REA & Process Mining: How to Combine them for Auditing?

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Abstract

In international trade, reliability, security and cost effective logistic chain management are very important challenges that can only be met by innovative usages of IT. The Extended Single Window(ESW) project aims at a drastic reduction of physical inspections of goods in main ports by coordinated planning of government authorities, reliable transport to and from hinterland hubs and administrative cost reduction. Some savings can be achieved by improving the distribution of data, but more is possible by re-engineering the inspection processes from an audit perspective. Auditing is being studied in an SOA perspective. The question is then: "Who is auditing what, why, where and how?" This as part of ESW project is the objective of our research. In this paper we will present our research plan to achieve this objective and will describe how auditing can be set up with a combination of REA and process mining.

Keywords: Auditing, Customs Control, Service-Oriented Architecture, REA, Process Mining

1 Introduction

With the global economic growth of the last few decades, trade processes need to be improved. All over the world authorities are developing rules and regulation for improving the trade facilitation. European Union (EU) is also not left behind. They are redesigning their customs practices and legislation through the use of IT, collaboration between Customs administration and businesses, and cooperation between national Customs administration. Following are the two main concepts to support these challenges, namely,

- Authorized Economic Operators (AEO): since 9-11-2001 incidents in the USA, risk is high on the international agenda. According to EU custom code AEO can be defined as "a market participant who is in the entire European Community can be labeled as safe and reliable, as far as his

customs activities are concerned, and who can derive advantage thereof in the whole Community" [6].

- Single Window (SW). The main value a SW has for country or economy is to save time and cost which in turn increases the efficiency. SW bridges between government and agencies. In order to complete the import/export processes, traders have to make visits and deal with many government agencies at different location. In general we can say "A facility that allows parties involved in trade and transport to lodge standardized information and document with a single entry point to fulfill all import, export, and transit-related regulatory requirements. If information is electronic then individual data elements should only be submitted once" [14]. SW concept is recognized and promoted by several world organizations like United Nations Economic Commission for Europe (UNECE) and its Center for Trade Facilitation and Electronic Business (UN/CEFACT), World Customs Organization (WCO), SITPRO Limited of the United Kingdom and the Association of Southeast Asian Nations (ASEAN).

Importing/exporting traders or their agents have to communicate with all the intermediary parties which make possible the trade like customs, shipping companies, insurance companies, and many more. For each step traders have to visit and provide all the details of their import/export by themselves. In parallel they have to deal with the suppliers, manufactures and other related companies. This costs lot of time and effort from the traders.

On one side SW's objective is to reduce the administrative burden and on the other side it enables more control, security and safety. These aspects contradict each other somewhat, so a balance between these aspects needs to be found. If SW achieves reduction in the administrative burden then it will be able to have faster and more efficient transportation of goods in combination with reduction of costs.

'SW' refers to a single electronic entrance point where authorized operators can sent the information and other agencies involved in frontier control (such as police, border customs, veterinary and environmental authorities ..etc) use it.

The SW concept is expanded to fit into a broader area; the name of this new concept is Extended Single Window (ESW). SW streamlines the data between government and agencies but ESW is planning to help in changing the data requirements as well as data compatibility issues with the help of a service bus. Figure 1 and 2 shows the comparison of the concepts. For instance, if needed, in SW Border authorities, bank and others have to communicate with each other which cause extra work while in ESW information service bus provides a platform for all of them to communicate. ESW will re-engineer the control procedures by going back to the risk that a control could have, and then compare alternative mitigation strategies. "Aim of ESW is to develop an integrated coordinated border management solution for ports and airports for reliable, secure, and cost effective logistic chains throughout the Netherlands, which can enable an excellent logistic gateway to Europe" [13]. Shippers in EU have to face

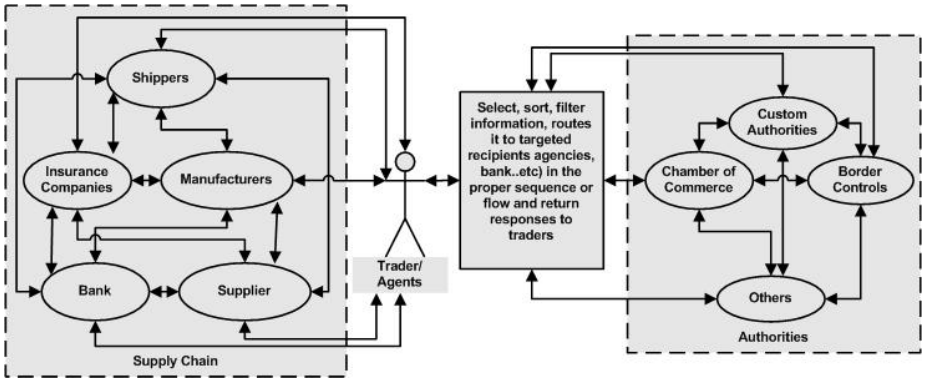

Figure 1: Single Window

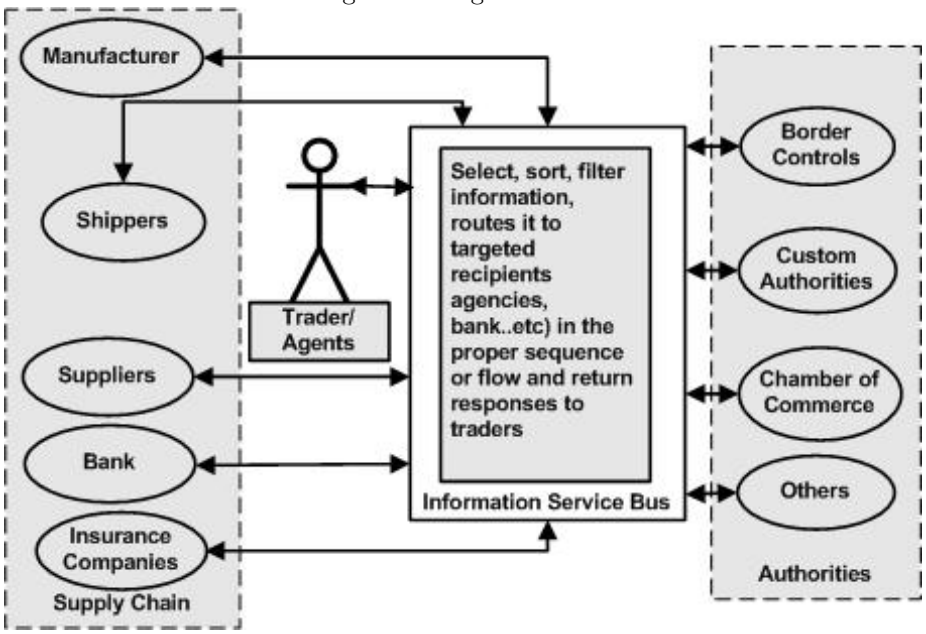

Figure 2: Extended Single Window

Figure 3: Real World Problem

extensive rules and regulation whenever they have to import/export from/to EU. Which cause time consumption, administrative load, declaration procedures, planning and coordination among different government/non-government agencies. " ESW is planning to manage import/export at ports, airports and extending to hinterland hubs according the Modernized Customs Code (MCC). It also includes the outgoing goods for instance preceded by export and incoming goods for instance followed by transit". [13].

Part of ESW objective is to improve the efficiency as well as the effectiveness of governance mechanisms in international trade and logistics, innovative forms of auditing and auditing processes redesign are required that make optimal use of new technology. The Service-Oriented Architecture (SOA) provides a strong foundation for achieving such an objective. In the following section we will discuss our research plan in detail. Based on our specific domain of custom and companies section 3 will describes how REA and process mining can be used for the purpose of auditing.

2 Research Focus

The focus of ESW is on existing/potential problems between custom and companies. Figure 3 gives an idea about the problem domain in which we can see that problem arises between shippers/trading companies and custom during import/export procedure.

Some companies have selected for exploring problems of import and export procedures. From each company we have identified set of problems. List of these identified problems helped us in identifying our research question and designing our research plan. In this paper we will discuss our research plan, research model and research goal based on the set of problems [3, 2].

2.1 Research Scope and Relevance

Service Orientation is the emerging IT standard whose global openness, design for agility, dynamic orchestration and single-source approach offer new opportunities in trade and logistics.

The ultimate objective of our research is process innovation in trade and logistics, like in ESW. To support this innovation, our research aims to explore process innovation (at the concept level): service-based process innovation in the transport domain, new governance models in the administrative domain, and especially the interplay between these two [1]. The process innovations that we

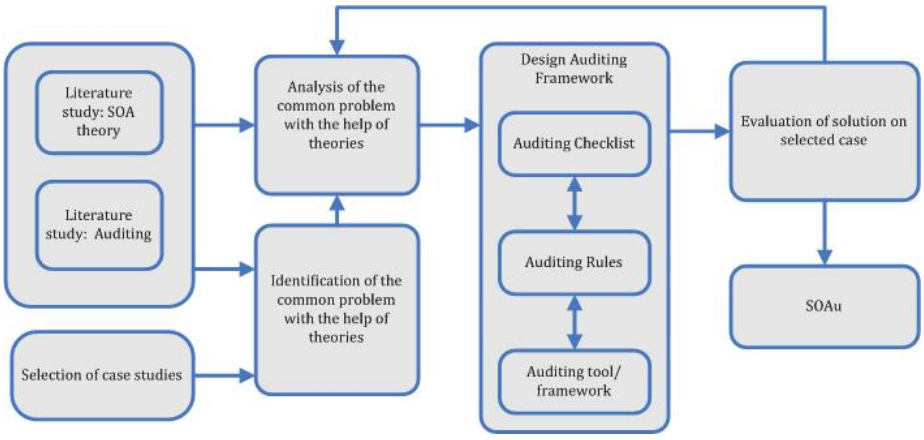

Figure 4: Research Model

foresee draw on already existing and still to be developed technical innovations that we group together under the label of Service Oriented Auditing (SOAu).

SOAu aims at the use of service-oriented technology to support auditing processes, in particular continuous and online monitoring. In our research we are considering that business services generate business events (including service request and service response events) and all of them can be published on the enterprise information service bus (EISB). With respect to continuous monitoring (CM) service two categories of events have been studied (i) operational events (ii) economic events - using REA business ontology [8].

2.2 Research Model

Our research objective can be described in more scientific terminology as follows.

"How to explore the innovation potential of Service-Oriented Auditing and provide an evaluation framework based on explicit control effectiveness and cost criteria" [13].

This is a complex question with lot of details hidden in it. We will follow the strategy of "divide and conquer". We will use the steps of Wieringa and Heerkens [21] to formulate research sub-questions. Figure 4 describes our research model in detail,

Our research topic "Service Oriented Auditing (SOAu)" consists of two main terms one is Service Oriented Architecture (SOA) and other is Auditing. Our literature review explores in both directions. Through literature survey we will identify research gaps. To identify the existing and potential problems we need to go to the real world scenarios. For this purpose ESW has selected many companies, from these companies we will get list of problems. We will analyze these problems with the help of different theories (like OLAT, PROM, and e^3-Controls..etc.) and will try to find out the solution of these. Outcome of analysis phase and list of problems will help us to proceed towards some auditing

mechanism. Auditing mechanism can be a checklist of auditing procedure, can be a set of defined rules and can be a tool to do it automatically. Research is always unpredictable so we can call the final outcome as auditing mechanism, which can consist of these three (checklist, rules, tools) or a combination. Our research will not end up after designing auditing mechanism, the real task begins right after that. We will evaluate these mechanisms and will move forward and backward between analysis and design phase of the research model.

3 Auditing using REA and Process Mining

Auditing is an evaluation/ monitoring of an organization or process to check whether sufficient control mechanisms are in place to make the provided information reliable. In this section we will see how REA and process mining can be of added value for the purpose of auditing.

3.1 REA

A generalized accounting framework is REA which is designed to be used in shared data environment for professionals (accountants and non-accountants). The Resource-Event-Agent (REA) ontology was first formulated in 1982 [8]. A resource is any object that is under the control of an agent and regarded as valuable by some agent. An agent is an individual or organization capable of having control over economic resources, and transferring or receiving the control to or from other agents. The constituents of processes are called economic events. The basis of REA is the semantic data model for accounting proposed by McCarthy [8]. REA mainly focuses on enterprise concepts such as accountability and control principles. REA discusses interconnected transaction cycles that all contribute to the generation of value for the enterprise. Usually each transaction cycle consist of business processes. REA uses the principle of economic reciprocity (i.e., give and take), the resources whose value is affected by these events and the agents involved in these events. REA recognizes two kinds of duality between events: conversion duality and exchange duality. REA structures provide a solid basis for dealing the economic events in SOA environment [10]. There is a direct mapping from REA models to database structures [4]. The dualities express integrity constraints that can be used for both the design of control mechanisms (preventive) and for the detection of deviating behavior (detective).

3.2 Process Mining

Process mining aims to extract knowledge from event logs recorded by an information system. For the purpose of process mining more and more events are being recorded thus providing detailed event logs about the history of processes. With the help of process mining techniques we can extract information from event logs. Process mining also helps to conformance of processes, detect

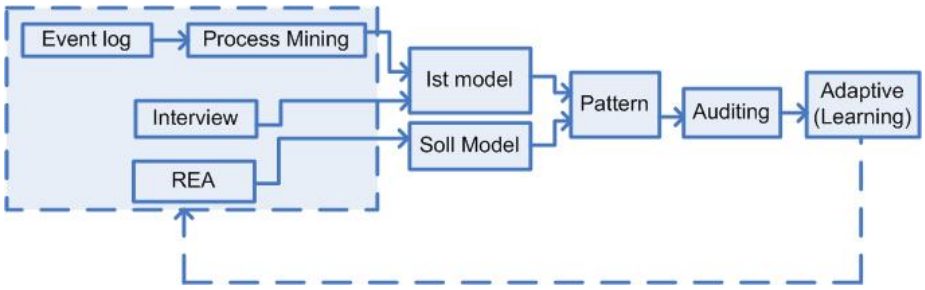

Figure 5: Auditing with the help of REA and Process Mining

bottlenecks, predict execution problems and monitor deviations (e.g., comparing the observed events with predefined models or business rules). It is closely related to BAM (Business Activity Monitoring), BOM (Business Operations Management), BPI (Business Process Intelligence), and Data/ Workflow Mining [15].

3.3 Auditing

In auditing, business processes with built-in controls for preventive and detective measures are central. With the help of process mining techniques and tools we can find control flows, authorization rules, business data models, organizational models and business rules [11, 12, 17]. In general, mining techniques try to deduce patterns and rule from facts.These facts are in the form of event logs which are derived form event performed at runtime. There are mainly two advantages of using event logs, first it provides the auditor with more data, and secondly it provides a human-independent way of recording data [7]. REA model focuses on accounting information for the accounting and non-accounting professionals. Both REA and Process mining can enhance the process of auditing. At one side Weigand and Elsas have discussed auditing using REA [20] on the other side Jans et al [7] describe the use of process mining and event log for the auditing. We are taking one step further by using REA and Process mining together. Figure 5 shows how to audit with the help of REA and Process mining,

With the help of process mining conformance checking is possible as shown in ProM tool [16]. For example Rozinat and van der Aalst [11, 12] compared process model and event log and reported the deviations in event logs. IST and SOLL are used with respect to the nature of an audit object, we consider it to consist of two related objects of a different modality, being:

- the object which is subject to the audit, called the IST, As Is? audit object, and,
- the object which is used as a norm in the audit of the IST object, called the SOLL, “To Be? audit object.

Similarly in Figure 5, we are getting IST model from event logs while REA can provide the SOLL model. Interviews from the companies contribute in the IST model as well. REA is based on economic events and audit patterns relate operational events to REA events. This mapping is a human interpretation task, although some computational support may be possible. Patterns are based on IST and SOLL models. Figure 5 further shows that audit logs are also input to process mining, which feeds adaptive learning. Once auditing is being done on these patterns a learning cycle could be started for future reference. van der Aalst et al [18] discusses three basic types of controls in a business. They are (i) Detective : In this type of control we can see the deviation form the SOLL model. As shown in Figure 5 by comparing IST and SOLL model we get the deviation patterns. (ii) Corrective: this type is similar to previous one but have the added functionality that is to attempt to correct the deviation. As shown in Figure 5 during the process of audit we can ask company to overcome the deviation patterns identified by comparing IST and SOLL models. (iii)Preventive : In this type of control we are trying to prevent the deviation to be happen. Backward arrow from 'adaptive learning' to the dotted box in the Figure 5 show this control.

By means of a simple example we can tell how process mining of event logs add value to auditing. Custom defines a set of rules and regulation[5] for the companies who want to be AEO certified.These regulations provide the SOLL model. Based on these guidelines company design/re-design its control procedures. Then company apply for the AEO certification. Custom inspects the control procedures of the company. Sometime during this inception process custom authorities ask (cf Figure 5 interview box) for the details. In case they feel suspected about any control they went into detail and do process mining of event logs to see what is actually happened (cf Figure 5 Process mining box). In this way IST model is develop. With the help of IST and SOLL model patterns are develop which will be audited by custom authorities. In these patterns custom authorities can see which pattern is violated, less violated, mostly violated or not violated at all. Where company need to apply more control and where company is rigid in its controls. Based on these patterns if custom authorities does not find company compliant then with the help of Adaptive learning the company uses the cycle presented in Figure 5 by itself. Process mining of audit logs provide a great deal of information for the adaptive leaning in case of need. With each cycle content of the adaptive learning will be improved. Thus listing of the possible events that can happen will be in IST model (partial or complete) of the enterprise system. Process mining tools can help to make manually constructed partial IST models more complete [19].Process mining of audit logs enhance the adaptive learning cycle.

Therefore, In order to audit the core enterprise, the auditor must identify the SOLL and IST modality. Buffer contents may have illicit decreases or increases. Such errors have consequences for the other audit objects. The duality axioms of REA have SOLL modality. More normative constraints, such as permissions and authorizations, can be specified on the REA policy level [9].

4 Conclusion

To reduce cost and effort, Custom is trying to maximize the digital interaction with/among customers. ESW is a step towards it. Our intended contribution in ESW is SOAu and the research plan is presented in this paper. This paper is not intended to write the last word on the subject of how event logs, process mining and REA can add value to auditing. This is the beginning of the research. Both practitioners and researchers have much to do to explore what process mining and REA can accomplish for auditors in custom domain. There is a need to evaluate the proposed model on a case study and see the results as well.

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