A solution for real time monitoring and auditing of organizational transactions

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Abstract

The controlling and auditing of organizational transactions in real time allows to determine the degree of reliability with which they are carried out, mitigating the organizational risk. This paper presents a solution proposal under a new vision for organizational auditing and monitoring in real time since it is focused on the implementation of continuous assurance services in organizational transactions in compliance with the formalisms of a business ontological model. Furthermore, this paper contributes for a new paradigm of the transactional auditing, which is intended to be at a very low and detailed level of organizational transactions.

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1. Introduction

Currently organizations are facing several challenges, for example their organizational transactions have grown in volume and complexity and they are living in highly regulated business environments. Thus, controlling and monitoring mechanisms are needed in order to evaluate and validate all transactions, in a comprehensive manner, to meet the controls and regulations. However, the traditional audit process occurs mostly after the completion of transactions, since it is not feasible to audit them in time. Thereby it makes it possible to inhibit the risk associated to their execution. Therefore, for many organizations there is a significant risk of errors and fraud and these are not detected in time, resulting in a negative impact on organizations. See, for example, the current global financial crisis and successive well-known scandals in some organizations, such as Lehman Brothers, A-Tec, Madoff, Kaupthing Bank, WorldCom, Enron, Parmalat and Tyco cases and many others [1-4].

Thus, any organization must be sufficiently prepared to survive, regardless of exposure and of the large number of risks it is subject to, by implementing a suitable system of Continuous Assurance in accordance with applicable legislative and regulatory framework. Continuous Assurance has been assuming an important role within the organizational context because it is the application of emerging information technologies to the standard techniques of auditing. "Continuous" does not mean real time, but it means to be effective, considering and being consistent with the pulse and rhythm of each organizational transaction and process [5, 6].

These aspects have propelled to create a new awareness of corporate governance and of the growing importance of monitoring and controlling the various organizational transactions (that is, any activity performed within a business process). Along with this evidence, a study by PricewaterhouseCoopers [7] examined various organizations and concluded that about 89% of participating organizations intend to adopt more solutions of continuous auditing and monitoring by 2012.

1.1. Motivation

Given the foregoing, it is necessary to find solutions which allow organizations to evaluate, monitor and validate their transactions continuously and independently, preferably in a non-intrusive way. The optimization of the operational performance will be also possible if this auditing is done in real time (in the shortest time possible after its execution), reducing in this way the associated risks.

Alongside this, there is another aspect to consider in relation to organizational transactions: risk profiles. In this context, risk profiles refer to the classification of different types of behavior that may occur in the execution of one transaction. In this work, two terms are considered to characterize risk profiles: negative profiles, which refer to all unwanted behaviors during the execution of transactions, for example incomplete or poorly executed operations; lack of crucial procedures; non-conformities; delays; incongruities and malfeasance and positive profiles, which refer to all valid and appropriate events [8, 9].

Thus, this paper focuses on answering to the implementation of real time assurance services, having as support the organizational transactions according to an ontological model of organizational transactions. An ontological model is important because it helps to understand the essence of the organizational transactions and processes and their relationships and characteristics. In parallel, a simpler business view, detached from any ontological representation, results in the inability to generate organizational knowledge [10]. Therefore, this work intends its prototype to be a system with a broader and detailed vision of organizational processes and transactions, thus respecting the formalities of an ontological model capable of representing the organizational reality. The work presented in this paper is supported by “Enterprise Ontology”, the model proposed by Dietz [11]. This model is adapted to represent the essential structure of the organizational
transactions with no significant complexities but simultaneously with coherence (i.e. parts constituting an integral whole), consistency (there is no contradiction or irregularities), comprehension (all the important issues are handled) and concisely (i.e. model does not contain superfluous matters). Furthermore, it has been applied successfully in some practical projects in recent years [12].

This paper is structured in six sections, including this introduction to the topic and the motivation. In the next section follows a brief literature review. Then, the solution proposal is presented, one that shows evidence of being effective in achieving the stated objectives. Section 4 presents the main results which are intended to be achieved and overviews a methodology for implementation and evaluation of the proposed solution. Finally, the last section presents the authors’ conclusions.

2. Literature review

This section aims to present some paradigms and concepts associated with the monitoring and auditing at the level of execution of the organizational transactions and processes. Some researches and applications related to the topic are also presented. Thus, the concepts which are here evinced have features and specificities similar to those presented for the prototype conceptualized in this paper.

The first two concepts intended to refer are Business Activity Monitoring (BAM) and Business Process Management (BPM). BAM allows that events generated by various applications and systems of an organization, or by services of inter-organizational cooperation, can be processed in real time in order to identify critical situations in the performance indicators. It aims to obtain a better insight into the business activities, and thus improve their effectiveness. BAM identifies and analyzes in real time the cause-effect relationships between events, enabling the system and/ or staff to take effective and proactive measures in response to specific identified scenarios. It allows, for example the early detection of abnormal events in business processes as a whole, or some of their constituent parts [13, 14]. In turn, BPM is defined as “supporting business processes using methods, techniques and software to design, enact, control and analyze operational processes involving humans, organizations, applications, documents and other sources of information” [15]. The BPM systems are complex assemblies of software components and tools that together provide features which allow us to develop, deploy and implement solutions based on business processes. Moreover, they enable the visualization, monitoring and management of events within the business process, and allow the highest-level visualization of the state of the execution of business processes, reducing the causes of the occurrences of exceptions [14].

Another interesting concept to present here is Complex Event Processing, (CEP) which includes methods, techniques and tools to process events in real time. CEP analyzes a series of data in real time and identifies patterns and generates events that can be processed and treated. This processing is done in memory and its logic is defined by a series of queries on all received data [16, 17]. In short, CEP is capable of processing high amount of data from different sources; operates in bitstream; has low latency; has limited processing window and can handle different types of operations on data, such as filtering, correlation, aggregation and association patterns.

2.1. Related work

Researchers from the Brandeis University, Brown University, and MIT carried out the project Aurora [18]. This project was designed to handle and manage a very large amount of data streams and allows its users to create their own queries from a set of available operators. These operators are connected to other operators or may simply provide results. These operators may derive from the output data from other operators or external data sources. Aurora is capable of optimizing the query considering the QoS indexes provided by the operators
and other indexes and system inputs specified by the users. This was a precursor of other identical monitoring systems of data flow, e.g. Medusa [19] and Borealis [20]. Like Aurora, the project STREAM [21] is a Data Stream Management System. The STREAM supports a large number of declarative continuous queries over continuous data streams and/or over traditional data repositories. The monitoring is done by controlling the results of queries made.

The work EasyCredit [14, 22] is an example of successful implementation in the banking sector. It is a system like BAM, using the concept of CEP and the pipeline used in the management and monitoring of credit transactions in real time.

Some works on this topic, in which event monitoring is done using log records, were also found. Within this group of works surveyed, one of them uses mining tools and CEP to analyze records of a database log in real time, and presents the sequence and the model of the transactions analyzed [16]. Furthermore, using mining techniques on log records, the possibility of recognition of events was demonstrated. It is able to link events that are not associated a priori with any workflow or process model to a new model, in other words it contributes for the discovery of new process and transactional models [23].

Another work of reference [24] describes an approach for automating the discovery of patterns of activity in organizational process models through an ontology. This discovery of patterns is done through a mapping between the elements collected in the processing of the process and the elements of the ontology. This is done primarily to verify if the process contains the necessary elements to meet the definition of each process pattern.

3. Solution proposal

This chapter aims to present a proposal for a solution which shows evidence of being effective in achieving the stated objectives. In this proposal the requirements that must be implemented are presented along with a possible conceptual architecture to meet these requirements. However, this section does not aim to describe technologically the solution, but to clarify, from a conceptual point of view, the purpose of each one and their relationships, following the alignment of the requirements which will be described.

A solution that addresses the problems and motivations presented in this paper should meet some requirements. The first one is the necessity to conceptualize a layer of non-intrusive internal control mechanisms in order to be incorporated in the operational information system (e.g. in the ERP). This system supports the execution of the organizational transactions to be monitored and audited. These internal control mechanisms, when embedded into ERP system, must be aligned with the ontological model of Dietz. In other words, the design of these mechanisms will have to take into account the different types of events, stages and relationships that constitute the essence of each transaction. Furthermore, a component that manages and stores the results which derive from the internal control mechanisms is also needed. Another tool is required in order to devise for the extraction of results of the internal control mechanisms and their transformation and storage in the previous component. This extraction of data provided by internal control mechanisms should be made as soon as possible after the occurrence of the event monitored by the respective control.

A key requirement of this proposal is the development of risk profiles repository. It should be able to maintain and manage the known negative and positive profiles of each organizational transaction to be monitored and audited. These profiles must be also modeled according to the ontological model. Another key requirement is the development of a module which compares the data from the internal control mechanisms with the records maintained in the risk profiles repository. In addition, it must be able to determine which profile is being followed by running each transaction. Moreover, if the situation that is running is unknown and is not classified in the risk profiles repository, it is intended that this module is capable of introducing this
new behavior in the repository. Then, it should require the classification of this new profile by the responsible of the system, now designated as transactional auditor.

Finally, the on-line results of the comparison module presented above should be stored in a repository in real time. This repository will contain the history of the results of the transaction auditing and monitoring and a picture of the current situation regarding the organizational transactions still in progress. This component will allow an interface with the transactional auditor, queries, the preparation of audit reports, notifications and alerts.

The architecture represented schematically in Fig. 1. was conceptualized based on the sought objectives and in the general requirements specified. From the analysis of this architecture, it is perceived that the proposed solution is intended to be permanently connected to the organizations operational information system. In other words, the internal control mechanisms should be incorporated in the ERP in order to monitor the status of the various phases and stages defined by the ontological model of organizational transactions. Thereby, they are able to support the proposed solution, and consequently the monitoring and auditing of organizational transactions.

The component represented by number 8 is the element responsible for the extraction of the state of internal control mechanisms and the data they may provide in order to integrate all this information in a repository (component 1). This will manage and maintain this information referring to the various states of execution of transactions. Component 2 illustrates the risk profiles repository of the organizational transactions to be monitored and audited.

The component represented by number 3 is the module aimed to be able to compare the various records in the risk profiles repository (via the data flow 6) and determine which profile is being followed by running each transaction, according to information received by component 1 (through the data flow 5). Furthermore, if we are facing a situation which is not classified in the risk profiles repository, it is intended that this module is capable of introducing this new behavior in the repository (via the data flow 7) and subsequently be classified as positive or negative profile. The results carried out by the comparison module (component 3) are sent to a repository (component 4), on which an interface for viewing current and historic state of controlling of the audited transactions should be developed. The auditing repository should notify and alert the transactional auditor when a negative behavior occurs, e.g. sending an e-mail or a sms.
3.1. Technical considerations

CEP would be tendentiously the choice in order to develop the component responsible for the detection and identification in real time of the risk profile. This, considering the set of facts presented in the literature review and the fact that the risk profile is being followed in execution of the various organizational transactions to be monitored and audited. Such a choice would be due to the features and performance of this paradigm in the processing of large amount of events and its ability to respond in real time. However, there is a requirement of the prototype which indicates that it must work with the organizations operational information systems in a non-intrusive way, which puts into question, in some part, the use of CEP in the development of this component. CEP is primarily designed to work with transient data, and data processing is done in memory. In turn, the fact that the system must be non-intrusive, the functional architecture is designed so that it acts upon data resulting from the execution of transactions in operational systems. In other words, the data to be processed will be persistent.

Databases are an option to process persistent data, with the advantage that they do not have specified time intervals contrary to the CEP processing. Because the system acts directly in the database of the operational systems, it means that the organizational events associated with persistent data have already occurred. Thus, the use of triggers in operational databases is a way of detection of events, since the insertion, edition or deletion of a record or a record field means the occurrence of an event of a given organizational transaction. Then, the component will render the activation of these triggers as if they were an occurrence of an event.

The "real time" is advertised as one of the requirements of the system and is defined within this work as the time interval closer to the occurrence of an event, respecting the rhythm of execution of organizational transactions. Thus, it seems that a database approach is sufficient to the functions of monitoring and auditing, despite not having a lower latency as CEP. This, because the purpose of the system is not to act in a direct and intrusive way on organizational execution of transactions, but rather to work with reports and alerts. Consider...
that the time and the rhythm of organizational transactions are variable and in different orders of greatness (the same transaction may have running times in the order of minutes, days or several months depending on the situation in question). Therefore, the time in which the user of the prototype has to react in a corrective way, after being alerted of an anomaly, is also variable, depending on the pace of the transaction in question. “A real-time system is one, where the correctness not only depends on the functionality but also on the timeliness of this functionality” [25].

4. Methodology and results

The deployment of the solution proposed above will intend to achieve some results. The first one is to ascertain whether it is feasible to build a repository of risk profiles, following the structure and pattern of the transaction axiom of Dietz’s ontology, managing multiple positive and negative profiles of organizational transactions. Another intended result is to demonstrate that the repository of risk profiles is a crucial element in the real-time monitoring and controlling of organizational transactions, checking if this repository has the information needed for an analysis and evaluation of how transactions are being carried out.

The development and implementation of internal control mechanisms capable of providing information about the transaction state in its various phases defined in Dietz’s ontology are another result to be reached. Finally, we intended to attest that the proposed solution, implemented in accordance with the vision presented in the research problem, is able to respond in real-time about the state of execution of organizational transactions, thus constituting a system with Continuous Assurance.

Based on the research problem presented, the solution projected and the results envisioned, triangulation is the research approach proposed, followed by a qualitative approach, combined with aspects of a quantitative approach [26, 27]. The choice of a qualitative approach is due to the fact that the research in question was more targeted, in a general way, to aspects of management and organizations [28]. However, the quantitative approach is justified because there will be a deployment of a prototype able to provide the collection and analysis of some data that may lead to findings from the technological point of view [26].

For the classification of the interpretation of research, the positivist and interpretive epistemologies are the ones to be used. The positivist epistemology will be used to objectively observe and analyze the results of scientific investigation from the technological point of view [29]. Simultaneously, the interpretive epistemology will be used to validate the resolution of the problem and understand the value of this result to an organizational environment. However, the final interpretation is a partial analysis because it will be based on a limited set of organizational transactions, subject of study [26, 30].

To conduct the research, the case study is the methodology which best suits the problem presented, because the research is more empirical, investigating the feasibility of a system prototype in a real (simulated) context and the resolution of organizational problems [26, 31]. Finally, the observation seems to be the appropriate research technique/tool to validate the raised research hypotheses. This technique is based on the observation of a set of phenomena in order to collect data, on a systematic basis, about the behavior of the prototype. The combination of indirect and direct observation seems to yield interesting results, by confrontation of users’ opinion with researchers’ opinion [32, 33].

To concretize the case study we intend to deploy the prototype and evaluate it in an organizational environment, and to this end, we aim to use the curriculum unit “Enterprise Simulation” from the Higher Institute of Accounting and Administration of the University of Aveiro. This yields a controlled environment, and also allows the application of the prototype in different organizational areas. “Enterprise Simulation”, included in the last year of the degree in Accounting, aims to simulate the organizational activities. These activities incite dozens of groups of students to create their own enterprise (in one of various organizational areas, like services, commerce, industry and public services), develop its operations in the business during an
operational period in accordance with the economic calendar and prepare and disseminate financial statements [34]. The university provides a well-structured simulation environment that is very close to reality and an infrastructure of information systems and that covers all the needs of organizations in their business activities. The internal control mechanisms described in the architecture of the solution proposal will be incorporated in this infrastructure of information systems which the university provides.

5. Final considerations

A solution with assurance services capable of continuous monitoring of organizational transactions in compliance with the formalisms of a business ontological model is an innovative vision. This because transactions are monitored and audited at a very low level, contrary to what happens in most monitoring of transactions that occurs at a high level (for example, comparing whether a completed transaction followed a set of established procedures). Another innovative vision presented in this paper is the implementation of a repository that contains and maintains the risk profiles of the transactions to monitor and audit, following the presented ontology.

This paper contributes for this new vision with a proposal of a conceptual architecture of a management information system which aims continuous monitoring of organizational transactions executed and supported exclusively in digital format supported by a business ontological model.

References

[6]. Vasarhelyi, M. A., M. Alles, K. T. Williams, Continuous assurance for the now economy. 1st ed. Sydney: Institute of Chartered Accountants in Australia; 2010
[8]. Santos, C., Modelo Conceptual para Auditoria Organizacional Contínua com Análise em Tempo Real. 1 ed: Editorial Novembro; 2009


[32]. Coolican, H., Research Methods and Statistics in Psychology: Hodder and Stoughton; 2004
