TOWARDS AN ONTOLOGY-BASED NETWORK FOR BANKING SUPERVISION

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Abstract: in recent years, in banking and in the supervision of this activity within the framework of the EU, intensive use has been made of IT resources, with the object of optimising the achievement of objectives inspired by the Basel II international agreement. In a first phase, formats based on XML (eXtensible Markup Language) were applied to effect the submission of financial information from banking entities to the supervisory bodies, which are grouped around the CEBS (Committee of European Banking Supervisors). Subsequently, the creation of XBRL (eXtensible Business Reporting Language) represented a further step towards better quality of information and towards homogenisation among supervisory authorities across Europe. However, new needs going beyond the submission and storage of information require the use of standards that involve a more rigorous semantic definition. In this article we explore the applicability of an information submission model based on OWL (Web Ontology Language) that permits the subsequent implementation of knowledge-sharing systems - such as the Set of Experience Knowledge Structure - among the various banking supervisors. That applicability has been tested by measuring the Value Compatibility existing between the semantic technology and the needs of the existing European banking environment.

Keywords: XML, XBRL, OWL, knowledge sharing systems, EU banking, Semantic Web.
Categories: I.2.4, H.1, H.4, H.5, K.4.2, L1.

1 Introduction

Banking supervision in the EU framework is an increasingly complex task. All supervised financial entities - basically banks and investment entities - must submit periodical information to their corresponding supervisory authorities; these then evaluate this information, applying criteria of qualitative and quantitative character; and later, they take decisions on the acceptability of the financial state of these

entities, or on the need to apply corrective measures. In certain circumstances the authorities communicate these decisions and analyses to other supervisory authorities of one or more of the States members of the EU.

This action scenario has recently made it necessary to establish instruments and procedures for connection between supervisory authorities and financial entities, based on meta-data languages derived from XML (eXtensible Markup Language). The process of connection has ensured a certain degree of homogeneity in the formats for the presentation of information, which has represented a great step forward in the treatment of this information, thus facilitating more agile decision-making by the authorities [Bonsón, 07].

However, the complexity of the network formed by financial entities and supervisory authorities calls for a further step in this evolution, through the implementation of appropriate knowledge storage and sharing systems that allow a higher degree of automation, and by taking further advantage of supervision experiences. The Set of Experience Knowledge Structure proposed by Sanin et al. [Sanin, 07] appears to respond fully to this challenge. The current informative input lacks the necessary robustness to be employed as substratum for these new systems; for this reason an evolution is proposed in the transmission and treatment of information based on formal OWL ontologies. The suitability of this meta-language for the purpose outlined is tested by means of a case study conducted using a standardized questionnaire, to measure the Value Compatibility [Bunker, 07] (that is, the suitability at the technological, organisational and cultural levels) existing between the OWL technology and the normative-organisational setting of European banking supervision.

2 Banking Supervision: the decisional process today.

2.1 EU systems: types of banks and supervisors

The circumstances in which European banking supervision and associated activities are unfolding can be summarised in two fundamental facts that reflect the complexity of the system:

- The commercial banks and investment entities, under the principles of the free movement of capital ruling in the EU, can obtain authorization to operate in any of the member countries.

- The national supervisors, grouped in the CEBS (Committee of European Banking Supervisors) [CEBS, 07], possess even greater individual prerogatives and can exercise a certain degree of discretionality in their supervision activities.

Therefore, a supervisor can monitor the activity and financial situation of a bank of its own member State, or of another member State. Equally, a commercial bank or investment entity can be subject to the supervision of the authority of its State of

origin and/or of the State different from that of its origin in which it carries out its activities, thus having to report information to different authorities in different places.

2.2 Implications of Basel II.

The Bank of International Settlements of Basel has issued "Basel II" [Basel II, 07], a new recommended framework of good financial and banking practices, of risk management, and of collaboration between supervisory authorities and supervised financial entities. The solvency Directives, which have been formulated to introduce the principles of Basle II specifically in the EU, include numerous national options and discretionalities that will have to be exercised, either by the supervised entities or by the national supervisory authorities. The principles that define that series of options and discretionalities can be stated as:

- "Option": the competent authorities must choose one of the various alternatives included in the Community legislation for complying with a given rule or standard.
- "Discretion" / "National discretionality": the competent authorities can opt to apply or not apply a given rule or standard.
- "Mutual recognition": the competent authorities allow the entities under their jurisdiction to apply, in certain areas of national discretionality, the treatment chosen by another member state, with respect to the solvency directives.

In this scenario, the decisions that emanate from the supervisory authority may end up as heterogeneous or inconsistent, unless the appropriate interconnection is ensured between data bases and knowledge bases. In other words, an urgent need has arisen for a system of representation and storage of each supervisory decision made, such that advantage can be taken of it again, in time or in space, in another member state of the EU.

2.3 Decisional process: the need for knowledge sharing.

The European banking supervisors, which act together through the CEBS, monitor the activity of more than 7000 commercial banks and similar entities. From their periodical analysis of information, they reach formal decisions on the acceptability of the financial situation of these entities, on whether to require an increase in their reserves, and even the imposition of sanctions. Each national supervisor therefore needs to have in place formal systems to support consistent decision-making, since the volume of information received must be processed based on the principle of "re-cycling" or re-use; in other words, making effective use of the work done in past decision-making processes. In addition, the essential collaboration between supervisors belonging to the European network requires the use of rigorous and secure telematic transmission means for these tasks. The environment of European banking supervision therefore constitutes a real scenario for the development of a Set of Experience Knowledge Structure [Samin, 07]. This system is an attempt to

represent and store in a convenient way the formal decisions reached, so that they can be exploited again in the same organisation or network, in similar circumstances. The representation of the formal decisions requires the use of:

- Variables: suitably represented by means of vectors that contain a set of inter-related data in the context of a particular previous formal decision. For example: a decision of the supervisor to increase the reserves that a commercial bank must implement, associated with the datum of capital recorded by the entity, ruling interest rates, expectations of movements in the market, and data on the behaviour of the bank's debtors.

- Functions: relationships between the variables or between values of the vectors of the same variable. For example, that the reserves to be assigned should be a percentage of the datum of capital recorded by the entity, or of the capital recorded in another entity that has obtained a positive rating by the supervisor in respect of its financial situation.

- Constraints: restrictions on the variables. For example, the minimum and maximum levels between which the banking variables controlled by the supervisor should be allowed to move.

- Rules: structures in the form of "IF-THEN-ELSE", on the variables. For example, if the reserves of a bank drop below a given amount, the decision of the supervisor must be not to award a positive rating to the conduct of the bank; therefore, it must order an increase in the reserves to be set aside by that bank.

The combination of variables, functions, constraints and rules formally define each decision taken; these can then be recorded and later re-utilised [Sanin, 07]. The potential availability of this formalised structure for the decisions taken in banking supervision in the EU context is presented as a new way of collaborating and enhancing the efficiency of the network formed by the national supervisors, who thus share not only their information but also their complete decisional process in particular cases [Fig. 1]. However, it is essential to verify that the technologies available in this network are appropriate to enable the processing of these types of structure.

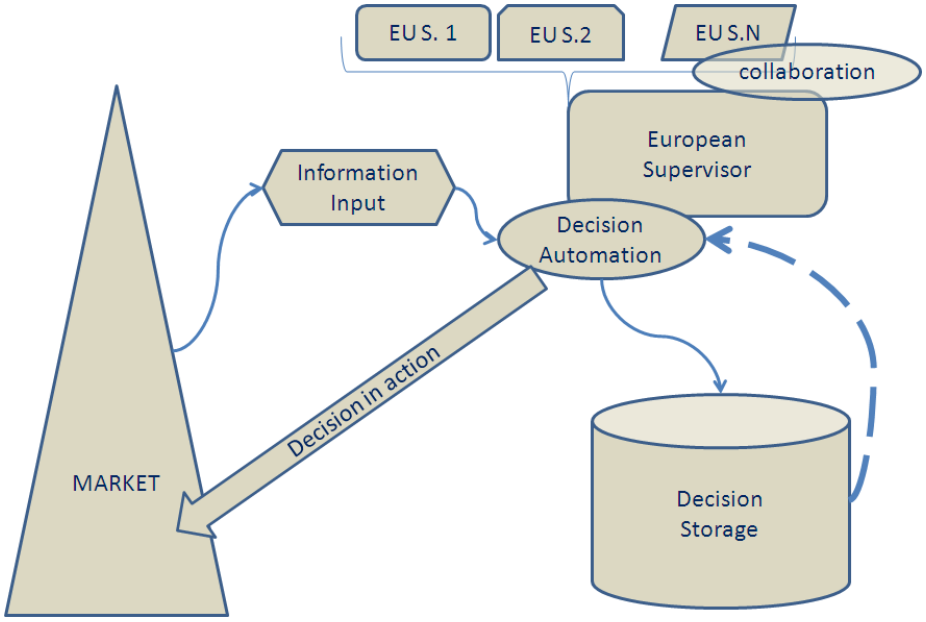

Figure 1: A simple schema for formal decision storage and re-usage.

3 Applicability of knowledge sharing systems: semantic problem –case study.

3.1 The input of the system: key factor.

Meeting the need to have available adequate technological means for the real implementation of a Set of Experience Knowledge Structure commences with the examination of the degree of rigour applied the inputs to the system. It is clear that the possibility of formally storing past decisions depends on the capacity to represent precise information correctly. Sanin *et al*. [Sanin, 07] propose a system based on the OWL (Web Ontology Language); this is a language published by the W3C in 2004, and which is making possible the representation of the so-called Semantic Web, adding a high degree of formalisation to digitalised information. In fact, these authors show that OWL is the best technological option that, a priori, can be considered appropriate for serving as a basis for the Set of Experience Knowledge Structure. In effect, the corresponding Ontologies or semantic representations, modelled on reality by means of Classes, Properties and Instances, can be written in OWL, following a rigorous logic; and it can be fully adapted to the parameters of Variables, Functions, Constraints and Rules of the decision framework. On the other hand, ontologies are also seen as content theory. One of the main interests in ontologies is due to the alternation of focus between content theories and mechanism theories in AI. Ontologies are essentially content theories because their main contribution is to

identify specific classes of objects and relations that exist in a particular domain [García, 06]. However, in the European banking network, previous structures [Bonsón, 07] have been implemented, that are worth examining to determine if they are suitable for the implementation of the knowledge system proposed or if they suffer from any disadvantages.

3.2 XML and XBRL: previous steps toward a semantic input.

Unlike HTML, which utilises meta-labelling to specify the visual format intended for the information transmitted, XML provides additional information (meta-information) on the precise nature of the datum in question. XML is the de facto standard [Madria, 05] in telematic transmission and in the storage of information. However, many XML initiatives have been put into operation for vertical or horizontal B2B transmission, such as ebXML, RosettaNet, HL7, and cXML. The diversity of XML formats causes difficulty in facilitating exchanges of XML-based data [Ho, 04]. For this reason, a new language based on XML has been created specifically for use in the area of financial management and communication.

XBRL (eXtensible Business Reporting Language) is the digital mark-up language successor to XML (eXtensible Mark-up Language) and serves as the nexus between different entities when transmitting business information telematically. XBRL is based on the production of different XBRL Taxonomies, which are generated and agreed by consensus in various working groups formed by specialists in computer software, systems and business. The principal mission of these Groups is to generate a specific Taxonomy; that is, the group analyses the model of business reporting that XBRL is intended to support and facilitate, and identifies univocally a dictionary of terms for utilising these labels in the subsequent generation of Reports in XBRL containing real data that will be transmitted telematically. Thus the Working Group generates the Taxonomy, which is made available free on the Internet, and this allows users to generate various types of Report and validate them correctly; the taxonomy thus represents the best "substratum" for expressing business information of all kinds for utilisation by the numerous applications that companies and other organisations must use to manage this information. When the XBRL taxonomy is generated, much care is taken to introduce different business rules into it. These rules take material form by way of standards of presentation, labels in different languages, rules of calculation and logical relationships; these are standards and rules with which the real data "hosted" by the digital labels in the various XBRL Reports must comply. A plain text file with the .xml extension supports the transmission of the data expressed in this new language. XBRL Reports are usually very compact in size, which increases the capacity of existing computer systems, in addition to the advantages offered by the syntax that ensures that items of data are conveyed intact and perfectly delimited. By means of this language a scenario is provided in which the issuers and recipients of this type of information find an efficient "substratum" for making use of it digitally and electronically in various ways, and particularly for using the latest high-performance analytical applications, since all the relevant business information is contained or can readily be contained in XBRL Reports (Fig. 2).

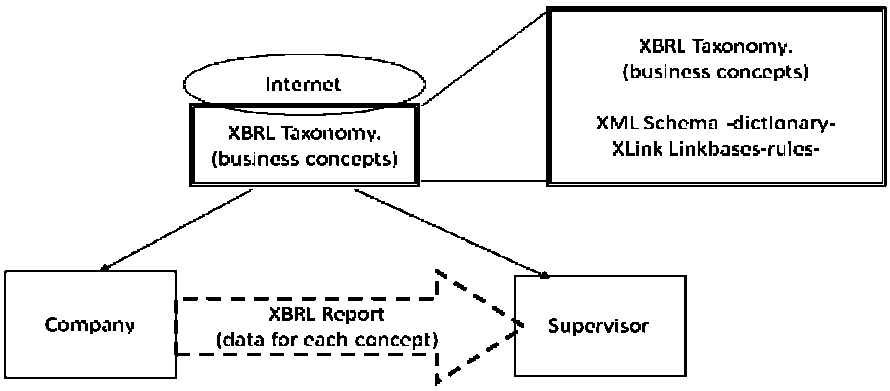

Figure 2: XBRL in operation.

There exist various mechanisms for the calculation and logical validation of content of the labels that comprise an XBRL taxonomy. Because these labels, and the real data that these labels "host" when an XBRL report is produced, can be submitted to these mechanisms, they become simple but powerful tools. When business information is expressed by XBRL, this represents an additional guarantee of the quality of this information. Furthermore, XBRL taxonomies can be extended by the user privately; this facility ensures that, on the one hand, companies can make use of their own more detailed reporting models with particular characteristics specific to their own business, for internal use, and on the other, that there is no loss of compatibility with the general model that the company must use to report externally. In other words, once a taxonomy has been created at the European level, extensions can be created to cover the particular features of the adapted national regulatory frameworks, thus ensuring the homogeneity of the system of information and giving it the flexibility that the framework requires.

However, if it is intended to go beyond a rigorous submission of information for the supervisors, and to implement a Set of Experience Knowledge Structure, account needs to be taken of various limitations of XBRL for this particular purpose. Although, as stated, XBRL provides semantically rich information [Debreceny, 01], García et al. [García, 07] have now made a detailed analysis of the characteristics that XBRL possesses against OWL; these authors report the following as the most important:

- Neither XML Schema nor XLink, which are pillars of XBRL, were originally conceived to support the representation of semantic information by way of ontologies, and when they are utilised to this end, the expressive capacity offered is insufficient.

- OWL explicitly enables the inclusion of relationships of belonging/ownership, cardinality and equivalence that would be very difficult to implement by means of the Linkbases of XBRL.

- The semantic structures in OWL serve to ease the maintenance of the system in which they are implanted, which is a functionality not available with XBRL.

- XBRL is designed for the submission of information; if more complex functionalities are added to a system, such as a Web site, it is necessary to implement OWL ontologies.

- XBRL currently only allows validations of the addition and subtraction type to be introduced, whereas with OWL ontologies all the mathematical operations that may be required can be represented.

- The semantic information added with OWL allows the systems themselves to operate on the data, whereas with XBRL all the operations that are not included in the validation of the Taxonomy must be implemented at the level of the application, or done manually.

- OWL presents the particular feature that it is not possible for the user to generate proprietary types of data, a useful characteristic that XBRL does possess. However, this deficiency is now being already addressed with initiatives like OWL-Eu [Pan, 06].

- It is possible to map XBRL taxonomies onto in body of OWL ontologies, to enable users to exploit the potentialities of XBRL in the activities of data submission and those of OWL in respect of data processing at the destination.

In this respect, consideration should be given to the convenience of a possible mapping of XBRL onto OWL, or of its complete substitution as a format of submission. Currently there exist semi-automatic techniques of accurate mapping that preserve information against possible losses [He, 06]. In addition, Ontologies open new possibilities for the integration of information, such as financial news conveniently expressed in a semantic structure [Wang, 07]. Additionally, it is now possible to correlate diverse OWL ontologies in an effective way [Cuenca, 06]. Proposals have even been put forward that provide support to the necessary evolution of these future ontologies [Plessers, 07]. This tool is desirable, therefore, insofar as OWL offers more attractive possibilities in the processing of information that would require the Set of Experience Knowledge Structure.

3.3 The need for OWL ontology-based input. Compatibility tested by means of a Value Compatibility case study

Given the preceding arguments, it has been thought appropriate to implement a substitution or mapping of the systems of submission currently in place, based on XML formats, towards a system of information representation based on OWL. This new language, in addition to enabling novel functionalities such as the re-utilisation of information, and rigorous logical representation of the decisions taken, may also, in the future, make it possible to use technologies based on the establishment of networks of intelligent agents [Tran, 2007]. It is necessary therefore to test the compatibility of this language not only with the technological environment, but also with the cultural-organisational setting in which the activities of banking supervision in Europe are unfolding. Bunker et al. [Bunker, 2007] state the need to test not only the technological compatibility of the standards and IT applications that are intended to be implemented but also to go further by means of Value Compatibility testing. Value compatibility refers to the fit or match between the innovation and the norms or values of the potential adopters. For example, if the innovation forces people to work in isolation, where they value team work, then the innovation is unlikely to be seen as useful, or to be accepted in the organisation. To perform this full analysis, it is necessary to study three different dimensions, referring to the technology that it is intended to implement, in this case OWL, as a new procedure for the submission of information to supervisory authorities that allows the subsequent processing of the data in accordance with the parameters of the Set of Experience Knowledge Structure, and referring to the normative-organisational environment in which it is intended to be applied: in this case, the European banking supervisors, grouped together in the CEBS.

The three dimensions are:

- Structure: this measures the compatibility in aspects such as the structure of the chain of command in the organisation, the need for specialisation and formalisation, and other aspects associated with the way in which the entity and the technology are each structured.

- Practices: this tests the differences between orientation to the job or to the employee, normative character against practical character, and other points that concern the ways that the entity and the technology put into operation normally function and perform.

- Culture: this observes the principal traits in respect of the principles of organisational culture, including attention to detail, stability, importance of team work, and monitors to see if putting the new technology into operation conflicts with values implanted in the organisation.

In order to explore the possibility of putting this technological solution into effect, a procedure of consultation has been carried out. A questionnaire has been devised and addressed on an anonymous basis to members of the COREP (COmmon REPorting)

Working Group; this Group is formed by specialists in banking supervision and technological implementation, and was established by the CEBS in the EU [CEBS, 07]. For each dimension, a series of metrics have been devised, which are applied to the technology and to the organisational framework. These were then made available to the experts consulted and they were asked to consider the degree of compatibility existing (see Annex).

The results show that there are some variables in which there is considerable difference between the business environment and the features of the technology. In respect of the Structural Dimension, the business environment of the European banking supervisors is very specialized, but there is not any special departmental structure. At the same time, the supervisors think that, according to their perceptions of the nature of the technology, the OWL technology does not require a particularly high degree of specialization – maybe subordinates could deal with the technology without advanced knowledge of banking supervision, due to the level of automation provided. Regarding the Practice Dimension, the main divergence is found on the normative versus pragmatic approaches. In this case, the supervisors consider that the supervisory tasks are mainly pragmatic, while the OWL technology moves the workflow style closer to the normative point of view, in the sense that it supports the entry into force of the Basel II framework. In the rest of the variables considered, there appears to be a sufficient degree of Value Compatibility between the OWL environment proposed and the Basel II banking supervision challenges. Specifically, the Cultural Dimension shows that the levels of innovation and risk-taking, the outcome orientation and the aggressiveness are moderate, and that there are high degrees of attention to detail, orientation to people and teams, and stability in both the business environment and the technology proposed.

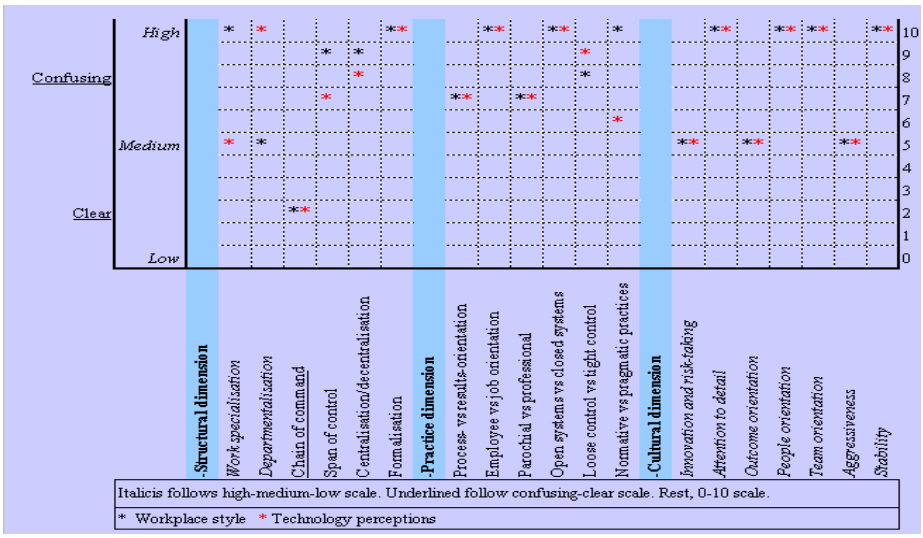

Table 1: Results from COREP members.

4 Conclusion

Enterprises are becoming more knowledge-intensive, and the integration of various types of knowledge is becoming a challenge. It has been accepted that ontology is an important concept for knowledge integration [Huang, 07]. In particular, the present paper has revealed and discussed the growing complexity of banking activity and its corresponding supervision in the framework of the EU. This complexity has made it essential to apply diverse technologies, particularly in the field of the submission of information from the supervised entities - commercial banks and similar entities - to their corresponding supervisory authorities of each member state; the XBRL technology needs to be employed for this critical task. However, we argue that the need to take decisions periodically in respect of the acceptability of the situation of their supervised entities makes it necessary to implement a system to facilitate decision-making; such a system should be based on the parameters of the Set of Experience Knowledge Structure, that, due to its greater complexity, requires the use of an extremely powerful language for the representation and storage of the decisional information: OWL.

Lastly, a case study guided by a standardised questionnaire has been conducted in order to measure the Value Compatibility existing between a potential application of OWL and the normative-organisational setting of the CEBS, with the object of ensuring not only technological compatibility but also avoiding any possible adverse cultural and organisational repercussions of this potential application. The results illustrate that there exists a good level of Value Compatibility between the normative challenge and the new technology. Although there are some differences, these, in our opinion, would not make the implementation of this technological framework particularly difficult, in the sense that they focus on the same points that the Regulators must consider to achieve success in the new European environment, for example, the balance between normative and practical approaches.

5 Future Work

More work must be done to obtain, in the medium-term, a real Set of Experience Knowledge Structure, based on OWL technology, applied in the European banking supervision network. First of all, a statistically valid study of perceived compatibility must be conducted, to ensure the full compatibility between the technology and the regulatory demands. Second, the implementation of XBRL must be observed closely, and the relationship between the evolution of XBRL and OWL should be studied, in order to make their integration possible. Finally, the main entities involved, the regulators, commercial banks and IT companies, should maintain a continuous dialogue on these issues, taking special care with the training of personnel and the cultural acceptance of the necessary changes.

In addition, several technical aspects must be considered. For example, timing aspects should be addressed and ways to implement time facilities could be added – the

possibility of working on the basis of synchronous and asynchronous communication [Geyer, 08] – in both the model of the Set of Experience Knowledge Structure and the OWL technological possibilities, since it can safely be said that groupware environments represent the way in which European supervisors will conduct their future work.

Annex - Standardised questionnaire.

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