Decision Making Intelligent Agent on SOX Compliance over the Imports Process

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Abstract

The objective of this work is to define a decision support system over SOX (Sarbanes-Oxley Act) compatibility of the Imports Process based on Artificial Intelligence and Theory of Argumentation knowledge and techniques measuring at the same time the quality of how things were done on this specific process of the analyzed business case.

SOX Law in effect nowadays is worldwide facto standard for financial and economical operations of private sector with the main objective to protect investors of private sector and promote the financial health of private companies. In this framework we have developed a decision support intelligent expert model to help SOX control bodies, companies and auditors to support their SOX compliance decisions based on well founded bases like Artificial Intelligence and Theory of Argumentation.

The model here presented incorporates several key concepts like pre-existing expert knowledge base, a formalized and structure way to evaluate an existing business case focusing on the Imports Process, a semi automated fuzzy dynamic knowledge learning protocol and an structure method to evolve based on the facts of the business case and suggest an specific decision about the SOX compatibility of the specific business case.
Keywords: Multiagent Systems (MAS), Expert Systems (ES), Business Intelligence (BI), Decision Support Systems (DSS), Sarbanes-Oxley Act (SOX), Argumentation, Artificial Intelligence,

1. Introduction

As already showed by Fernandez et al. [1-3] (2013), in 2002 several US companies like Enron or Worldcom come out to the newspapers due to several financial scandals. Mainly due to the use of financial practices in the border of the legality. Consequences of this situation were very high stock exchange loses due to contagion effect and huge social alarm.

The reaction of the US government in the middle of 2002 was to create an specific Law with the main objective to increment the government control over financial operations of private sector companies looking to protect investors and avoid such financial scandals. This was the SOX Law (Sarbanes Oxley Act).

Due to the high level of existing globalization and to the fact that most of the big multinational US companies operate as well in the rest of the world, SOX Law is nowadays a facto standard all around the world.

Present paper propose an specific formal model based on Artificial Intelligence and Argumentation Theory which its main objective is to help and support private companies, auditors and control government bodies to take appropriate decisions about if the Imports Process of an specific business case is or not SOX compliant and on the other side, this model provides as well a key performance indicator of the quality of the Imports Process of such business case.

The application of our proposed model over an specific business case will generate or suggest an specific decision about SOX compatibility. This suggested decision will be based on specific evidences of such business case on how the Import Process has been done, based as well on pre-existing human expert knowledge the model has, based on an specific semi automated fuzzy learning protocol and based on existing court resolutions.

Pre-existing decision support multiagent systems are based on generic problems in typical fields like Medicine, Law, Negotiations, ecommerce or Learning processes. Our model resolves an specific problem : decision on SOX compatibility or not of the Imports Process of an specific business case inside the Purchasing Cycle of goods and services using a novel combination of Artificial Intelligence and Argumentation Theory and combining this approach with an initial pre-existing human expert knowledge and with a semi automatic learning protocol to let the system evolves far beyond its initial knowledge.

2. State of the art

SOX Law is formed by eleven chapters but there are three that are the most relevant for our model : (1) "Corporate Responsibility and Financial Reports", (2) "Revision of Internal Controls by Company Management" and (3) "Corporate Responsibility on the Financial Reports". Those sections state that General Directors and Financial Directors of private companies have full personal civil and penal responsibility over financial reports publish by their companies. This means that it is key important for companies to know before they publish whatever financial report if this is or not SOX compliant. Our model help those companies to support their decision. Our model supports as well auditors to take a decision on SOX compatibility if needed and supports as well government control bodies.

Financial reports of whatever private company will be SOX compliant if and only if all its business cases handle during this reporting period are SOX compliant. Whatever business case will be SOX compliant if and only if all its financial cycles including Purchasing Cycle is SOX compliant. One of the key processes of this Purchasing Cycle is the Imports Process, so SOX compatibility of this process will directly affect the full SOX compatibility of the full business case.

In connection with Artificial Intelligence and its relation with Theory of Argumentation, there are in the bibliography many examples of it like : [4-13] Fox et al. 1992, Frause et al. 1995, Dimpoulos et al. 1999, Dung 1995, Bernard & Hunter 2008, Bench-Capon & Dune 2007, Kraus et al. 1998, Rahwan & Simari 2009, Boella et al 2005. This relation covers a wide range of fields like argumentation computational models, hybrid argumentation models, persuasion models, strategic behaviour models, legal reasoning or e-democracy based on argumentation.

In general, there are two types of argumentation : abstract argumentation and deductive argumentation. Abstract argumentation takes care only about the coexistence of those arguments and their attack or support relationships between each other without taking care of the meaning of each argument. On the other side, deductive argumentation takes care of the composition of each argument in terms of its individual components. One of the most important and relevant paper about abstract argumentation is Dung[7] in 1995, and other related works like Boella et al. [13] in 2005. Deductive argumentation has the objective to handle non evident information and after an specific reasoning process, reach an specific decision on its truthfulness or not, generating during the reasoning process supported or non supported arguments in front of the root hypothesis.

Multiagent systems inside Artificial Intelligence is a very important application field for Argumentation Theory due to the fact that the agents of whatever multiagent system to reach whatever objective need to cooperate and communicate between each other as a fundamental activity inside the system. This communication need is a perfect application field for Argumentation Theory letting the agents to share proposals and evolve taking decisions.

We can find several bibliographic references showing different types of formal dialogues to govern those agent communications : [14-21] (Walton & Krabe, 1995, Cogan et al. 2005, Amgoud et al. 2000, Reed 1998, Parsons et al. 2003, & Sklar and Parsons 2004).

Other examples of the relationship between Argumentation Theory and Multiagent Systems are [22-27] Belsiotis et al. 2009, Devereux & Reed 2009, Matt et al. 2009, Wardeh et al. 2009, Morge & Mancarella 2009, Thim 2009.

With regards the connection between Artificial Intelligence and Financial Sector, almost of the present papers and studies are prior to the publication of the present SOX Law in 2002 and show the already existing concern to show if published financial reports were true or not. Some examples are [28-41] : Changchit et al 1999, Meservy 1986, O'Callaghan 1994, Liu et al. 2009, Kumar & Liu 2008, Changchit & Holsapple 2004, Korvin et al. 2004, Deshmukh and Talluru 1998, Fanning & Cogger 1998, Coakley et al 1995, Fanning & Cogger 1994, Welch et al. 1998, Sirvastava et al. 1998 o Sarkar et al. 1998.

Based on our bibliographic research on the topic and up to the best of our knowledge, the model here proposed is a novel proposal on SOX compatibility over the Import Process using both Multiagent Systems and Argumentation Theory as the basement.

3. Proposed model

The objective of the present work is to design an argumentative SOX compliant decision support system over the Imports Process of the financial products and services Purchasing Cycle using technologies of both Artificial Intelligence and Argumentative Negotiation to support companies to identify non SOX compliant situations before it will be too much late and to support financial auditor to decide if the economic and financial periodical results published by those companies are or not compliant with the SOX Law. As well it is explained how this system can be incorporated into a higher level multiagent intelligent expert system to cover the full financial purchasing cycle.

The economic and financial results published by a company will be compatible with SOX law, if all economic and financial operations that belong to these results are as well SOX compliant. As well, all those economic and financial operations are SOX compliant if all the projects or business cases that compose those results are SOX compliant too. An specific business case will be SOX compliant if all the financial cycles that constitute it, are compatible with the SOX Law.

The key processes that compose a typical Purchasing Cycle are usually : (1) Suppliers' Selection, (2) Suppliers' Contracting, (3) Approval of Purchase Orders, (4) Creation of Purchase Orders, (5) Documentary Receipt of Orders, (6) Imports, (7) Check of Invoices, (8) Approval of Invoices without Purchase Order and (9) Suppliers' Maintenance. The Purchasing Cycle of a certain business case will be compatible with SOX regulation, if all its processes are SOX compliant. This proposed model is focused on the Imports Process of the Purchasing Cycle and its compatibility with the SOX regulation. The decision support system here designed, is going to be implemented by an argumentative intelligent expert agent which has the objective to help companies and auditors to decide if the Imports Process followed in the analyzed business case is or not compatible with the SOX Law and as well as second objective to provide a measure of the quality of that process carried out in the analyzed business case.

The agent has being designed with an specific structure optimized to reach the final objective of the system. Those are the elements that compose this structure : (1) Agent's Objective, (2) Initial Beliefs or Base Knowledge of the Agent, (3) Information Seeking Dialog Protocol, (4) Facts Valuation Protocol based on Agent's Beliefs, (5) Agent's Valuation Matrix over the Business Case Facts based on its Beliefs of Knowledge Base, (6) Intra-Agent Decision Making Protocol (Intra-Agent Reasoning Process on SOX Compatibility based on Deductive Argumentation. Conclusive Individual Phase of the Agent) and (7) Dynamic Knowledge Learning Protocol.

3.1 Agent's Objective

The agent's main objective is to verify if the Imports Process of the business case that is being analyzed is or not compatible with the SOX legislation. As secondary objective, it will provide a measure of the quality of that process carried out in the analyzed business case. For both objectives, it will be check if every belief on the initial beliefs base matches or not with a fact of the facts base of the business case, and in case of matching, how much (quantitative value of this matching).

3.2 Beliefs or Base Knowledge

In this section it is gathered the initial knowledge of the agent as a set of beliefs. It represents the knowledge the agent has on the specific analyzed process without taking in mind any other possible knowledge derived from the experience and from the learning. The above mentioned beliefs will be enumerated and their characteristics will be indicated.

1.- Customs management

This is a key belief of the knowledge base of this agent. The existence or not of a fact of the analyzed business case that matches to this belief, will be a key point for SOX compatibility as well as for the final valuation of the quality of the Imports Process.

At the same time, from quality point of view, this is as well a relevant belief.

This belief is mainly checking if the product has been identified properly at customs and all relevant custom taxes have been paid according to the present legislation and customs authorities.

3.3 Information Seeking Dialog Protocol

Before explaining this protocol, let's remark that the right focus of this protocol is the Imports Process of the specific business case we are analyzing.

This protocol is designed to let the agent interrogates the analyzed business case looking for relevant information to be analyzed later on to determine on the basis of the initial knowledge of the agent, which one is the degree of quality of the followed process in that business case, as well as to value if the above mentioned process has complied with SOX regulation. The agent inquires the business case according to the beliefs it has in its initial knowledge, and for every question, the agent will gather from the business case an answer with the needed detailed information accordingly to every belief. In this specific model this agent will be concentrated on the specific part of the business case that matches with the Imports Process.

This protocol is designed taking in mind two ideas : (1) one of the most important elements of an agent is its initial knowledge formed by its beliefs, and (2) a business case can be considered as a set of facts which constitute all the information about how things were done along the life of the above mentioned business case. The aim of this protocol is to capture for every belief of the agent, the correspondent fact of the facts base of the business case which corresponds with the above mentioned belief. Once captured, it will be necessary to see how much it is in line with the specific belief of the agent both from a quality point of view and from SOX compliant point of view.

Basically this protocol consists on the idea that the agent asks to the business case, " how did you do this during the Imports Process? ", and the business case will answer to the agent with the "arguments" or "evidences" of how it did it. Evidences that later on will be analyzed by the agent. It is necessary to keep in mind that the agent has a clear idea of how it is necessary to do the things in every stage of the business case based on its initial knowledge, and that what the agent is looking, is to analyze if inside the business case, things were done as should be.

This Information Seeking Dialog Protocol constitutes a phase in which the agent individually explores the whole documentation of the analyzed business case from Importss point of view with the objective to compile as much evidences as possible on how things were done. Those beliefs as already commented, constitute the initial knowledge or base knowledge of the agent and represent the fundamental characteristics of the process that the agent is analyzing.

The Imports Agent analyzes the Imports Process and in the above mentioned process there is a series of key characteristics. This kind of details are "beliefs" of the agent and more important, inside these beliefs, inside its agent's initial knowledge, the agent has a clear idea of how things should be done.

When the agent analyzes the business case with this protocol, it compiles all the facts of the business case which match with its beliefs. It can happen that for a certain belief a fact does not exist in the facts base of the business case, denoting steps inside the business case that they should have done and has not been like that. With this protocol, the agent will take this under consideration for coming stages at the time to value the quality of the process and take the appropriate decision about SOX compatibility according to this situation.

The inspection of the agent over the business case will be realized across a mediating agent which will facilitate the communication between both. This mediating agent represents the person responsible for the business case in the company, and for each question of the agent who analyzes the case, can seek inside the business case documentation to analyze the above mentioned documentation and to provide a response to the formulated question.

Here (Fig. 1) it is presented the protocol in which the agent inquires the analyzed business case with the objective to gather needed information about its beliefs. This collected information will allow to value the initial beliefs from SOX compatibility point of view and from quality point of view.

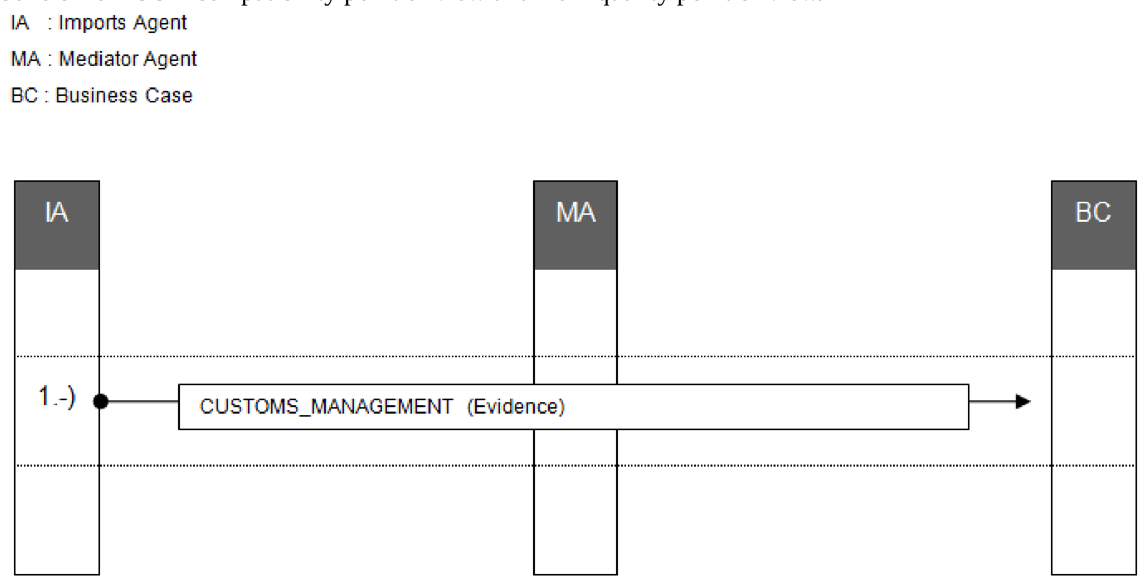

Fig. 1. Information Seeking Dialog Protocol

Let's see in next the next section how to value these collected facts.

3.4 Facts Valuation Protocol based on Agent's Beliefs

This protocol allows the agent to be able to value the facts previously gathered as evidences with the Information Seeking Dialog Protocol about the Imports Process. The valuation of these evidences will be carried out based on two approaches: (1) quality of the process, and (2) compatibility with SOX legislation. Two weight factors have been assigned to each belief respectively for quality and for SOX compatibility. The weight of quality will denote the relevance of that belief in the global valuation of quality of the whole analyzed process. The weight of SOX compatibility will only denote if this specific belief is relevant or not from SOX compliant point of view. Qualities' weight will be used in a numeric way to calculate the final quality of the specific analyzed process. SOX compatibilities' weight won't be used in a numeric way, it will indicate if that belief is or not relevant for the compatibility with SOX legislation.

Regarding valuation of quality, there will be numeric values inside the range [-10, 10], where -10 will denote a penalization in the valuation of quality, and 10 will denote the maximum value of quality. Regarding valuation of SOX compatibility, the possible values will be logical boolean values : true (t) or false (f). True denotes that this belief matches a fact of the facts base of the analyzed business case and therefore the process analyzed by this agent, regarding that belief, is compatible with the SOX legislation. False value will mean the opposite. Let's briefly explain these key elements :

Belief type : possible values can be :
- a.-) Critical or Irrelevant for SOX compatibility
- b.-) Important or not for the quality of the process.

SOX compatibility weight : possible values can be :
- a.-) 1 if it is needed and mandatory for SOX compatibility
- b.-) 0 in rest of cases

Quality weight :
- possible values will go from 0 to 1 taking in mind that agent's beliefs don't have the same relevance in the quality of the process. Critical SOX beliefs will have a total relevance of 50% over the rest of agent's beliefs although these would be less in number.)

SOX compatibility valuation : possible values can be :
- Logical boolean valuation : true (t) or false (f)
- (t) if this belief exists in the facts base of the analyzed business case
- (f) in rest of cases
- (NA) in case this belief is irrelevant for SOX compatibility

Quality valuation : possible values can be :
- Valuation of the fact of the analyzed business case corresponding to this belief inside the range [-10 (penalization), 10]

This agent has one key belief composing the initial base knowledge of the agent : (1) – Customs management. This is the valuation protocol for such belief :

1.- Customs management (Table 1):

Belief type	Critical for SOX compatibility. Important for the quality of the process.
SOX compatibility weight	1 (needed and mandatory belief for SOX compatibility)
Quality weight	1 (100% of the weight to the unique belief of this agent)
SOX compatibility valuation	Logical boolean valuation with values true (t) or false (f). (t) if this belief occurs in the facts base of the analyzed business case. That is to say, if for every purchase order, it has been done the needed customs management aline with the specific present legislation, identifying the product accordingly and paying needed legal custom taxes. As well it will be true whenever in the business case there were no import factors to avoid penalization of this case at global level. (f) in rest of cases.
Quality valuation	Valuation of the fact of the business case that corresponds to this belief inside the range [-10 (penalization), 10] -10 (penalization) there is no customs management according with respective present legislation. 10 in rest of cases

Table. 1. Imports Valuation Protocol

3.5 Agent's Valuation Matrix over the Business Case Facts based on its Beliefs or Knowledge Base

In this section, It is showed in table format all valuations gathered by the previous Facts Valuation Protocol based on Agent’s Beliefs over each one of the facts of the analyzed business case focusing always on the Imports Process.

It is needed to highlight, as indicated before, that SOX compatibility weights are indicators of if that belief is or not relevant from SOX compatibility point of view. In the case of being a relevant belief for SOX compatibility, it will be indicated with an unitary weight (1), and its value according to the previous protocol, will be true (t) meaning that it is SOX_COMPLIANT or false (f) meaning NON_SOX_COMPLIANT. In the case of being an irrelevant belief for SOX compatibility, its weight will be null (0), and their value won't be relevant (it doesn't apply, NA).

The final valuation of SOX compatibility of the whole agent over the specific Imports Process that is being analyzed, will be calculated by an inference rule describe more in detailed in the next protocol (Intra-Agent Decision Making Protocol). The final valuation of quality of the process analyzed by this agent, will be given by the weighted sum of all the quality values obtained in each one of the analyzed facts of the business case.

Table 3 describes more in detailed the Valuation Matrix over the Facts for the Imports Process.

IMPORTS PROCESS	SOX COMPATIBILITY VALUATION weight(value)	QUALITY VALUATION OF THE IMPORTS PROCESS weight(value)
1.- CUSTOMS_MANAGEMENT	1 (v)	1/2 (v)

Table. 3. Agent's Valuation Matrix over the Imports Process

3.6 Intra-Agent Decision Making Protocol. (Intra-Agent Reasoning Process on SOX Compatibility based on Deductive Argumentation. Conclusive Individual Phase of the Agent)

In this section it is shown the reasoning side of agent which uses a deductive argumentation protocol, makes its own decision about if the Imports Process of the analyzed business case is or not SOX compliant. This protocol is based on Classical Logic Theory or Logic of Predicates and the central base of this protocol is an inference rule which uses as arguments, the result of the valuation of beliefs from the previous phase (Agent's Valuation Matrix over the Business Case Facts based on its Beliefs or Knowledge Base). Specifically those relevant beliefs for SOX compatibility.

The objective of this protocol is to try to demonstrate the truthfulness of a hypothesis that establishes that the process that is being analyzed by this agent is compatible with the SOX legislation (Table 4).

	INDIVIDUAL HYPOTHESIS
1.-AGENT OF IMPORTS	H1: *The Imports Process followed in the analyzed business case complies with the SOX regulation.*

Table. 4. Agent's Hypothesis

Here, the agent will determine the truthfulness or not of the corresponding hypothesis based on an inference rule. This inference rule will come specified in advance by a combination of the agent's beliefs or the agent's initial knowledge with a learning factor that will gather the previous accumulated experience in past business cases, together with the option of new dynamic knowledge collected by a human expert just in case of needed (Fig.2 & Fig. 3).

CUSTOMS_MANAGEMENT (Evidence1) ▼
LEARNING_FACTOR (Evidence1) →

SOX_COMPLIANT(PROCESS_OF_IMPORTS)

Fig. 2. Main Rule

┐ **CUSTOMS_MANAGEMENT** (Evidence1) ▲
┐ **LEARNING_FACTOR** (Evidence1) →

SOX_NO_COMPLIANT(PROCESS_OF_IMPORTS)

Fig. 3. Complementary Rule

This protocol uses notation of Classical Logic or Predicates Logic with its logical operators : ┐ (negation), ▲(conjunction), ▼(disjunction), → (implication), ↔ (biconditional).

The arguments to be used in this protocol are : (1) Customs Management and (2) Learning Factor. First argument represents the agent's static knowledge based on their beliefs or base knowledge. The second argument represents its experience or dynamic knowledge, it means, the knowledge that this agent has acquired as the time went on in the analysis of other business cases.

The argument that represents the static knowledge here used and that are part of the antecedent of the inference

rule, are the result of the valuation of their boolean respective functions in the process followed with the Facts Valuation Protocol based on Agent's Beliefs for SOX compatibility, and therefore they are variables with true (t) or false (f) value.
The argument that represents the dynamic knowledge, will also have true (t) or false (f) value depending on the result of the learning protocol. This learning protocol will take into consideration evidences presented by the business case in this specific Imports Process.
SOX_COMPLIANT is defined like a boolean function or logical predicate that can take boolean true (t) or false (f) values and its semantic represents the compatibility with the SOX regulation. SOX_COMPLIANT (PROCESS_OF_IMPORTS) composes the consequent of the main inference rule and therefore based on its arguments, this rule allows us to obtain its truthfulness or falsehood. The conclusion is represented by the consequent of the previous inference rule and its truthfulness will depend on the truthfulness of the predicates that form the antecedent of the rule.
These previous inference rules establish that SOX_COMPLIANT (PROCESS_OF_IMPORTS) will be true if its antecedent belonging to the static knowledge (argument 1) is true, or, if the learning factor that represents the dynamic knowledge indicates this truthfulness. That is to say SOX_COMPLIANT (PROCESS_OF_IMPORTS) will be true (t) if all critical beliefs for SOX compatibility (static knowledge) are true, or, although they weren't, it will be also true (t) if its dynamic knowledge (learning factor) indicates it, based on its past experiences. This means that the Dynamic Knowledge Learning Protocol will be taken in use only if the initial static knowledge by itself cannot determine a positive SOX compatibility.
The truthfulness or not of SOX_COMPLIANT (PROCESS_OF_IMPORTS) will allow us to demonstrate or to reject the hypothesis previously outlined. NON_SOX_COMPLIANT (PROCESS_OF_IMPORTS) is defined as well as a boolean function or logical predicate which can take true (t) or false (f) values and is the logical complementary predicate of SOX_COMPLIANT.

3.7 Dynamic Knowledge Learning Protocol

As indicated by Fernandez et al. [1-3] in 2013 , a Dynamic Knowledge Learning Protocol should be a key part of an expert system to let the system be able to accumulate past experiences (knowledge) to contribute in future cases to improve its performance. In this specific Imports Process it is really important to introduce the key characteristics of this process inside the core of this learning protocol to be really optimized and let the system be fine tuned on the problem we are solving. We are referring to the main key characteristic of this process : (1) customs management. This already mentioned main characteristic will be part of the core of this protocol and will be represented by the term $\mu_{e1'}^{e1}$ we are going to explain.
The agent uses its static knowledge or fundamental beliefs to determine the SOX compatibility of the analyzed Imports Process. If the static knowledge can not determine a positive SOX compatibility, this Dynamic Fuzzy Learning Protocol will be taken in use. There is the possibility that based on the agent's previous experience it can be verified if in similar cases with similar evidences and after consulting to the human expert, it was decided to value this process as compatible with SOX. In other words, to see if this case is an exception to the static knowledge of the agent.
There are specific situations that can go beyond the static initially predefined beliefs, and that they will be based on specific court judgments over real cases in which a very specific context after the analysis of the court gives a result of SOX compatibility even although static initial knowledge states a non SOX compatibility. It means we would be under exceptions of real cases that the human expert knows and that belong to court resolutions or decisions of the control organisms on specific business cases where a series of specific evidences, opposite to what it is indicate by the initial knowledge, would have determined a positive SOX compatibility. These exceptions, through the learning protocol, will allow our agent to learn and to evolve beyond the initial knowledge formed by its beliefs.
As indicated by Capobianco, Chesñevar and Simari [42], the agents should be able to adapt to dynamic and changing environments. Pinzon et al., (2011) establish the need of self-adaptation ability as an important characteristic in multiagent systems. In this line, Fukumoto and Sawamura [43] proposed a model in which the results or conclusions are back propagated to the initial knowledge to enrich future possible argumentations. With this protocol, the agent is able to change its beliefs, improving its knowledge beyond its initial state.
As the time goes on, the system should learn from its previous experiences (PE) with previous analyzed business cases as well as from the consultations to an external human expert (HE) representing the knowledge over recent court decisions on exceptional situations so it can be defined the following learning factor relationship (lf) that represents how the knowledge of the system is evolving with each new business case. Here, it can be seen how the previous experience combines with the opinion of the external human expert and feeds the "future" previous experience term, allowing the system to accumulate the knowledge and learn.
In real life, sometimes we can find previous similar experiences but not exactly the same ones. This is model

under the SE (similar experiences) term that models some kind of uncertainty or fuzzy knowledge. In this case a certain evidence (e1') can be considered as (e1) if an only if their respective degree of belonging to that evidence is for example 90%. This percentage is called, degree of certainty and will be represented by ϕ. If we don't want to take uncertainty of fuzzy knowledge into consideration, we will take this parameter as 100%.

$$lf : \underset{(pe_t, he_t, se_t)}{PExHExSE} \underset{\rightarrow}{\rightarrow} \underset{lf\,(pe_t, he_t)}{PE} \quad (1)$$

Given a state "t" in which the model is analyzing an specific business case, for each specific evidence e1, it can be defined the learning factor (lf) as a function of the previous experience (pe) in that moment, similar (but not equal) previous experiences (assuming a certain risk or degree of uncertainty) and the opinion of the human expert (he) taking into consideration the combination of both evidences.

$$lf_t^{e1} = \alpha_t^{e1} \cdot pe_t^{e1} + \beta_t^{e1} \cdot se_t^{e1} + \gamma_t^{e1} \cdot he_t^{e1} \quad (2)$$

α_t^{e1e2} is the activation factor of the previous experience (pe) on an specific instant t and for specific evidence e1. Its value on instant t will be 1 just in case there is previous (equal) experience for that evidence and 0 if no previous experience.

$$\alpha_t^{e1} = \begin{cases} 1 \quad if \quad \exists\, lf_i^{e1} \in \{0,1\},\; i \in \{1,\ldots,t\text{-}1\} \\ 0 \quad otherwise \end{cases} \quad (3)$$

β_t^{e1e2} is the activation factor of the similar experiences (se) term on an specific instant t and for specific evidence e1. Its value on instant t will be 1 just in case we accept a certain risk or degree of uncertainty in our approximation to the evidence e1.

$$\beta_t^{e1} = \begin{cases} 1 \quad if \quad \phi < 100\%, \phi \in [0\%,\ldots,100\%] \\ 0 \quad if \quad \phi = 100\% \end{cases} \quad (4)$$

ϕ is the degree of certainty we assume. A value of 100% means no uncertainty. This means 100% of certainty so we are not assuming any kind of risk at the time to find similar experiences in the past. If ϕ is minor than 100%, then we are assuming a certain degree of uncertainty when we are approximating past evidence e1' like e1 under specific previously defined criteria. ϕ is the degree of certainty, so it means that (100%-ϕ) represents the degree of uncertainty or risk we are assuming in our approximations of past evidence (e1') by (e1).

We defined $\mu_{e1'}^{e1}$ as well, like degree of belonging of e1' to e1, being e1' a past evidence and e1 the evidence we are analyzing on instant t.

The condition to consider or approximate a past evidence e1' to e1 should be that $\mu_{e1'}^{e1} >= \phi$

Taking in mind that evidence e1 represents the documental_receipts, we correlate $\mu_{e1'}^{e1}$ with the rates of documental receipts of both evidences in front of the total number of purchase orders. This criteria is subjective and comes from our experience.

$$\mu_{e1'}^{e1} = \begin{cases} 1 & if \quad tsga^{e1'} \geq tsga^{e1} \\ \dfrac{tsga^{e1'}}{tsga^{e1}} & if \quad tsga^{e1'} < tsga^{e1} \end{cases} \quad (5)$$

And tsga represent the rate of imports that are following the already previously defined criteria :

$$tsga = \frac{number\_of\ imports\ following\_predifined\_criteria}{total\_number\_of\_imports} \quad (6)$$

γ_t^{e1e2} is the activation factor of the human expert (he) on an specific instant t and for specific evidence e1. Its value on instant t will be 1 just in case there is no previous experience for those evidences (equal or similar) and 0 if previous experience (similar or equal) for those evidences exists.

$$\gamma_t^{e1} = \begin{cases} 1\, if\ \alpha = 0\ and\ \beta = 0 \\ 1\, if\ \alpha = 0\ and\ \beta = 1\ and\ no\ \exists\, se_t^{e1} \\ 0\ otherwise \end{cases} \quad (7)$$

pe_t^{e1e2} represents the previous experience and will exist just in case there is a previous learning factor for that specific evidence e1 in a previous instant before t. If that is the case, the specific activation factor α_t^{e1e2} will be 1.

$$pe_t^{e1} = \begin{cases} 1\ if\ \alpha_t^{e1} = 1\ \ and\ \ \exists\, lf_i^{e1} = 1\ ,\ i \in \{1,\dots t\text{-}1\} \\ 0\ if\ \alpha_t^{e1} = 1\ \ and\ \ \exists\, lf_i^{e1} = 0\ ,\ i \in \{1,\dots t\text{-}1\} \end{cases} \quad (8)$$

This factor represents as well the accumulated experience in the past.

$$pe_t^{e1} = lf_{t-1}^{e1} \quad (9)$$

As we have indicated before, this protocol handles fuzzy knowledge letting us to approximate the evidence (e1) by similar but not equal evidence (e1') from the past. This is manage under the term similar experience (se_t^{e1e2}) and let us to approximate e1 by e1' only after an specific previously defined threshold ϕ (degree of certainty)

$$se_t^{e1} = lf_t^{e1'} if\ \mu_{e1'}^{e1} > \phi \quad (10)$$

Last but not least is the human expert indicator he_t^{e1e2} that will be activated by its activation factor just in case there is no previous experience (equal or similar) available for indicated evidences in previous instants of time. This human expert factor will be 1 just in case the human expert indicates a positive SOX compatibility and 0 if negative SOX compatibility is determined.

$$he_t^{e1} = \begin{cases} 1\ \ if\ \gamma_t^{e1} = 1\ \ and\ \ positive\ SOX\ compatibility\ is\ determined\ by\ the\ human\ expert\ \ for\ e1\ evidence. \\ 0\ \ if\ \gamma_t^{e1} = 1\ \ and\ negative\ SOX\ compatibility\ is\ determined\ by\ the\ human\ expert\ \ for\ e1\ evidence. \end{cases} \quad (11)$$

Our original learning factor expression, can be shown as well like :

1.-) If $\alpha = 1 \Rightarrow \beta = 0$ and $\gamma = 0$ then $lf_t^{e1} = \alpha_t^{e1} \cdot p_t^{e1}$ (12)

2.-) If $\alpha = 0\ and\ \phi = 100\%\ (\beta = 0) \Rightarrow \gamma = 1$ then $lf_t^{e1} = \gamma_t^{e1} \cdot he_t^{e1}$ (13)

This protocol lets us as well to work with no risk, with no fuzzy knowledge leaving the full responsibility of non crystal clear decisions to the human expert. To do this, we only need to establish our working degree of certainty as 100%. If we do this, we have the following :

$$\phi = 100\% \Rightarrow \beta_t^{e1} = 0 \quad (14)$$

And developing the learning factor initial expression we get the following :

$$lf_t^{e1} = \alpha_t^{e1} \cdot pe_t^{e1} + \beta_t^{e1} \cdot se_t^{e1} + \gamma_t^{e1} \cdot he_t^{e1} \quad (15)$$

$$lf_t^{e1} = \alpha_t^{e1} \cdot pe_t^{e1} + \gamma_t^{e1} \cdot he_t^{e1} \quad (16)$$

$$lf_t^{e1} = \alpha_t^{e1} \cdot lf_{t-1}^{e1} + \gamma_t^{e1} \cdot he_t^{e1} \quad (17)$$

$$lf_t^{e1} = \alpha_t^{e1} \cdot (\alpha_{t-1}^{e1} \cdot pe_{t-1}^{e1} + \gamma_{t1}^{e1} \cdot he_{t-1}^{e1}) + \gamma_t^{e1} \cdot he_t^{e1} \quad (18)$$

$$lf_t^{e1} = \alpha_t^{e1} \cdot (\alpha_{t-1}^{e1} \cdot lf_{t-2}^{e1} + \gamma_{t-1}^{e1} \cdot he_{t-1}^{e1}) + \gamma_t^{e1} \cdot he_t^{e1} \quad (19)$$

$$lf_t^{e1} = \alpha_t^{e1} \cdot (\alpha_{t-1}^{e1} \cdot (\alpha_{t-2}^{e1} \cdot pe_{t-2}^{e1} + \gamma_{t-2}^{e1} \cdot he_{t-2}^{e1}) + \gamma_{t-1}^{e1} \cdot he_{t-1}^{e1}) + \gamma_t^{e1} \cdot he_t^{e1} \quad (20)$$

$\bullet\bullet\bullet$

And generalizing this development, we get the following expression that represents the accumulated learning experience via propagated past experiences or via consultation to the human expert. The consultation to the human expert in an specific instant of time for a pair of specific evidence e1 is propagated to the future via (pe) previous experience factor and will let us to reuse this specific consultation in similar future cases.

$$lf_t^{e1} = \sum_{i=2}^{t} \prod_{j=i}^{t} \alpha_j^{e1} \cdot \gamma_{i-1}^{e1} \cdot he_{i-1}^{e1} \quad (21)$$

This expression represents the learning factor model (without fuzzy knowledge, with 100% of certainty) here proposed and will take value 1 in case of positive SOX compatibility and 0 in case of negative SOX compatibility. This value will come via accumulated past experiences or via consultation to the human expert.

The following diagram represents this learning process and it will only be used when the static knowledge or the base beliefs establish a negative SOX compatibility. The learning process consists on checking the previously managed business cases by this agent, and based on the evidences provided by the present business case, see if there were cases in which the human expert indicated under a similar situation, a positive SOX compatibility. Otherwise, it will mean that there is not previous experience and the protocol will step to consult to the human expert with the evidences provided by this business case.

Human expert based on knowledge of this matter and based on knowledge of court specific resolutions will determine if there is or not a positive SOX compatibility. Just in case of a positive SOX compatibility, this compatibility will solve the present process of our business case and at the same time it will increase our agent's knowledge for similar future cases, storing this decision in the dynamic knowledge base. Figure 4 (Fig. 4) describes more in detail this protocol.

The agent by itself and based on its experience over several analyzed business cases will grow up in knowledge and will fine tune its final conclusions. This part of agent learning begins to be useful during a massive use of the system with a big number of business cases and where specific cases show complex situations that comes out the static SOX regulation and where specific control organisms and courts need to take SOX compliant decisions that will be taken into consideration as precedents for future similar cases or situations.

These kind of resolutions over exceptional situations not covered by the static SOX regulation will generate a jurisprudence base which experts can consult and apply using the learning protocol here described. At the same time the agent using this protocol is able to assimilate and add those resolutions to its initial knowledge growing in terms of knowledge.

There are several recent researches ([44] Capera et al., 2003; [45] Razavi, Perrot, & Guelfi, 2005; [46] Weyns, et al., 2004; [47] Zambonelli, Jennings & Wooldridge, 2003; [48] Ontañon & Plaza, 2006; [49] Parsons & Sklar, 2005), where it has being shown the need to design multiagent systems able to adapt to the changes happened in their closed environment. With this Learning Protocol our model follows this tendency being able to adapt to legislation changes and to exceptional situations too.

IA : Imports Agent
BDA : Base of Dynamic Knowledge of the Agent
HE : Human Expert

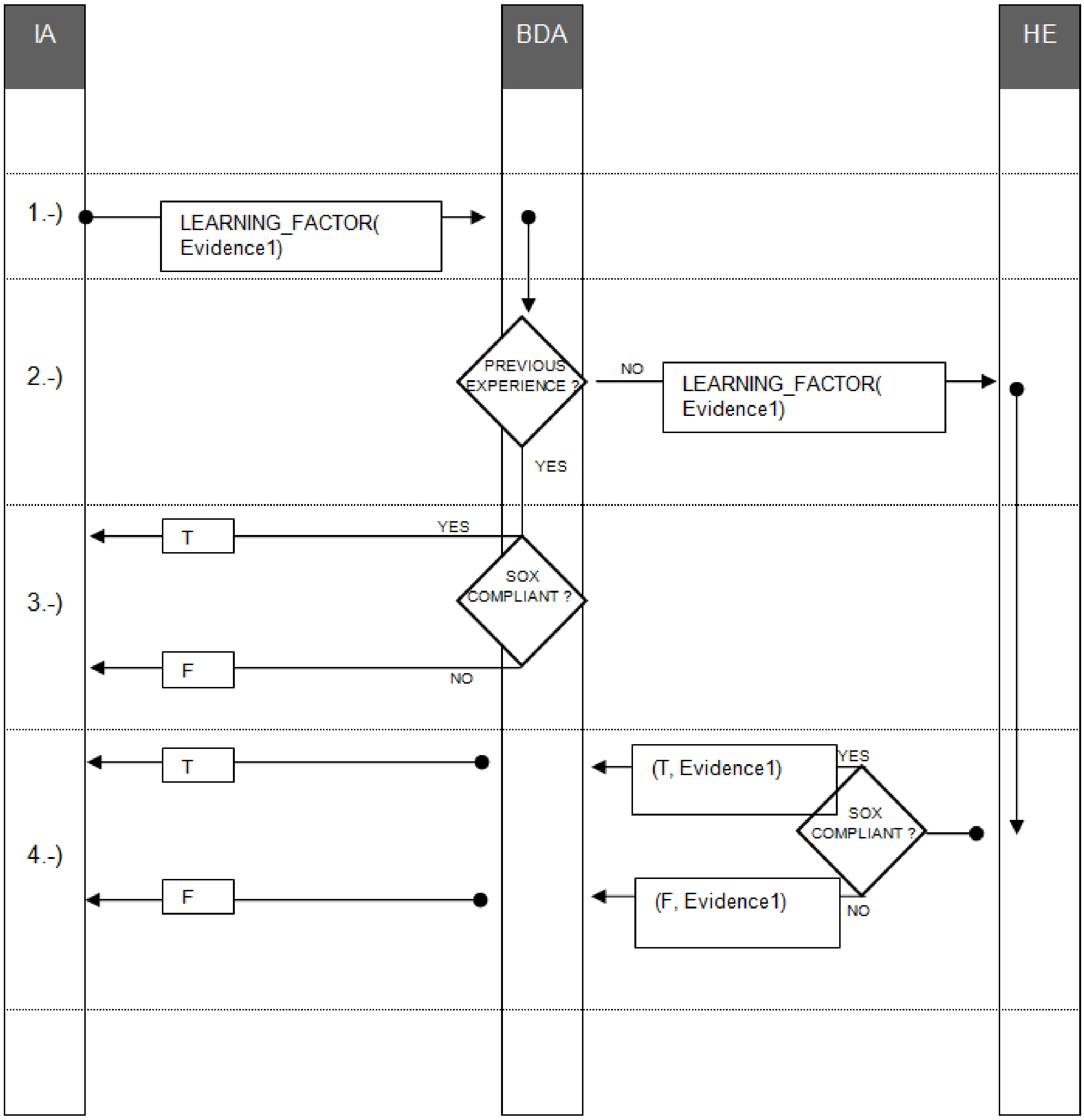

Fig. 4. Dynamic Knowledge Learning Protocol

4. Integration with a higher level multiagent intelligent system

[50] Kakas, Maudet and Moraitis (2004) proposed an inter-agent communication model in which they should fulfil the communication protocols defined in advance, take into consideration both the individual agent preferences and the global objectives and being able to handle exceptional situations.

Here it is describe how the previously describe Argumentative SOX Compliant Decision Support Intelligent Expert System can be integrated in a higher level multiagent intelligent system to cover the full Purchasing Cycle. As already described, this Purchasing Cycle is commonly compose by nine key processes : (1) Suppliers' Selection, (2) Suppliers' Contracting, (3) Approval of Purchase Orders, (4) Creation of Purchase Orders, (5) Documentary Receipt of Orders, (6) Imports, (7) Check of Invoices, (8) Approval of Invoices without Purchase Order and (9) Suppliers' Maintenance.

The integration as highlighted by Fernandez et al. [1-3] in 2013 can be done in a two steps approach : (1) Joint Deliberative Dialog Protocol and (2) Inter-Agent Decision Making Protocol. The first one will specific on the process we are analyzing (Imports Process) and the second one will be share between all the agents that will form the full multiagent system. Next section explain this Joint Deliberative Dialog Protocol of the to the

Imports Process.

4.1 Joint Deliberative Dialog Protocol. (Cooperative Joint Phase with the rest of the Multiagent System)

Deliberative communication among agents is a key element in multiagent technology to let the full system to evolve towards a common agreed decision or step in its way to reach the final objective ([52] Corchado & Laza, 2003; [53] Corchado et al., 2003).

This section is dedicated to the Joint Deliberative Dialog Protocol, in which the agent will carry out a proposal towards rest of the agents that compose the multiagent system. This proposal will consist on proposing that the corresponding process this agent monitors, based on the data obtained after having interrogated and analyzed the business case, be or not compatible with the SOX regulation (Fig. 5).

A0 = Agent of Suppliers Selection Agent = AS
A1= Agent of Suppliers Contracting = AC
A2 = Agent of Approval of Purchase Orders = AAPO
A3 = Agent of Creation of Purchase Orders = ACPO
A4 = Agent of Documentary Receipt of Orders = AR
A5 = Agent of Imports = AI
A6 = Agent of Checking of Invoices = ACI
A7 = Agent of Approval of Invoices without Purchase Order = AAI
A8 = Agent of Suppliers' Maintenance = ASM

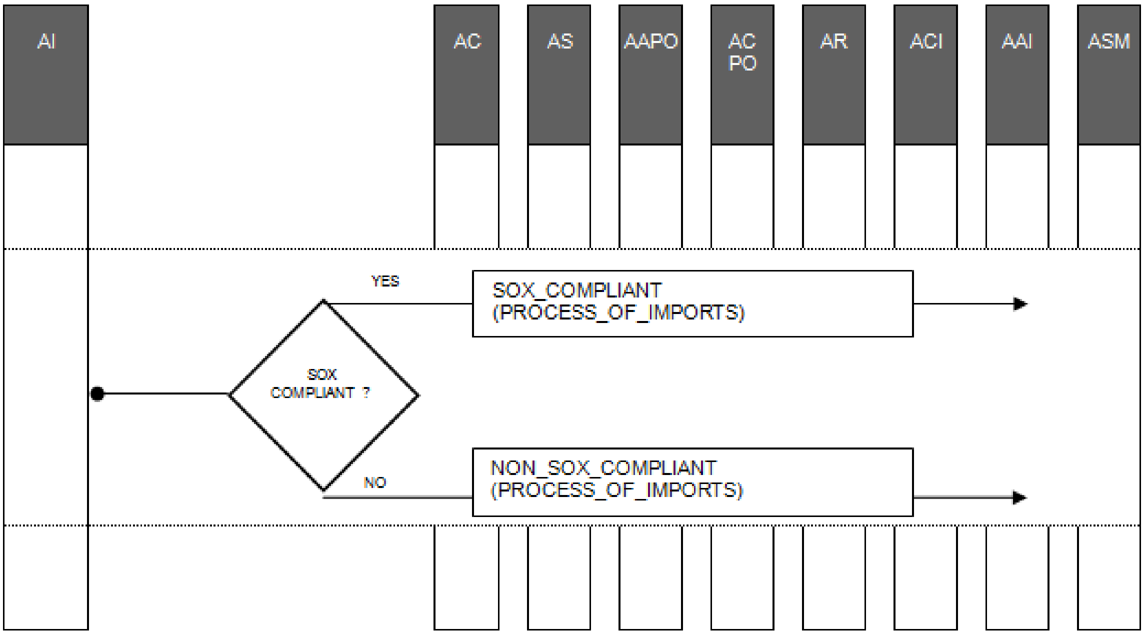

Fig. 5. Joint Deliberative Dialog Protocol (Inquire).

As answers, each of the other agents will send to this agent during the deliberation process an attack message, contradicting its proposal, or a support message, supporting it. Veenen and Prakken in 2005 (Veenen J., Prakken, H., 2005) proposed a model in which agents are able to reject the original proposal at the same time they give a justified reason about it.

The attack message that an agent will answer to another with the objective of contradicting its initial proposal will consist on sending an opposite message to the one proposed. That is to say, if a SOX_COMPLIANT (compatible with the SOX regulation) was proposed, a NON_SOX_COMPLIANT (not compatible with the SOX regulation) would be answered. If a NON_SOX_COMPLIANT is proposed, a SOX_COMPLIANT would be answered.

The support message that an agent will answer to another with the objective of supporting its initial proposal will consist on sending a message that reaffirms and support the agent's proposal. That is to say, if a SOX_COMPLIANT was proposed, a SOX_COMPLIANT would be answer and if a NON_SOX_COMPLIANT was proposed, a NON_SOX_COMPLIANT would be answered (Fig. 6).

At the end of this protocol, and after all the agents in an individual way have decided about the compatibility or not with the SOX regulation of their process, the system will be in a stage in which all the agents know the results or individual decisions made by the rest of agents.

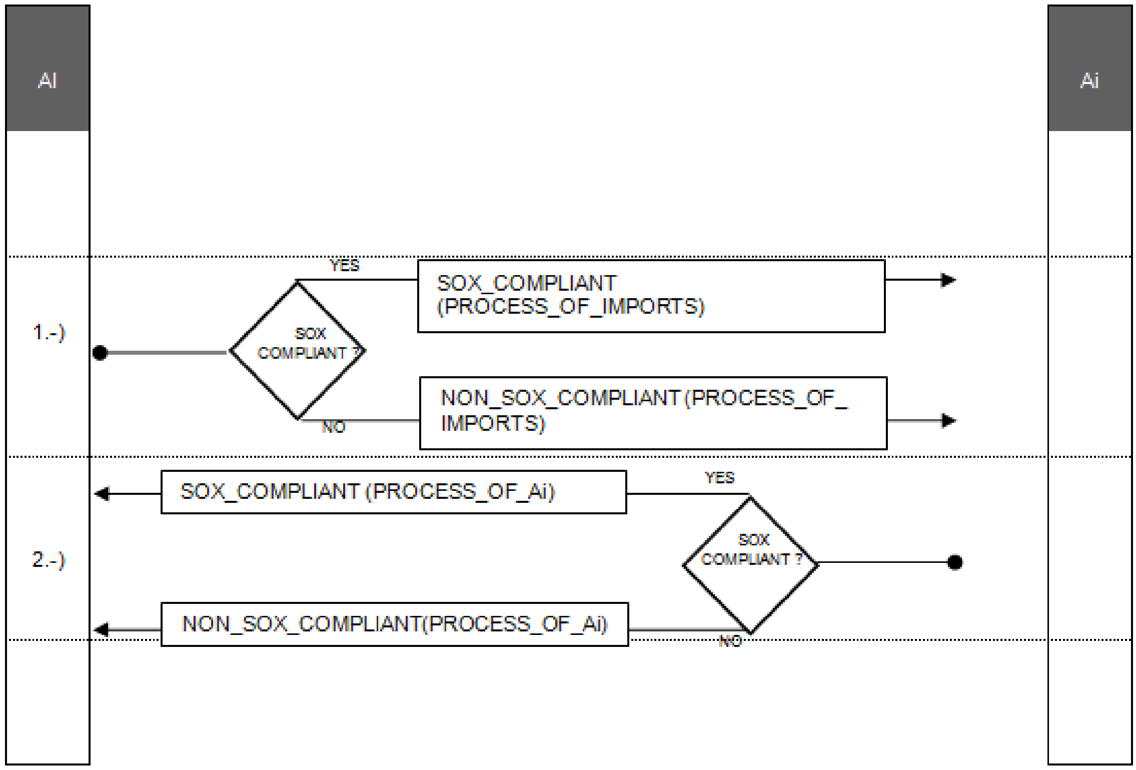

Fig. 6. Joint Deliberative Dialog Protocol (Inquire & Answer).

There are in the literature several studies ([54] Esteva, et al., 2001; [55] Hubner, Sichman & Boissier, 2004; [56] Parunak & Odell, 2002) showing the fact that multiagent systems need a higher level of organization to coordinate all the agents of the system. The Joint Deliberative Dialogue Protocol proposes a parallel alternative in which all the agents share its individual findings among the rest of the agents of the system with final idea that in a further phase, all those agents together will use this shared knowledge to find a common agreed decision about the final compatibility over the full Purchasing Cycle.

5. Results

Here it is shown the results obtained after applying the proposed model to a real specific business case. The following table summarizes the results of the firsts two protocols : (1) Information Seeking Dialog Protocol and (2) Facts Valuation Protocol based on Agent's Beliefs (Table 5).

AGENT'S VALUATION MATRIX OVER THE BUSINESS CASE FACTS BASED ON ITS BELIEFS OR KNOWLEDGE BASE.	SOX COMPATIBILITY VALUATION weight(value)	QUALITY VALUATION OF THE IMPORTS PROCESS weight(value)
1.- CUSTOMS_MANAGEMENT	1 (T: true)	1 (10)
	SOX COMPATIBILITY VALUATION	QUALITY VALUATION OF THE IMPORTS PROCESS
		= 10

Table. 5. Agent's Valuation Matrix over the Business Case Facts based on its Beliefs

According to the Facts Valuation Protocol based on the Agent's Beliefs, between all beliefs of the agent's static knowledge, all of them are decisive for the SOX compatibility. These beliefs determine as well the quality of the followed process in the analyzed business case.

From quality point of view all the key facts of the business case have obtained the maximum value as indicated in Table 6, and according to the weight factors, the final punctuation has the maximum value too.

From SOX compliance point of view, both relevant SOX facts have obtained a true value according to the Facts Valuation Protocol based on Agent's Beliefs.

The valuation of these key SOX facts are the inputs for the Intra-Agent Decision Making Protocol during the conclusive individual phase of the agent (Fig. 7 & 8).

	INDIVIDUAL HYPOTHESIS
1.-AGENT OF IMPORTS PROCESS	H1: *The Imports Process followed in the analyzed business case complies with the SOX regulation.*

Table. 6. Agent's Hypothesis

⊥
CUSTOMS_MANAGEMENT (Evidence1) ▼
LEARNING_FACTOR (Evidence1) ⟶

SOX_COMPLIANT(PROCESS_OF_IMPORTS)

Fig. 7. Imports Process. Intra-Agent Decision Making Main Inference Rule

¬ **CUSTOMS_MANAGEMENT** (Evidence1) ▲
¬ **LEARNING_FACTOR** (Evidence1) ⟶

SOX_NO_COMPLIANT(PROCESS_OF_IMPORTS)

Fig. 8. Imports Process. Intra-Agent Decision Making Complementary Inference Rule

According to the Intra-Agent Decision Making Protocol, the first two antecedents of the main rule, are true and therefore it is not necessary to appeal to the third antecedent (LEARNING_FACTOR) to be able to conclude that SOX_COMPLIANT (PROCESS_OF_IMPORTS) is true. The previous reasoning process, based on the agent's static knowledge, has been able to state that the followed Imports Process is compatible with the SOX regulation, and it has not been needed to use the knowledge based on the agent's past experiences neither to a human expert to make the decision.
In this case the agent and their static knowledge have been enough to reach the conclusion. This fact is positive in the sense that the process has followed the SOX legislation rigorously but on the other hand, it has not allowed the agent to be able to learn, to be able to increase its dynamic knowledge. Finally, the present agent concludes that the followed process of the analyzed business case is SOX_COMPLIANT.
Nowadays and in relation to the model here design, after revising different international bibliographical sources and up to the best of our knowledge it isn't found any publication that uses Multiagent Systems and Theory of Argumentation in the implementation of internal controls SOX with the objective of identify if a Imports Process of an specific business case is or not compatible with the SOX Law supporting auditors and companies to take their appropriate decisions about this SOX compliance.

6. Conclusions

As already explain in Introduction Section, SOX Law was an inflexion point on how government control bodies monitor the health of private sector from financial point of view looking always to protect the investors and to avoid financial fraudulent behaviours inside the core of those private companies.
As well it has been show in this paper how Artificial Intelligence in combination with Theory of Argumentation can be a powerful tool to address, manage and support complicated decisions about if an specific business case is or not SOX compliant. On the other hand, SOX compliance topics are an important application field of Artificial Intelligence as already show in this paper.
This paper evidence how Scientific Research on Artificial Intelligence and Business World can be successfully combine together to improve and support each other.
Last but not least is how Fuzzy technologies and techniques are more and more a key tool of the core of whatever Decision Support System. Things are not only black or white and this should be taken into consideration and will help us to improve the performance of our models.

7. Disclosure

The content of this paper reflects only the opinion of the authors with independence of their affiliations.

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