Improved Business Intelligence Solution with Reimbursement Tracking System for the Brazilian Ministry of Planning, Budget and Management

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Abstract: Business Intelligence (BI) systems are crucial for assisting the decision making processes of private and governmental institutions. The Human Resources Auditing Department (CGAUD) of the Brazilian Ministry of Planning, Budget and Management (MP) has been developing its own BI for auditing the payroll of all federal employees since 2010. Given that the monthly payroll is approximately 12.5 billion reais, the initial version of the proposed BI system in 2012 was able to audit approximately 1.5 billion reais. In this paper, we propose an improved BI system, which can deal with an increased volume of data, a greater amount of monitoring trails and a higher granularity of the final reports. As consequence, the total audit value has increased to approximately 5 billion reais. In addition, our new BI system has incorporated a Reimbursement Tracking System for monitoring the payroll of federal employees who have to reimburse the Brazilian government. Around 4.5 million reais are automatically monthly tracked by our new BI system. Our proposed BI system has been validated using the real environment of the MP and the results are compared to the previous BI system.

1 INTRODUCTION

According to (Brown & Brudney, 2011), electronic government (e-gov) is the use of technology, especially Web-based applications to enhance access to and efficiently deliver government information and services.

In this context, the Human Resources Auditing Department (CGAUD) previously known as AUDIR, which belongs to the Brazilian Ministry of Planning, Budget and Management, in Portuguese *Ministério do Planejamento, Orçamento e Gestão* (MP), has created its own BI system in order to support and to automatize the auditing process of the payroll of the Brazilian federal employees. Such BI system is aligned with a holistic governance approach for sustainable development taking into account aspects such as efficacy, transparency, responsiveness, participation and social inclusion in the delivery of public services (United Nations, 2012).

In (Campos, et al., 2012), an initial BI solution was presented where the authors proposed to use an ontology indexation process via concept maps in order to detect irregularities on the payrolls of the Brazilian federal staff. The BI system in (Campos, et al., 2012) had some limitations, for instance, in terms of velocity, i.e. system responsiveness. Therefore, in (Huacarpuma, Rodrigues, Serrano, da Costa, de Sousa Junior and Holanda, 2013), we show that the incorporation of Big Data schemes in our BI system can significantly increase its velocity.

In this paper, we propose an improved BI system, which can deal with an increased volume of data, a greater amount of monitoring trails and a higher granularity of the final reports. In addition, our new BI system has incorporated a Reimbursement Tracking System known as SIGA for monitoring the payroll of federal employees who have to reimburse the Brazilian government.

The remainder of this paper is divided into five sections. Section 2 presents the state of the art, while Section 3 presents the original audit process without BI and our previous BI system solution. The proposed

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improved BI system solution with reimbursement tracking system is described in Section 4, and Section 5 shows the achieved results. Finally, in Section 6 the conclusions are drawn.

2 STATE OF THE ART

Among different types of information and communication technologies (ICT), business intelligence based solutions are being widely employed in e-government systems for different purposes (Gil-Garcia & Martinez-Moyano, 2007). The study presented in (Cordella & Iannacci, 2010) reveals how this technology is important in the development of information systems used in e-government initiatives, while (Hamner, Negrón, Taha & Brahimi, 2012) discusses cases of success and fail in implementing e-government systems and the role of BI and other technologies in this process.

In the work presented in (Bukhsh & Weigand, 2012), the authors describe an approach called Service-Oriented Auditing, which is an innovative auditing service based on the Service-Oriented Architecture. This approach aims to tackle coordination problems among different governmental entities while performing activities chains that depend on each other. At certain degree this work is related to our in the sense that the audit process carried on by CGAUD can be seen as a process chain as the one handled in the referred work. However, the BI-based solution proposed in our work provide additional features, compared to the Service-Oriented one proposed by these authors, as a comprehensive tool to scrutinize data, while their approach just provide the process automation.

3 CGAUD AUDIT PROCESS SCENARIO

One of the main responsibilities of the CGAUD is to audit the payroll of the federal staff. The payroll is monthly elaborated, and includes the information about the active, retired and pensioners of the Federal Public Administration. 16 Gb of information are generated every month, containing the data about 6,2 million federal employees and summing a total value around R$ 12.5 billion. The basic element of the payroll is called rubric. Each rubric stands for a positive or negative value that is included on the payroll according to the characteristics of the position of each federal employee. There are 2,200 different rubrics. The data of the payroll is stored on the database called Integrated System for the Administration of Human Resources, in Portuguese *Sistema Integrado de Administração de Recursos Humanos* (SIAPE).

The legal base that regulates the payroll is the Federal Constitution of Brazil and there are also other specific laws and decrees that complement it. According to this legislation, the responsibility of the CGAUD department is to analyse the rubrics of every payroll in order to detect incompatibility of benefits, inconsistencies and irregularities.

The audit process is based on audit trails, which consist of a set of rules based on the legislation that are used to verify the irregularities on the payrolls. Once the inconsistency on the payment is detected, the auditors are informed in order to take the required actions to fix the inconsistency or the irregularity.

In Subsection 3.1, we overview the original audit process without any automatized system, while in Subsection 3.2, we review our previous BI system.

3.1 Original Audit Process

Before the deployment of the initial BI solution proposed in (Campos, et al., 2012), the audit process was manually performed. The payrolls were generated and the salary was transferred to the employees, the CGAUD personnel ran manually a query on a small part of the payroll database with a set of filters that maps the current legislation. Such filters are known as trails as shown in Figure 1. The result set containing the possible irregular cases was exported to an Excel document where each register was analysed in detail by the auditors.

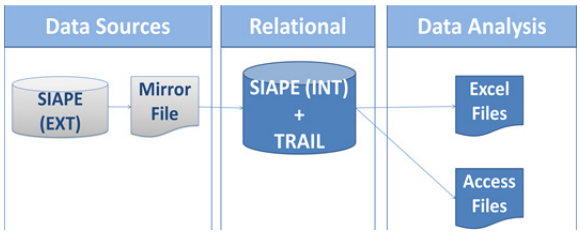

Figure 1: Original audit process.

Such method had several limitations that implied a low efficiency on the audit process. The first and more evident is the fact that it was executed after the payment was done. In case an irregularity was detected, another bureaucratic process was required to recover the money paid due to this irregularity. Also, this manual process required an intensive human intervention, which implies the expenses of human resources and possible errors on data manipulation.

Finally, the presentation of the data and the possibility of elaborating statistics and historic views were very limited.

Considering this scenario, a BI system with preventive control, automatic process and access to the statistics has been proposed in (Campos, et al., 2012). The proposed BI system should be able to detect irregularities before the payment was done. In addition, the audit process in the BI system should have almost no human intervention in order to reduce the expenses in human resources and to increase its reliability. Finally, a different and clearer presentation of the data, including different types of graphics, lists, reports and dashboards should be added.

3.2 The Previous BI Solution

In a first approach for the solution, we proposed in (Campos, et al., 2012) a BI system considering the federal payroll information and some important audit trails in order to automatically monitor the audit process.

The first step of the conception of a BI system is the identification and definition of the indicators required by the decision-making managers. In a previous work described in (Fernandes, Amaro, da Costa, Martins, Serrano and de Sousa Jr., 2012), it is shown how this process can be improved by the use of concept maps. This approach was applied to the concept of Audit Trails. Figure 2 shows the BI system considered in (Campos, et al., 2012).

Once the indicators have been defined, a BI solution for providing that information to the decision-making responsible manager is built. However, from the sources of information to the final reports, the data have to be processed in several steps.

As shown in Figure 2, the payroll data is generated and stored on the SIAPE database. Each row of the database is identified by the field called *matricula_servidor*, a unique id for each federal employee. Moreover, the information contained in the SIAPE database is divided into two groups: personal information and financial information. This information is sent to the CGAUD department through a mirror file.

The 16 Gb data is received every month, and it is directly loaded onto a relational database. This relational database contains also the result of the execution of the audit trails.

This data is extracted from the data sources through an Extract-Transform-Load (ETL) process, where the data is transformed and prepared to be loaded onto the DW.

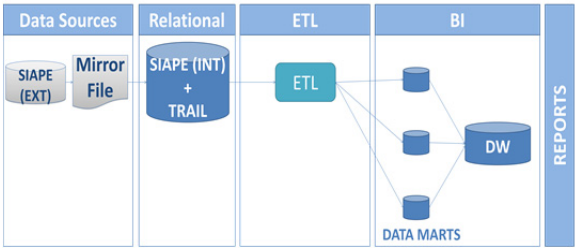

Figure 2: Previous BI solution proposed in (Campos, et al., 2012).

A general problem of ETL tools is their limited interoperability due to proprietary application programming interfaces (API) and proprietary metadata formats making it difficult to combine the functionality of several tools (Oracle, 2005). In order to avoid this drawback, the Pentaho Data Integration (PDI) tool was adopted. Its connection is based on Java Database Connectivity (JDBC) technology that establishes a set of classes and interfaces (API) in Java that allows sending and receiving SQL instructions from any relational database.

The BI step is composed by several Data Marts (DM) that concentrate all the information in a Data Warehouse (DW). A DW is a database used for reporting and data analysis and it is a central repository of data which is created by integrating data from different sources. Data warehouses store current as well as historical data and are used for creating trending reports for senior management reporting such as annual and quarterly comparisons. On the other hand, DM are smaller slices of the DW containing the data of a specific area of the system, according to the semantics of the application under concern.

Although the previous solution solved several problems of the original system, new requirements were identified and solved by our new BI system as described in Section 4.

4 THE PROPOSED IMPROVED BI SOLUTION FOR THE CGAUD SCENARIO

Based on the new requirements, a new BI solution was needed. In subsection 4.1, the functionalities of the proposed reimbursement tracking system known as SIGA application are explained, while subsection 4.2 contains the details of the new BI proposed solution.

4.1 The Proposed SIGA Reimbursement Tracking System

One of the limitations of previous BI solution was the low efficiency on the tracking of the detected irregularities or inconsistencies. Therefore, we propose here the SIGA application, which is a reimbursement tracking system that supports the auditor along the tracking process of an irregularity or an inconsistency detected on the Audit Trails.

According to Figure 3, the implemented SIGA functionalities are (1) Audit Trails, (2) Document Management, (3) Process Registration, (4) Process Monitoring, (5) Exception Register, (6) Reimbursement Tracking and (7) Reporting.

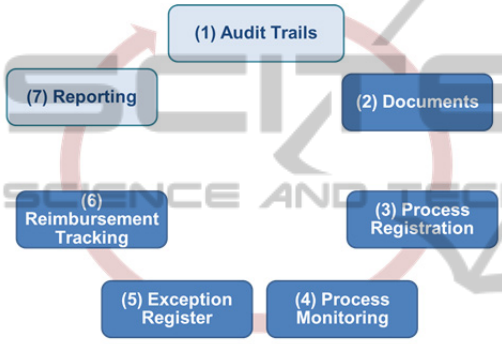

Figure 3: The proposed SIGA reimbursement tracking system composed of seven steps.

As shown in Figure 3, the SIGA reimbursement tracking process starts with the execution of the Audit Trails (1). Once an irregularity is detected, several documents have to be created in order to register it and notify the department charged of the payment of the federal employee. These documents can be automatically created and easily monitored through the Documents module (2) of the SIGA. With the detected irregularity and the correspondent documents, a new process is created into the application using the Process registration module (3).

Also, for each irregularity an internal process on SIGA is created. This process can be linked to one or several documents and is related to the starting user. As the audit process requires several analyses by different auditors, there is a Process Monitoring module (4) that allows changing the responsible user, the status of the process and tracks the historical evolution of the process.

Continuing with the flow in Figure 3, the Exception Register module (5) permits to register specific cases and exceptions that may occur again in the next month. Therefore, an exceptional case which can be for instance protected by some judicial authorization will not be detected again.

If the irregularity is not an exception, then the process is confirmed as irregular, the public employee has to refund the received value to the public treasury. In this case, the Reimbursement Tracking module (6) registers the process and monitors it until the reimbursement is finished. This module is of special interest as it allows monitoring the complete reimbursement process, something that was previously very difficult to be done. Moreover, this module also provides an estimate of the total amount of month to complete the reimbursement process. Therefore, the monthly portion refunded by the federal employee can be adjusted according to his or her age.

Finally, in (7) Reporting, different types of reports can be generated by selecting specific cases, for instance, by the total amount of the reimbursement ro by the final age of the federal employee at the end of the process.

4.2 The Improved BI Solution

Due to the useful amount of the data generated by the SIGA, the BI solution included integration with the SIGA allowing evaluating the efficiency of monitoring of the processes carried out into the MP. Therefore, our proposed BI solution has two data sources: the SIAPE database and the SIGA database as shown in Figure 4.

In our improved solution shown in Figure 4, the data received from the SIAPE is actually loaded onto an Operational Data Store (ODS). The ODS contains all the registers of the mirror file and becomes the internal data source. The inclusion of the ODS facilitates the operational access to the data coming from external entities and provides more reliability to the loading process of the data.

From the ODS, the personal and financial information about the federal staff is loaded onto a relational database called internal SIAPE where the information is consolidated and more reliability and consistency are guaranteed. As implemented in the previous solution, the Trail database contains the result of the execution of the audit trails. Also two databases SIGA and Trail are also used in this relational step. The SIGA database contains the information generated by the SIGA software.

DM and DW relations can be configured into two manners: top-down and bottom-up. In the first case, exposed on Figure 2, several DM are created with the information coming from different sources and then joined in order to build the DW. Top-down environments are architected to deliver precise answers to predefined questions. On the other hand,

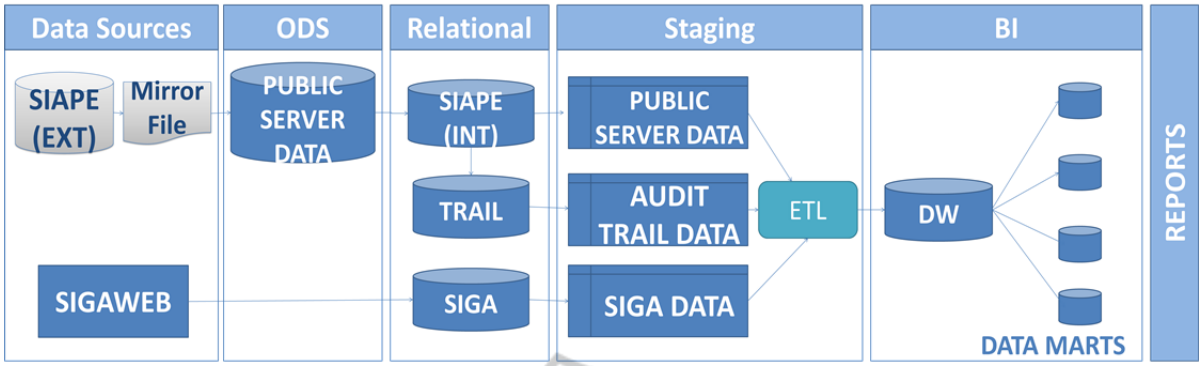

Figure 4: Proposed BI solution with the SIGA reimbursement tracking system.

in bottom-up environments like the one used in Figure 4, all the data is first integrated into the DW and then subdivided in several DM.

In this new BI system, a top-down structure has been adopted. First, a DW is built with the data obtained on the ETL process, and from this, four DM are created: Audit trails, Restitution to the treasury, Payroll and SIGA.

In the previous BI solution, a bottom-up structure was used. However, it showed some limitations mainly due the increasing volume of the data, the addition of new modules of the system with specific indicators and the necessity of increasing the granularity on the final reports. In this new scenario, where precise and detailed reports in four different knowledge areas are required, the top-down structure has been observed as the most efficient.

Finally, the information loaded on the four DM can be easily accessed from the Pentaho Report Designer and used to create different types of outputs such as Static Reports, Dashboards, Maps or Web Services.

5 BI REPORTS. PRESENTATION OF THE RESULTS

In this section, some results obtained with our improved BI system are presented.

Figures 5 and Figure 6 show the evolution of the volume of the auditing process per month, in terms of number of cases and value in BRL, respectively. In both cases we observe a quite stable tendency on time, with two evident exceptions on June and November. This is due to the 13th payment, an extra payment that all the public sector staff receives in Brazil, which is divided into two parts. In comparison with the results presented in (Campos, et al., 2012), in which the value of the audited rubric is 1,5 billion, there is a clear increase in the audited value due to the new trails that were created and due to the capability to manage bigger volumes of data.

Figure 7 and Figure 8 show the evolution of the detected irregular cases per month. When an irregular case is detected, the responsible or the audition analyses the case and notifies the correspondent department in order to avoid the irregular payment on the next month. In this case it is possible to observe a clear decreasing tendency, which demonstrates the efficiency of the proposed system in identifying irregularities, which can be fixed and do not appear in the following months.

Figure 9 and Figure 10 show the evolution in time of the number of cases and value of the restitution to the treasury. In this case note that there is a very irregular evolution, since the restitution to the treasury is a complex juridical process. Therefore, although the system correctly detects the irregularity, the restitution is not done automatically, since it depends on the analysis of a juridical process.

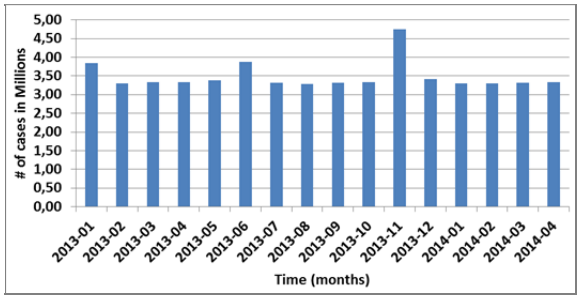

Figure 5: Evolution of the audited quantity per month based on the incompatibility of rubrics.

6 CONCLUSIONS

In the present work, we proposed an improved BI solution for the Department for the Auditing of

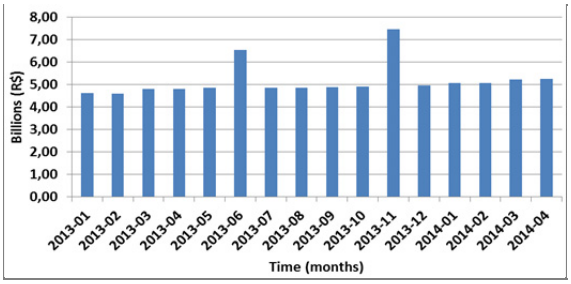

Figure 6: Evolution of the audited value per month based on the incompatibility of rubrics,

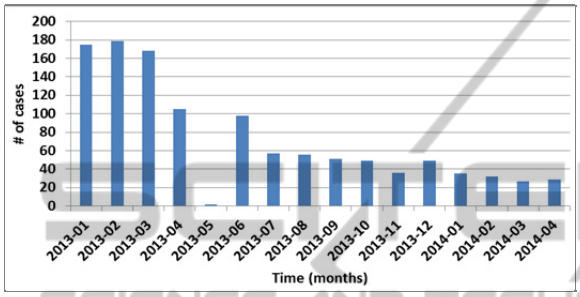

Figure 7: Evolution of the amount of irregular cases per month based on the incompatibility of rubrics.

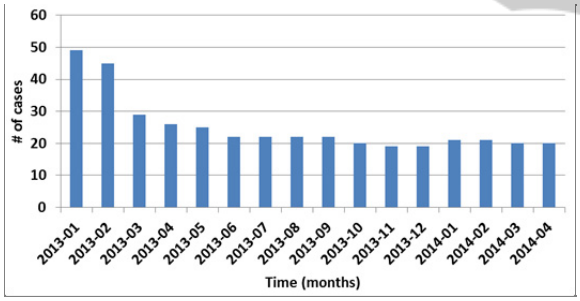

Figure 8: Evolution of the amount of irregular cases per month taking into account only the irregular extra salary for alimentation.

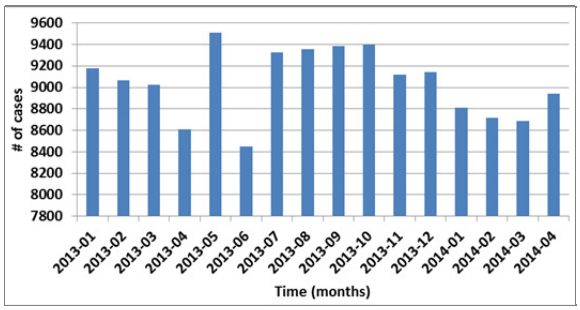

Figure 9: Restitution to the public treasury.

Human Resources (CGAUD) of the Brazilian Ministry of Planning, Budget and Management. A new software module including the complete

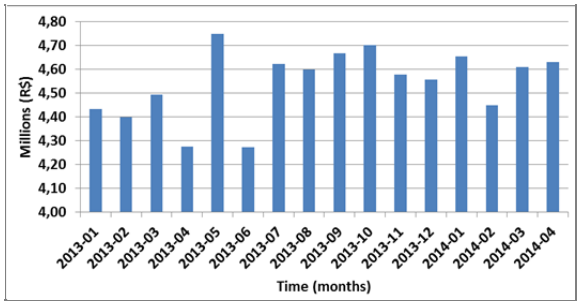

Figure 10: Restitution to the public treasury.

Reimbursement Tracking System has been implemented.

Moreover, the improved BI solution based on a top-down structure fulfils the new requirements of the project, which are to manage a bigger volume of data, to include the restitution to the treasury module on the BI and to provide more customization on the granularity of the final reports.

The results were validated using the real data of the federal staff payroll providing evidence of the technical and social efficiency of the new BI system.

As a future work, the inclusion of predictive analytics module to support the evaluation of the resulting indicators in order to detect statistically irregularity and future incidents is planned.

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