A Compliance Management Ontology: Developing Shared Understanding through Models

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Abstract. Managing regulatory compliance is increasingly challenging and costly for organizations world-wide. Due to the diversity of stakeholders in compliance management initiatives, any effort towards providing compliance management solutions demands a common understanding of compliance management concepts and practice. This paper reports on research undertaken to develop an ontology to create a shared conceptualization of the compliance management domain, namely CoMOn (Compliance Management Ontology). The ontology concepts are extracted from interviews and surveys of compliance management experts and practitioners, and refined through synthesis with leading academic literature related to compliance management. A semiotic framework was utilized to conduct a rigorous evaluation of CoMOn through a series of eight case studies spanning a number of industry sectors. The consensus achieved through the evaluation has positioned CoMOn as a comprehensive domain ontology for Compliance Management.

Keywords: domain ontology, compliance management, compliance vocabulary, semiotics.

1 Introduction

Compliance refers to ensuring that business processes, operations, and practice are in accordance with a prescribed and/or agreed set of norms [1]. Compliance requirements are associated with regulations that may be introduced either externally to an organization or internally by the organization itself. They may stem from legislature and regulatory bodies (e.g. Sarbanes-Oxley, Basel II, HIPAA), standards and codes of practice (e.g. SCOR, ISO9000) and business partner contracts. Accordingly, compliance management is referred to as the coordinated set of activities designed to assure that all elements of the business (processes, employees, partners, and assets) strictly follow any established regulatory requirements.

Regulatory compliance has attracted much concern by organizations across the globe over the last decade. Introduction of regulations such as the Sarbanes-Oxley Act of 2002 (SOX), Health Insurance Portability and Accountability Act of 1996

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(HIPAA), and Anti-Money Laundering and Counter-Terrorism Financing Act 2006 has made regulatory compliance a focal point of many organizations. Even though compliance activities are predominantly viewed as a burden by organizations [2], failing to comply is no longer an option [3]. Breaches of compliance may result in serious, and sometimes even disastrous, situations for the organizations concerned. For example, several high profile, corporate scandals - Enron, WorldCom (USA), Parmalat (Italy), HIH (Australia), and Tyco International (France) - were associated with significant market and reputational damage.

Compliance management spans across many, if not all, industry sectors and applications, such as financial services, information security, environment, healthcare services, and manufacturing [4]. Managing compliance is highly challenging, given that compliance engages interests from a wide variety of stakeholders, such as compliance professionals, auditors, customers (clients), business/contract partners, suppliers, and regulatory/authoritative bodies. The variety of stakeholders, together with the variety of sources of compliance requirements and their frequently changing nature, leads to increasing challenges for compliance management, in part due to the lack of a common vocabulary and shared understanding of related concepts and artifacts for use in compliance management initiatives. In particular, difficulties in establishing the relationship of compliance and risk functions of an organization with its various (line of) business functions has been highlighted by the compliance expert and practitioner community [5]. We posit that the vast body of knowledge that exists within conceptual modeling research, and its established role in facilitating shared understanding, can contribute significantly in this regard. For example, Gruber [6] defines ontology, in the context of computer and information sciences, as a set of representational primitives with which one can model a domain of knowledge or discourse. The primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members) [6]. Gruniger and Lee [7] argue that the use of ontology benefits an organization in three ways. First, it serves as a communication medium between computational systems and humans. Second, it is useful as a computational reference. Third, it facilitates the reuse of knowledge for structuring or organizing libraries or repositories of plans. Not surprisingly, ontology has been widely used to represent many real world cases [8, 9].

Accordingly, we embarked upon the development of a shared conceptualization of compliance management landscape within organizations in the form of a Compliance Management Ontology – named CoMOn. CoMOn is derived from interviews and surveys of compliance management experts and practitioners, and further synthesized with industry and scholarly articles. It is developed and evaluated following the ENTERPRISE methodology [10, 11], and can be represented formally (e.g. through web ontology language - OWL) or informally (see section 4.4). CoMOn has also been subject to a rigorous validation process based on a well established semiotic framework [12]. The validation is conducted through a series of eight case studies that span several industry sectors in both public and private arenas. This paper presents the results of the study that led to the development of CoMOn, its subsequent evaluation and final refinement.

The remainder of the paper unfolds as follows. In section 2, we introduce the related work associated with compliance management and ontology development. Following this discussion, section 3 presents the methodology employed for CoMOn development, including a detailed report on the evaluation phase. Section 4 presents the actual ontology building development process, Section 5 details of the (post-evaluation and refinement) CoMOn concepts and levels. Finally, a summary of the methodological and empirical lessons learnt from this work, together with future research, is presented in section 6.

2 Related Work

Over the past decade, compliance management has received relatively scarce yet increasing attention from the academic Information Systems community [4]. A recent review of compliance management research [4] provides a comprehensive snapshot of articles that address relevant compliance management topics categorized as exploratory or case studies, solution papers, and papers that have elements of both. Figure 1 presents the yearly distribution of articles relevant to compliance management that are published in Information Systems (IS) publication outlets. The study includes 374 papers (identified as relevant from 22227 papers) from premium Information Systems journals (as promoted by the Association for Information Systems), reputed Information Systems conferences and some additional popular journals in the discipline.

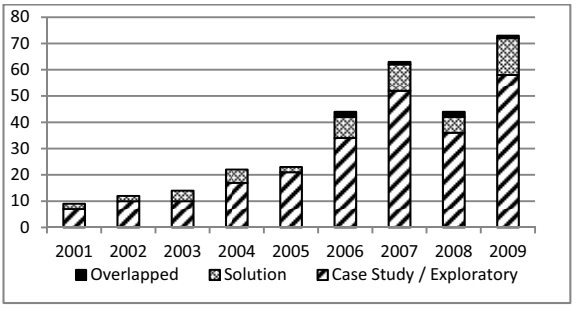

Fig. 1. Distribution of Compliance Management related Articles per Type per Year

Among these articles, several offer compliance management solutions. To name a few, Banker et al.[13], for example, introduce a model which assists in identifying intensity of terms required in contractual agreement. Kim et al. [14] describe the development and application of an evaluative data model for ISO 9000 compliance, while Weitzner et al. [15] propose a technical architecture required to support information systems accountability. Several contributions also offer frameworks. For example, in the context of HIPAA, Davis and Hikmet [16] introduce a framework that facilitates identifying and analyzing the training needs of organizations. Meanwhile, Mishra and Weistroffer [17] offer a framework that can be applied as a practical guide by systems development managers in planning early compliance needs.

Despite the apparent increase in number of published papers, there are gaps between these research contributions and industry needs [5]. One area particularly highlighted by industry experts is the absence of comprehensive shared vocabulary on compliance, and conceptualization of compliance management requirements in general [5]. Without an agreement on required compliance management concepts and vocabulary, not only is the uptake of leading research difficult, but so is the communication of compliance requirements within an organization. The latter in particular has the potential to result in severe penalties for organizations and the responsible personnel.

Addressing the above need is the focus of our research and the following sections present the various aspects of the development of a comprehensive domain ontology for compliance management.

3 Research Methodology

Our study is governed by the over-arching Design Science paradigm [18] given our focus on the development and evaluation of an artifact – an ontology. Ontology development is a difficult and time-consuming process [6] and, thus, requires a structured approach. A review of methods and techniques for ontology development indicates that several methodologies are available [7, 10, 11, 19-22].

3.1 Ontology Development Approach

While comparisons of methodologies and proposals of new methodologies do exist [23], our experience with ontology development indicates that there is limited guidance within existing ontology development methodologies on how to identify, gather, and use input in ontology development. One of the few works on this topic is that of Velardi et al. [24], who describe a text mining technique that aids an ontology engineer in identifying the important concepts in a domain ontology. Similarly, Brusa et al. [8] discuss their experience in developing a government budgetary ontology based on inputs from the provincial budgetary application, its related documentations, and a group of experts within an organization. While both works utilize inputs from a particular domain, they do not discuss how the relevant inputs were identified and prepared prior to the concept capturing process, and how the concepts were coded. In contrast, these aspects are considered in much detail and rigor in the ontology development approach adopted for CoMOn. Further, considering that industry relevance is an important factor that contributes to the usability and acceptability of a particular ontology, we address this need directly through our methodology.

Given that there are no related existing ontologies that can be applied for compliance management, the development of CoMOn is, by necessity, from the ground up. Accordingly, we adopt the ENTERPRISE [10, 11] methodology to guide the development. The choice of ENTERPRISE was largely based on its wide spread

utilization [25, 26] as a credible approach. Secondly, ENTERPRISE provides a good compromise between development guidance and freedom of representation of the domain, thus providing clear direction on the development front, while allowing the most appropriate choice of formal representation [21].

3.2 Ontology Evaluation Approach

The ontology evaluation approach requires a special mention from a methodological perspective. All methodologies for building ontologies recognize the importance of evaluation [21], as does the Design Science approach inherent to our research [18]. The evaluation of ontology includes examining how the ontology fits the particular domain it is designed to serve. For this purpose, we select a case study approach with a targeted set of questions based on the semiotic framework [12], as described below.

For the conduct of the evaluation case studies, the research team consisted of three experienced empirical researchers, one with the role of the main interviewer and two with a support role of note taking, related document analysis, and further probing. The case studies utilized data gathering instruments that facilitated feedback from practitioners in both quantitative and qualitative forms. A semiotic framework [12] was utilized to evaluate the compliance management ontology *quality*. In [12], Burton-Jones *et al.* introduce four metrics to evaluate the quality of ontology; namely, Syntactic Quality, Semantic Quality, Pragmatic Quality and Social Quality. Syntactic Quality is measured through Lawfulness (correctness of syntax) and Richness (breadth of syntax used). The second metric, Semantic Quality is measured through Interpretability (meaningfulness of terms), Consistency (consistency of meaning of terms) and Clarity (average number of word senses). The third metric, Pragmatic Quality includes Comprehensiveness (number of classes and properties), Accuracy (accuracy of information), and Relevance (relevance of information for a task). Finally, the fourth metric Social Quality includes Authority (extent to which other ontologies rely on this ontology) and History (the number of times the ontology has been used). As our ontology is new, we exclude Social Quality in this study. We argue that an ontology can only be evaluated on its social quality after it has been in use for a period of time and thus leave this component for future work.

For the purpose of the evaluation, we develop an interview protocol aimed at capturing participant feedback on the quality of the ontology with respect to clarity (C), interpretability (I), comprehensiveness (M), accuracy (A), and relevance (R) of an individual concept in ontology (as derived from the semiotic framework [12]). Three remaining criteria *viz.* consistency, lawfulness, richness were excluded for this stage of the study. While these three criteria remain significant to our overall evaluation of the ontology, we leave these for our future work. We argue that evaluation on those criteria needs (1) familiarity with ontological terminology, for example, richness requires assessment of the types of terms (e.g. class, subclass, type, property, and relationships types); and (2) exemplification of concepts and their properties in order

to faithfully provide evaluation feedback, for example lawfulness requires consideration on the correctness of syntax which becomes more evident when reasoning through examples. More details on the planned future work are provided in section 6.

The interview protocol is structured through three supporting documents: The first document, Core Concept Evaluation that contains instructions to the participant and definition for each core concept. The participants specify their perception on the five criteria for quality evaluation, namely clarity (C), interpretability (I), comprehensiveness (M), and accuracy (A) for each of the concept on a 7-point Likert scale representing the level of their agreement for a particular criteria associated with a particular concept. Following this, relevance is captured by requiring participants to state whether a particular concept is relevant or not. The second document, Overall CoMOn Diagram is a document that provides the participants with the structure of concepts that represent CoMOn. This diagram includes Core concepts and its sub-concepts and also how these concepts are associated with each other. Finally, Catalogue of CoMOn's Concepts provides participants with the definitions of all detailed concepts, which were used particularly to evaluate the Comprehensiveness criteria. In addition, a number of open ended questions were included at the end to gather deeper insights and to ensure that any missing concepts were probed and identified.

In the following, we discuss the four phases, based on ENTERPRISE methodology, that have been adopted for the development of CoMOn.

4 Developing the Ontology

4.1 Identify Purpose and Scope

Identifying the purpose and scope of an ontology is critical to ensure a clear understanding of its intended use(s) and users [10]. In our study, the purpose of CoMOn is to provide practitioners, as well as the research community, with a shared conceptualization of compliance management domain. The expected users of this ontology are compliance management professionals, businesses that have compliance obligations, regulators, and researchers. The intended use is as a reference in describing, communicating, and implementing compliance related tasks.

Development of CoMOn is based on a synthesis of qualitative data from compliance management experts [5] and practitioners [27] (both being important in reflecting the real world aspects of compliance management) and leading research identified as relevant through a comprehensive literature study [4].

This collection of sources, with a stronger emphasis on qualitative data, provides a well-informed and industry-relevant ontology and reduces the risk of missing concepts. While the qualitative data stems from interviews with compliance management experts and surveys with compliance management professionals, the scholarly articles include a collection of highly cited compliance related articles published in workshops, conferences, and journals, as well as relevant industry sources such as Gartner Research, KPMG, and Open Compliance and Ethics Group (OCEG).

4.2 Ontology Building

ENTERPRISE [10, 11] recommends three stages in building an ontology *viz.* capturing, coding and integrating existing ontologies, as discussed below.

Capture. Ontology capture includes identifying key concepts and relationships in the domain, producing precise and unambiguous text definitions for such concepts and identifying terms to refer to such concepts [10]. Concept identification is a challenging task in the development of any ontology.

The data sources used for ontology development are qualitative in nature. Therefore, concept identification for CoMOn involved coding and analysis of all main sources of data, facilitated by a qualitative analysis tool (NVivo)[1]. NVivo was used to facilitate coding of the initial concepts and relationships that make up the ontology. The process started with an exhaustive analysis of corpus by the research team. Using a dual-coder approach, the researchers coded a fragment in the data sources when it represented a concept related to compliance management. The identification and selection of the fragment was based on whether the concept was directly mentioned in the fragment, or contained a phrase or statement which implied the concept. A node was created in NVivo to represent a group of fragments from the data sources that are relevant to a particular concept. The number of fragments supporting a particular node indicates how many times a particular concept was mentioned in the data sources. This process continued until all data were coded and resulted in 254 initial concept nodes.

After the initial capture of the 254 concept nodes, the concept identification was followed by a review process with the view to remove redundancy. Where synonyms were found, either one of the terms was selected due to wider usage, or a new, more accurate, term was defined to represent the concept. This process resulted in duplicate free and more generic concepts, reducing the number to 64 concepts. After a second round of coding and validation, the 64 concepts were hierarchically categorized based on 10 most prominent (or core) and generalized concepts. These provide us with 10 concepts as tier 1 and 54 concepts structured in tiers 2 through to 4. The set of 10 core concepts includes concepts of: **Business Process, Culture, Cost, Program, Requirements, Regulatee, Regulator, Risk Management, Service Provider, and Solutions**.

During the concept identification process, a simultaneous analysis on the data sources was also performed to identify any relationships that were indicated between the identified compliance management concepts. A node was also created in NVivo to represent a group of fragments from the data sources that provided evidence of a particular relationship between concepts.

The relationship nodes were then further classified by referring to the category of relationship i.e. specialization, aggregation and association [28]. Specialization and

[1] A qualitative data analysis software package that is used to code and analyse qualitative data gathered from surveys, interviews, observations, document analysis, or other text-based data. www.qsrinternational.com.

aggregation were used to structure the hierarchy of the identified concepts. Whereas association was used to depict non-hierarchical relationships e.g. dependency or impact. These three relationship types are referred to as type-of (specialization), part-of (aggregation), and assoc. (association) in the remainder of this paper.

Coding. Coding involves an explicit formal representation of the conceptualization captured in the earlier stage. Formal representation is required to restrict the possible misinterpretations of a particular concept. Furthermore, concepts are usually hierarchically organized through a structuring relation, such as is-a (class-superclass, instance-class) or part-of [21]. Typical representations that are available for ontology documentation are Web Ontology Language (OWL), KIF, Cyc, Ontolingua, and FLogic [29].

In our work, we employ the use of OWL (Web Ontology Language) [30] - a de facto standard for ontology representation on the web - to provide a formal representation of compliance management ontology (complete specification omitted due to space). The result is a formal representation of the concepts and their associated relationships and attributes in OWL. The OWL coding serves the multiple purposes of further disambiguation/checking, relationship structuring, version management and a foundation for future studies and tool support.

Integration with Existing Ontologies. Integration of ontologies is the process of reusing and synthesizing one or more relevant ontologies from different domains to develop a new ontology [31]. Ontology integration typically involves aggregating, combining, assembling together the source ontologies to form the resulting ontology, possibly after reused ontologies have suffered some changes, such as, extension, specialization, or adaptation [32]. At present, we found no existing ontology that is fit to be integrated with this ontology. Accordingly, at this stage we do not consider integration with existing ontologies due to this lack of relevance. This may change in future as relevant ontologies emerge.

4.3 Ontology Evaluation and Refinement

The methodological approach followed for evaluation of CoMOn is detailed in section 3.2. Following the aforementioned approach, eight case studies were conducted through interview sessions arranged with eight compliance management practitioners and professionals, and any additional documents being analyzed where relevant (e.g. policy documents). Participation was voluntary. We were motivated to ensure that participants include practitioners and professionals who are directly involved in compliance management practice in their organization and/or those who provide compliance management advisory services to clients. To that end, we enlisted the help of the Australasian Compliance Institute (ACI) and obtained a selection of experienced participants with insight into compliance management in organizations. The participants come from different industry domains such as legal, financial and

insurance services, gaming, transportation and public utilities. The size of organizations involved in the case studies includes two organizations with between 51-200 employees, one organization with between 201-500 employees and five organizations with 1001-5000 employees. Typical roles interviewed included: head of compliance, compliance managers, regulators and consultants. Each case study session started with an overview and description of CoMOn and provided the participants with Core Concepts Evaluation document and explaining how to use the Core Concept Evaluation document. At the same time, the overall CoMOn Diagram and Catalogue of CoMOn Concepts was introduced to facilitate participant understanding of CoMOn concepts.

Table 1. Mean scores for quality of core concepts

Concepts	C	I	A	M	R (Yes =1, No=0)
Business Process	6	6.4	6.1	5.8	1
Cost	5.5	5.8	4.6	4.5	1
Culture	5	5.6	5	5.5	1
Program	6	6.1	5.4	5.5	1
Regulator	5.3	6	4.8	5.6	1
Regulatee	6.3	6.5	5.9	6.1	1
Requirements	5.5	6.1	5.5	5.6	1
Risk Management	5.8	5.8	5.5	5.6	1
Solutions	5.6	5.9	5.6	5.9	1
Service Provider	5.5	5.6	5	5.5	1

In Table 1, we provide the results from the overall quality evaluation of core CoMOn concepts, in the form of mean scores of the five quality criteria for each of the individual core concepts. These scores were used to identify the concepts that may need refinement. For example, low accuracy and low comprehensiveness scores for the Cost concept (A=4.6 and M=4.5) may suggest that the definition of Cost as a concept needs a review to improve its accuracy and comprehensiveness in representing cost related concepts in compliance management context. We note that agreement is reached in terms of the relevancy of all core CoMOn concepts.

Overall, the feedback received throughout the evaluation case studies exhibited a high level of consistency, particularly in qualitative feedback. This feedback was utilized to drive the ontology refinement process and, hence, all changes made can be traced back to participants' feedback in most cases consensus. While quantitative data is based on scores on the quality of the concepts, qualitative data is based on interview recording and notes made during the interview sessions. Accordingly, we examine and assess each concept to decide whether it needs changes, will remain unchanged, or will be abandoned. The following paragraphs provide details of refinement process associated with CoMOn's core concepts.

Business Process. Business Process concept received high scores generally, except for Comprehensiveness (5.8), as participants highlighted the need for monitoring

mechanisms for processes and measurement to assess process success or failure. Therefore, the **Business Process concept was expanded to Business Process Management** which includes Business Process, Process Monitoring, and Process Improvement as its sub concepts.

Cost. Lower scores for the Cost concept particularly on Accuracy (4.6) and Comprehensiveness (4.5), as well as the reasons highlighted by the participants indicated that the "cost concepts need to incorporate more than monetary value" and "to include resources as part of non-compliance cost e.g. due to extra time allocated to persuade people to comply". Hence, the **Cost concept was renamed to Resources,** which include monetary and non-monetary costs (both are now the sub-concepts for Resources). The **definition of the Resources concept** and **the definition of its associated sub-concepts were also revised**.

Culture. Culture concept gained fair scores on all criteria indicating a need for improvement as highlighted by the participants e.g. "suggest to remove term 'system' from definition of culture", "to include 'strategic focus' to improve the definition", and "to include culture measurement…". Therefore, the **Culture concept was expanded to Culture Management,** which includes Culture, Organizational Commitment, and Culture Measurement; **the definitions were revised** accordingly.

Program. In conjunction with only fair scores for Accuracy and Comprehensiveness, the participants highlighted the need to align Program concept to AS 3806-2006 Standard on Compliance Programs[2]. Following the feedback, **the definition of the Program concept was aligned to Compliance Programs definition** as per AS 3806-2006 Standard, and also **requisite changes were made at the lower level concepts** to align the overall Program sub-concepts to AS 3806-2006 Standard. Interestingly we note that the initial Program concept and its sub-concepts were actually quite close to the standard. In particular, only 6% (one concept) of the total Program concepts (16 concepts) were removed, 2 new concepts have been added, and another 19% (3 concepts) were renamed and/or rearranged.

Requirements. Lower scores for Clarity, Accuracy and Comprehensiveness compared to Interpretability hints the need to improve the definition of the concept and also the coverage of Requirements concept. This is also supported by participants' feedback i.e., "obligations is a better term to be used to replace 'requirements' term", "the concept must include mandatory and voluntary obligations" and "the concept must include code of practice as its sub-concept", and "the lack of comprehensiveness due restricting the definition to only mandated requirements". Thus, the **Requirements concept was renamed to Obligations**. The **definition for this concept was also**

[2] AS 3806-2006, published on 9 March 2006, provides principles for the development, implementation and maintenance of effective compliance programs within both public and private organizations.

revised to include **mandatory and voluntary compliance obligations** and **Code of Practice was added** as a sub-concept of Voluntary Obligations.

Regulator. Regulator gained mixed scores on all criteria which we believe are a result of incorrect usage of term in the definition that makes the concept restricted. This is highlighted by participants as "the definition is too narrow and not applicable to its sub-concepts particularly Standard Organization and Contracting Party." and "need to cover 'self-regulated' industry, what kind of regulator suites them". Hence, the **Regulator concept was moved to be an attribute of Obligations** (previously Requirements).

Regulatee. Although Regulatee concept received reasonable scores, participant feedback indicated lack of need for it: "This concept may not necessarily be required as this would mean the organization itself." and "I have never heard of this term". Considering the need for ontology parsimony, the **Regulatee concept was removed from CoMOn**.

Risk Management. Risk Management concept received fair scores overall, suggesting that Risk Management concept needs improvement. Therefore, as suggested by all the participants the concept was aligned to the AS/NZS ISO 31000-2009 Standard on Risk Management.[3] Accordingly, **the definition for the Risk Management concept as well as some of the sub-concepts, was aligned to** the Risk Management definition as per the standard.

Solutions. In line with the scores, the participants highlighted that the concept can be improved by "to include explicit connection with Program concepts", "the definition can be broadened to include other services", and "to include audit in as a concept". Therefore, **the definition of the Solutions concept was revised to include services**. **Some changes were also made to the lower level concepts** with inclusion of Services and its sub-concepts namely Audit, Assurance and Advisory.

Service Provider. Service Provider concept received fair scores only and the participants stressed that Service Provider concept can be improved by "expanding the coverage to include service providers that also help managing compliance obligation", "including external party engagement to facilitate under-standing compliance obligations" and "broadening the definition to include such as outsource internal audit function". Considering Service Provider is closely tied with Solutions concept (service providers provide compliance related solutions), we found that it is more accurate to explicitly link Service Provider to Solutions concept. At the same time, this will help us to minimize the number of concepts in CoMOn. This concept **became an attribute of Services** (under the Solutions concept).

[3] AS/NZS ISO 31000-2009 is identical to, and has been reproduced from, ISO 31000:2009, Risk management—Principles and guidelines. Minor changes have been made to the Introduction to address the application of the standard in Australia and New Zealand.

4.4 Document

To facilitate future utility of the ontology, the ontology is documented in a way that can be easily referred to by the target users. In addition to the formal OWL representation, informal visual representations, concept catalog as well as a user friendly 'reference manual' has been prepared which facilitated the evaluation case studies discussed above, but will also be used as a reference document in future ontology realization and deployment studies with the intended users i.e. compliance management professionals, businesses (regulated entities), and regulators.

5 Compliance Management Ontology (Refined)

The refined ontology consists of 81 concepts. These concepts are structured into four main tiers, representing different levels of detail derived through progressive decomposition of higher tier concepts. For example, the Program concept has been detailed into Obligations Identification and Assessment, Competency and Training, Controls and Monitoring, Record Keeping and Reporting, Review, and Structure in Tier 2, and so on. Each concept is equipped with a definition, attributes, and examples of realization where available. Figure 2 shows CoMOn with its first, second and third tiers concepts after the evaluation and refinement phases. Due to space limitations, we are unable to provide a full list of definitions for all concepts. However, in Table 2, we provide a list of contains definitions for core CoMOn concepts.

Table 2. Definitions of core concepts

Concepts	Definitions
Business Process Management	A holistic management approach focused on aligning all aspects of an organization with the wants and needs of clients. It promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology.
Culture Management	The way the organization cultivates compliance culture.
Obligations	The prescribed and/or agreed set of norms that are mandated or voluntarily adopted by an organization or individual.
Program	A series of activities that when combined are intended to achieve the desired level of compliance.
Resources	Monetary and non-monetary resources allocated to meet compliance obligations.
Risk Management	Coordinated activities to direct and control an organization with regard to risk.
Solutions	A particular method, tool or service that provides assistance to the regulated organization in meeting their compliance obligations.

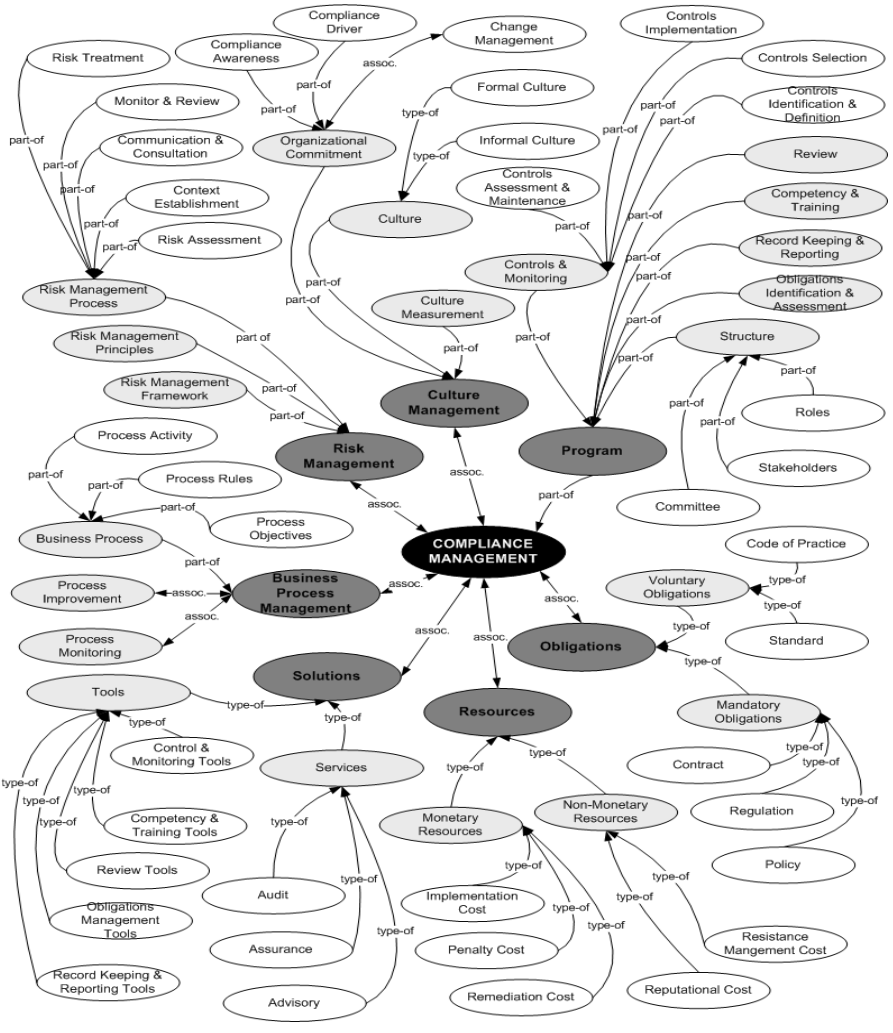

Fig. 2. Refined CoMOn with its first, second and third tier concepts

6 Concluding Discussion

In this paper, we have presented CoMOn - A Compliance Management Ontology, which was developed to address an evident need within the compliance management professional and research communities to have a common understanding of the various concepts that define the compliance management landscape. CoMOn is the result of a study that has spanned across the various phases of ontology development, evaluation and refinement. In particular, the ontological consensus achieved through the evaluation has positioned CoMOn as a comprehensive domain ontology for Compliance Management. Further, its role as a tool for communication and facilitation of shared understanding between various organizational functions has been notably recognized

within the Asia Pacific compliance management practitioner community, evidenced through interest from a number of industry groups to engage in future studies. The professional community has indicated that they also see this as a tool that they can use to assess the thoroughness of their compliance regimens and identify aspects of their compliance initiatives and programs that may be missing or lacking.

We are committed to ensuring that CoMoN is well evaluated from a variety of perspectives. Therefore, we are currently conducting an evaluation for the relationships within CoMOn, with the aim to further validate the existing relationships as well as identify further or missing relationships. As a next phase of this research, CoMOn will also be deployed in 7-10 organizations in early 2012 to conduct a longitudenal ontology realization study to thoroughly evaluate CoMOn's usability.

The development of this domain ontology has provided us with a number of insights into the methodological and empirical apporaches adopted, which are important to share. A detailed report on the experience is presented in [33], however below we provide a brief summary. First, ensuring the diversity of the sources that constitute the initial corpus for ontology capture is critical. We relied on four sources in this regard, namely industry experts or thought leaders, practitioners with more operational knowledge, industry reports and publications, and research literature. One weakness in this regard is the restriction of research literature to information systems venues only. Although to some extent the limitation does not seem to have compromised the overall quality of the ontology as presented in the results above. Second, we also note that use of support tools (e.g. NVivo) to conduct systematic analysis of the large body of text generated from multiple sources is essential.

Further it is evident in the compliance management industry, as with any other, that the related communities and stakeholders develop a number of conventions (or vocabulary favourites) that are hard to break. The introduction of two standards in the compliance (and risk) management industry, namely AS 3806-2006 Standard on Compliance Programs and AS/NZS ISO 31000-2009 Standard on Risk Management have assisted in overcoming this problem to some extent. Thus, we observe that where as achieving a full consensus is not practical, the ontology evaluation and refinement has to be carefully and systematically undertaken to ensure that the changes made can be fully justified. The use of quantitiative scores as well as the systematic analysis of qualitative feedback and informal discussions has proved immensely useful in acheiving justifiable changes and extensions to the ontology.

Finally, the empirical data collected through various phases of the study has interestingly revealed a number of other roles of such a domain ontology that were not listed in the original statement of purpose which was primarly to provide a shared understanding of the related concepts.

Overall, the ontology has been seen by the compliance professionals to potentially contribute towards: (1) facilitation of communication, not just for compliance obligations but also for organizational change that may stem from such obligations; (2) training and awareness raising related to organization's compliance and risk functions, and for improving employee competencies in this regard; (3) benchmarking or assessing the current state of the compliance management practice *viz.* what they have now, what is the best or typical practice, and what they possibly missed; (4) and lastly and rather obviously as a record keeping tool, given that the ontology provides a comprehensive information model for compliance related concepts.

References

1. Sadiq, W., Governatori, G., Namiri, K.: Modeling Control Objectives for Business Process Compliance. In: Alonso, G., Dadam, P., Rosemann, M. (eds.) BPM 2007. LNCS, vol. 4714, pp. 149–164. Springer, Heidelberg (2007)
2. Lu, R., Sadiq, S., Governatori, G.: Compliance Aware Business Process Design. In: 3rd International Workshop on Business Process Design (BPD 2007) (2007); In: ter Hofstede, A.H.M., Benatallah, B., Paik, H.-Y. (eds.) BPM Workshops 2007. LNCS, vol. 4928, pp. 120–131. Springer, Heidelberg (2008)
3. Louis Anon, J., Filowitz, H., Kovatch, J.M.: Integrating Sarbanes-Oxley Controls into an Investment Firm Governance Framework. The Journal of Investment Compliance 8, 40–43 (2007)
4. Syed Abdullah, N., Indulska, M., Sadiq, S.: A Study of Compliance Management in Information Systems Research. In: The 17th European Conference on Information Systems (ECIS 2009), Verona, Italy (2009)
5. Syed Abdullah, N., Sadiq, S., Indulska, M.: Emerging Challenges in Information Systems Research for Regulatory Compliance Management. In: Pernici, B. (ed.) CAiSE 2010. LNCS, vol. 6051, pp. 251–265. Springer, Heidelberg (2010)
6. Gruber, T.: Ontology. In: Liu, L., Özsu, M.T. (eds.) Encyclopedia of Database Systems. Springer, U.S (2009)
7. Grüninger, M., Lee, J.: Ontology Application and Design: Introduction. Communication of the ACM 45, 39–41 (2002)
8. Blomqvist, E., Öhgren, A.: Constructing an Enterprise Ontology for an Automotive Supplier. Engineering Applications of Artificial Intelligence 21, 386–397 (2008)
9. Moreira, E.D.S., Andréia, L., Martimiano, F., Brandão, A.J.D.S., Bernardes, M.C.: Ontologies for Information Security Management and Governance. Information Management & Computer Security 16, 150–165 (2008)
10. Uschold, M., King, M.: Towards a Methodology for Building Ontologies. In: Workshop on Basic Ontological Issues in Knowledge Sharing, Held in Conduction with IJCAI 1995, Montreal, Canada (1995)
11. Uschold, M.: Building Ontologies: Towards a Unified Methodology. In: 16th Annual Conf. of the British Computer Society Specialist Group on Expert Systems (1996)
12. Burton-Jones, A., Storey, V.C., Sugumaran, V., Ahluwalia, P.: A Semiotic Metrics Suite for Assessing the Quality of Ontologies. Data & Knowledge Engineering 55, 84–102 (2005)
13. Banker, R.D., Kalvenes, J., Patterson, R.A.: Information Technology, Contract Completeness, and Buyer-Supplier Relationships. Information Systems Research 17, 180–193 (2007)
14. Kim, H.M., Fox, M.S., Sengupta, A.: How to Build Enterprise Data Models to Achieve Compliance to Standards or Regulatory Requirements (and share data). Journal of the Association for Information Systems 8, 105–128 (2007)
15. Weitzner, D.J., Abelson, H., Berners-Lee, T., Feigenbaum, J., Hendler, J., Sussman, G.J.: Information Accountability. Communication of the ACM 51, 82–87 (2008)
16. Davis, C.J., Hikmet, N.: Training as Regulation and Development: An Exploration of the Needs of Enterprise Systems Users. Information & Management 45, 341–348 (2008)
17. Mishra, S., Weistroffer, H.R.: A Framework for Integrating Sarbanes-Oxley Compliance into The Systems Development Process. Communication of the Association for Information Systems 20, 712–727 (2007)

18. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design Science in Information Systems Research. MIS Quarterly 28, 75–105 (2004)
19. Fernández, M., Gómez-Pérez, A., Juristo, N.: METHONTOLOGY: From Ontological Art towards Ontological Engineering. In: AAAI 1997 Spring Symposium Series, pp. 33–40. AAAI Press (1997)
20. Fernández-López, M., Gómez-Pérez, A.: Overview and Analysis of Methodologies for Building Ontologies. The Knowledge Engineering Review 17, 129–156 (2002)
21. Pinto, H.S., Martins, J.P.: Ontologies: How can They be Built? Knowledge and Information Systems 6, 441–464 (2004)
22. Spyns, P., Tang, Y., Meersman, R.: An Ontology Engineering Methodology for DOGMA. Applied Ontology 3, 13–39 (2008)
23. Syed Abdullah, N., Sadiq, S., Indulska, M.: A Framework for Industry-Relevant Ontology Development. In: Proceedings of the 22nd Australasian Conference on Information Systems (ACIS 2011). AIS Electronic Library (AISeL), Sydney, Australia (2011)
24. Denaux, R., Dolbear, C., Hart, G., Dimitrova, V., Cohn, A.G.: Supporting Domain Experts to Construct Conceptual Ontologies: A Holistic Approach. Web Semantics: Science, Services and Agents on the World Wide Web 9, 113–127 (2011)
25. Paredes-Moreno, A., Martínez-López, F.J., Schwartz, D.G.: A Methodology for the Semiautomatic Creation of Data-driven Detailed Business Ontologies. Information Systems 35, 758–773 (2010)
26. Lim, S.C.J., Liu, Y., Lee, W.B.: A Methodology for Building a Semantically Annotated Multi-faceted Ontology for Product Family Modelling. Advanced Engineering Informatics 25, 147–161 (2011)
27. Syed Abdullah, N., Sadiq, S., Indulska, M.: Information Systems Research: Aligning to Industry Challenges in Management of Regulatory Compliance. In: Proceedings of the Pacific Asia Conference on Information Systems Engineering (PACIS 2010), Taipei, Taiwan (2010)
28. Booch, G., Rumbaugh, J., Jacobson, I.: Unified Modeling Language User Guide. Addison-Wesley Professional (2005)
29. Pulido, J.R.G., Ruiz, M.A.G., Herrera, R., Cabello, E., Legrand, S., Elliman, D.: Ontology Languages for the Semantic Web: A Never Completely Updated Review. Knowledge-Based Systems 19, 489–497 (2006)
30. W3C OWL Working Group: OWL 2 Web Ontology Language - Document Overview. World Wide Web Consortium (2009)
31. Pinto, H.S., Gómez-Pérez, A., Martins, J.P.: Some Issues on Ontology Integration. In: Proceedings of the IJCAI 1999 Workshop on Ontologies and Problem-Solving Methods (1999)
32. Pinto, H.S., Martins, J.P.: A Methodology for Ontology Integration. In: Proceedings of the 1st International Conference on Knowledge Capture, pp. 131–138. ACM, Victoria (2001)
33. Syed Abdullah, N., Sadiq, S., Indulska, M.: A Study of Ontology Construction: The Case of a Compliance Management Ontology. In: Ahmad, M.N., Colomb, R.M., Abdullah, M.S. (eds.) Ontology-Based Applications for Enterprise Systems and Knowledge Management. IGI Global (in press)