The inherent risks of the system process "*fine mesh agreements*" is the rate tion inadvertent agreements whose bills were rejected in with a nearby risk score of zero, accumulated range IA3 (Table 5). Thus, the reliability of the 9 AI algorithms generated , according to the illustration in Figure 5 , is measured by the rate of occurrence of failed agreements in the accumulated risk classification intervals, called IA3 to IA9 . In turn, the accuracy of the algorithm is checked by checking the distribution of failed agreements in the accumulated intervals, and the lower the occurrence of agreements in intervals close to 0, the more accurate the algorithm will be.

The Table 12 shows the rate ocorrênci the accounting agreements with rejected within Halftone them cumulative risk rating. The analysis engine that s rates occurs INSTANCE is the understanding that the credit rating threshold for estimating an approval or disapproval of an agreement is not immune to mistakes. For example, if the 2008 algorithm is adopted with a risk rating threshold of up to 0.4 as a condition for approving covenants, it means that approximately 86% of covenants with disapproved accounts would be unwise. Then, still in the 2008 algorithm, admitting a risk threshold of 0.5 proves the improper approval of 87% of the total of disapproved account agreements.

Risk contemplate c OVENANTS with provision of rejected bills							
Reach year for Algorithm training	IA3	IA4	IA5	IA6	IA7	IA8	IA9
2008	85.55%	87.05%	88.26%	89.61%	90.68%	91.74%	100.00%
2009	0.93%	3.56%	12.53%	24.98%	36.01%	45.34%	100.00%
2010	0.07%	0.93%	2.21%	8.75%	17.94%	22.28%	100.00%
2011	0.00%	0.93%	3.56%	9.61%	11.74%	17.37%	100.00%
2012	0.00%	0.21%	1.14%	4.27%	9.82%	16.73%	100.00%
2013	0.00%	0.14%	1.28%	2.57%	5.49%	11.90%	100.00%
2014	0.00%	0.14%	0.36%	1.85%	4.13%	9.54%	100.00%
2015	0.00%	0.14%	0.57%	1.71%	4.20%	11.32%	100.00%
2016	0.00%	0.21%	0.57%	1.28%	4.13%	9.40%	100.00%

Table 12 - Rate of occurrence of agreements with rejected accountability within the accumulated risk classification intervals .

As another example, the algorithm for the year 2013 shows a distribution of the occurrence rates of disapproved agreements in which there is a high concentration after the 0.9 threshold. This means that the 2013 algorithm is more accurate than that of 2008. If the risk threshold of 0.9 is adopted in the 2013 algorithm to approve all account benefits of covenants pending analysis , there is a chance to mistakenly approve about 10% of the disapproved agreements.

Furthermore , the observation of the data in Table 12 and the analysis of Figure 6 allows us to infer that the algorithm generated with the training sequence of the agreements signed in 2008 produced an unsatisfactory model due to its great imprecision. Then, the algorithm generated with the agreements signed until 2009 produced a better model than the previous one, but still unsatisfactory due to its imprecision. Ongoing, it appears that the model generated by the training sequence of the 2010 agreements is worse than that of 2011, which in turn is worse than that of 2012, which in turn is worse than that of 2013.

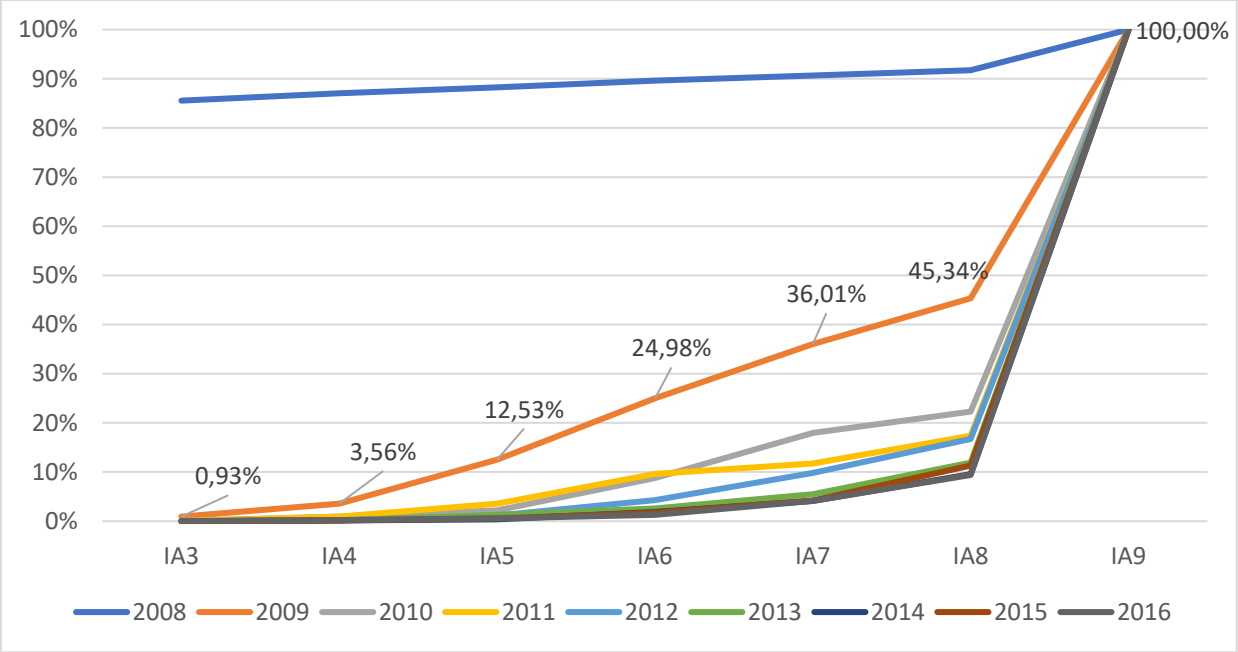

Figure 6 - Curve of occurrence of agreements with rejected accountability within the accumulated risk intervals.

Consequently, this inference supports the hypothesis raised that the classification accuracy of the machine learning algorithm increases as there is more data in the learning universe. However, m Erece highlight the fact that the 2010 algorithm is better than the 2011 algorithm to the accumulated interval IA6, although this has been generated with a lower volumetric training sequence that. Furthermore, it appears that the improvement in the accuracy of the algorithms produced has stagnated from the model generated with the sequence of training agreements entered into until 2013.

The Table 12 and Figure 6 show a timid improvement in accuracy of the algorithm, almost negligible. This fact allows us to answer hypothesis 2 , to the extent that there is a saturation point and that it was possible to establish the size of the training sequence for machine learning in which the increase in accuracy is no longer significant.

Finally, the algorithms produced with the size of saturated training sequences, that is, those produced with the agreements signed until the year 2013 onwards, establish an optimal risk threshold in the accumulated interval IA8. The analysis of Figure 6 allows to affirm that the curves of these algorithms have an inflection point precisely in the risk note 0.8, since the

rate of occurrence of disapproved agreements remains below 10% until this threshold, increasing drastically after this period. limit.

5. TECHNOLOGICAL-SOCIAL CONTRIBUTION

he objective of this research was, from tests of comparison between results generated by Artificial Intelligence algorithms and the results of accountability of agreements, to identify how the size of the training sequences of the machine learning algorithm are determinants in the accuracy forecasting the approval or disapproval of the accounts of an agreement. The validation of the automated accountability method is essential for the continuity of this innovative approach.

It investigated the behavior of the model by increasing the size of the universe used with the training machine learning . Thus, the possible occurrence of discrepancy in the 9 distinct models generated was evaluated . It was found that as the size of the training sequence grows , the precision of the produced algorithm increases . In addition, the diagnosis of the results indicates that the adoption of the predictive model to estimate the results of an agreement not s was problematic in case the size of the training sequence is larger the u equal to the saturation point. In this research, the saturation point was the sequence of training with agreements signed until 2013, consisting of 43,984 agreements (Table 9).

According to Ferreira & Bugarin (2008), voluntary intergovernmental transfers are not technically harmless. On the contrary, they have important implications for subnational political balances and should therefore be carefully regulated in order to avoid distortions that generate inefficiency.

In addition, a considerable portion of the transfer of discretionary resources in Brazil is done through SICONV (Meireles, 2019) , which are proposed by subnational governments and evaluated by the federal bureaucracy to be celebrated.

The life cycle of the transfer of discretionary resources ends with its rendering of accounts and consequent analysis by the transferring body, which opines for the approval or rejection of the accounts. Accountability analysis is a lengthy process and encourages the use of resources for its realization, in addition to trained public servants. In turn, the " *Malha Fina de Convênios* " system presents a quick and rational alternative for the analysis of accountability, configuring itself in innovation.

For Fukuyama (2004) , decision making in a bureaucratic organization must be guided by the transaction cost of the processes. In this line , the *"Malha Fina de Convênios* " system rationalizes the use of the workforce in the analysis of rendering of accounts by the granting agencies through the adoption of a risk appetite threshold in which the probable agreements with rejectable accounts would be inadvertently approved . The present study shows an inflection in this risk threshold at 0.8 (Figure 6).

Finally, s findings of this research validates m the current meto odology system " fine mesh agreements " , as it contains results satisfactory based articles the s in empirical tests of the predictive model . On the other hand, future research may advance in the relevance in which the AI algorithm distinguishes the identity of resource transferors. The assertiveness of the risk classification of onlending processes with algorithms generated with specific training sequences from each granting agency proves to be a fertile field.

It is noteworthy that the search results may be incorporated in the work process d the transfers volunteers from the Union to sub-national entities , allowing for even regulatory changes that regram the process of voluntary transfers of the U nion. In this sense lies the main collaboration of this work.

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