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Ontology-based Customer Complaint Management

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Abstract. This paper presents an ontology-based approach for managing and maintaining multilingual online customer complaints. To achieve trust and transparency in e-commerce communications and transactions, effective and cross-border complaint platforms need to be established and may be integrated in e-business activities. The effectiveness and width of such complaint service platforms depend on rising to several challenges, such as the sensitivity of business regulations and complaint resolution, the language and cultural diversity of the cross-border business parties, the extensibility according to the market needs and standards. In this paper, we show how such challenges can be addressed and simplified: first, we propose the construction of an ontology that captures the core knowledge of the customer complaint domain. Second, we show how the extensibility of a complaint platform can be simplified and managed. Finally, we show how a multilingual representation of this ontology may be constructed.

This paper outlines our main achievements in Topic Panel 6 ("Ontology, Extensibility and Integration"), which is a special interest group in the EU CCFORM Thematic Network project[1].

Keywords: Customer Complaint Management, CRM, e-CRM, Ontology, Core Ontology, Customer Complaint Ontology, DOGMA, ORM, Multilingual Representation of Ontologies.

1. Introduction and background

The use of the Internet for cross-border business is growing rapidly. However, in many cases the benefits of electronic commerce is not exploited fully by customers because of the frequent lack of trust and confidence in online cross-border purchases. To achieve fair trading and transparency in commercial communications and transactions, effective cross-border complaint platforms need to be established and involved in e-business activities [CIHF02] [CW87].

[1] (IST-2001-34908), 5th framework.

The CCFORM project aims to study and *reach consensus* about the foundation of online customer complaint management mechanisms by developing a standard but extensible form (called CC-form[2]) which has widespread industry and customer support. This CC-form must facilitate cross-language communication to support cross-border e-commerce and should be easy to implement in software tools. The CC-form will raise the basic standard of complaints management, and can be extended in vertical markets to provide sector-wide solutions, and by service providers to gain competitive advantages.

The main challenges of establishing and standardizing such a CC-form are: (1) the legal bases: the sensitivity on cross-border business regulations and privacy issues, (2) the diversity of language and cultural aspects: controlling and standardizing the semantics of the complaint terminology i.e. the intended meaning of the terms, and among different human languages, (3) customer sensitivity and business perspectives, (4) extensibility: the flexibility of extending the CC-form according to market needs and standards, e.g. extending the kinds of problems that a complainant can complain about, extending the kinds of resolutions, managing who may extend what, etc.

In order to tackle such challenges and to perfect the reference model for the complaint form, i.e. CC-form, the major work in the CCFORM project has been divided into six topic panels, each consisting out of 10-15 specialized members. Each panel has been intensively discussing different issues: TP1: Legal Affairs, TP2: Consumer Affairs, TP4: Standards for SMEs. TP5: Alternative Dispute Resolution Systems, TP6: Ontology, Extensibility and Integration, TP7: Vertical markets.

This work outlines our main achievements in the "Ontology, extensibility and integration, including multilingual and cultural issues" topic panel. The goal of this topic panel is to undertake the extensibility and multilingual demands. To approach this, a customer complaint ontology (CContology), lexicalized in multiple languages has been developed.

In the next section, the CContology will be presented. In section 3 we discuss the extensibility and organization of the CContology. In section 4 we show how an ontology can be lexicalized in different human languages. Finally, in section 5 some conclusions are drawn.

2. Customer Complaint ontology

The *customer complaint ontology* (CContology) intends to capture the knowledge elements (present in a so-called *conceptualization*) of the "customer complaint management" domain. Its core covers a semantic description of complaints that could be issued by any legal person against any other legal person (NGO, company, natural

[2] We refer to the project as CCFORM and to the target customer complaint form as "the CC-form".

person, government, etc.). It comprises business models, categories of complaints and resolutions, "best-practice" business rules, etc.

The main intended impact of the CCFORM project is that the results of the project will be a future initiation of a European online complaint platform that will provide a trusted portal between consumers and business entities. In this respect, the ontology is intended to become the basis for a future so-called *core ontology* in the domain of customer complaint management. Applying the CContology in such an European online complaint platform will enable the further refinement of the CContology.

The main use of such an ontology is 1) to be shared among all stakeholders and thus enable consistent implementation (and interoperation) of all their software complaint management mechanisms based on the shared background vocabulary; and 2) the CContology holds *business rules*, defined between concepts and relations, so that that *valid information structures can be enforced.* Furthermore, 3) to play the role of *core domain ontology*; it encompasses the core complaining elements, and *can be extended by individual or groups of firms.*

Although this CContology has been built and approved by all of six topic panels, in its current state it can only be considered a proposal. The CCFORM community, while representative for a sizable cross-section of the domain, is not a standardization body nor in a position for a *de facto* enforcement of this ontology as a generally agreed semantic specification. However, we claim the approach presented in this paper is designed to initiate and drive such a process.

The CContology is modularized into a set of (at this moment seven) so-called ontological commitment modules[3] : Complaint, Complainant, Recipient, Address, Complaint Problems, Complaint Resolutions, and Contract. Each commitment module consists of a set of binary conceptual relations and rules that specify and constrain the intended meaning of the concepts and relations. *An inclusion composition relationship can be defined between the commitment modules: all concepts and rules introduced in the included commitment module will be inherited in the including commitment module.*

Any complaint form, including the completed forms (i.e. the data), should be based on (i.e. commit to) the semantics represented in the CContology. Formally, for an application to commit to a certain commitment, it must satisfy all rules declared in this commitment. In other words, any possible world, for an application, must conform to the rules declared in its commitment(s) (cf. model-theoretic semantics). In [JLVM03], we illustrated an approach for semi-automatic ontology-driven generation of web forms: to model a CC web form, one selects the appropriate commitment modules,

[3] Notice that the commitment modules are not the ontology itself. An ontology, in our approach [JDM03][JM02], consists of an *Ontology Base* (holds intuitive domain knowledge) and a set of *ontological commitments* (each holding *formal* application-kind knowledge). Due to readability issues for non ontology-experts we have introduced the commitment modules before introducing the ontology base, which is presented in section 4.

composes them and then automatically generates the target web form from these composed commitment modules.

Let us now turn to present the content of the ontological commitment modules. The CContology is developed using the DogmaModeler ontology engineering tool [JDM03]. The commitment modules are represented graphically in figures 1 to 7 using ORM [H01], a conceptual graphical modeling notation[4] that is used in DogmaModeler. We provide an informal brief description of each commitment module after the corresponding ORM diagram. For the *formal specification* of the commitment modules, some prior background in ORM is required (e.g. see [H01]). The informal definitions of the concepts found in these commitment modules are provided in the ``Customer Complaint Glossary''[5].

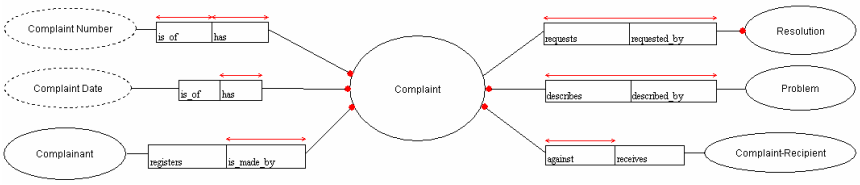
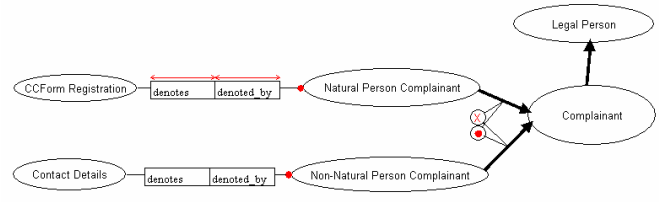


Fig. 1 : The ``Complaint'' ontological commitment module

Fig. 1 illustrates the ``Complaint'' commitment module. A `Complaint' is made by a `Complainant' against a `Complaint-Recipient' on a certain `Date'. A `Complaint' is identified by its `Complaint Number'. In a `Complaint' the `Complainant' issues at least one `Problem' to the `Complaint Recipient' and he may ask for some `Resolutions'.



[4] In ORM, ellipses denote concepts (e.g. "complaint") and rectangles denote relations. Each relation consists of two roles (e.g. "describes" and "described by"). Rules in ORM can also be represented graphically: the mandatory rule "●" between a concept and a role denotes that it is mandatory for the concept to play this role. The uniqueness rule "⟷" on top of a role denotes that the concept can play this role only once. If the uniqueness rule spans over two roles, then it denotes that the combination of the two roles should be played at most once. The exclusive rule "⊗" between two (or more) subtype relations (see fig. 2) denotes that there is no intersection between the instances of the sub concepts. The Total rule "⊙" between two (or more) subtype relations denotes that the instances of the super concept are exactly the union of the instances of the sub concepts. The exclusive-or rule "⊙" between two (or more) *roles* (see fig. 3) denotes that the concept which plays these roles must play at least one of them. See [H01] for more about the ORM notation.

[5] The "Consumer Complaint Glossary" is not included in this paper, but it is publicly available at http://www.starlab.vub.ac.be/ccform/CCGlossary.pdf

Fig. 2 : The ``Complainant'' ontological commitment module

Fig. 2 illustrates the ``Complainant'' commitment module. All `Complainants' are `Legal Persons'. A `Legal Person', as defined in the Glossary[5] , is any legal entity that has legal rights and responsibilities (e.g. it can be a Natural Person, a Company, a Government, an NGO, etc.). In the complaining context , and as commonly understood in most consumer regulations, a complainant can either be a consumer or a business customer, each implying a different legal basis for complaint handling. In Fig. 2 a complainant must be either a `Consumer Complainant' or a `Non-Consumer Complainant'. Each `Consumer Complainant' must have `Contact Details'. As will be shown in Fig.4, the mandatory contact information is only the `eMail' and the `Country' of the `Complainant'. A `Non-ConsumerComplainant' must have a `CCForm Registration', which is an enrollment in the complaint platform that uniquely identifies the `Non-Consumer Complainant' (and its various roles and contact details). The distinction between consumer and non-consumer complainants is not only based on the variation of their complaint handling regulations, but also on the preference of not obligating the inquiring of private information about consumers, such as his/her `Name', `Mailing Address', `Telephone', etc.

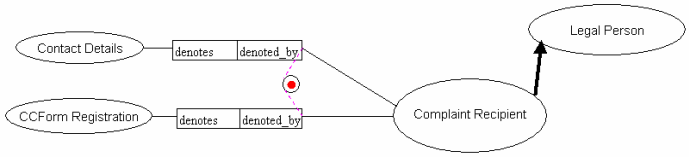


Fig. 3 : The ``Recipient'' ontological commitment module

Fig. 3 illustrates the ``Recipient'' commitment module. A `Recipient' is a `Legal Person'. When a `Complaint' is issued against a `Recipient' the `CCform Registration' or the `Contact Details' need to be provided.

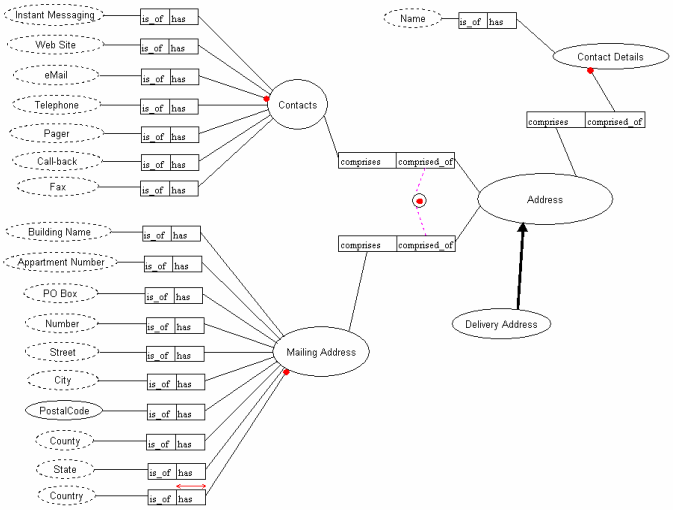


Fig. 4 : The ``Address'' ontological commitment module

Fig. 4 illustrates the ``Address'' commitment module. The `Contact Details' consist of a `Name' and an `Address'. An `Address' is comprised of `Contacts' and a `Mailing Address'. A `Mailing Address' must have a `Country', and can have all the traditional information of postal addresses in the European Union. `Contacts' are used for non-postal communication and must include at least an `eMail'. In addition, `Contacts' can include other non-postal communications ranging from `Fax' to `Instant Messaging'.

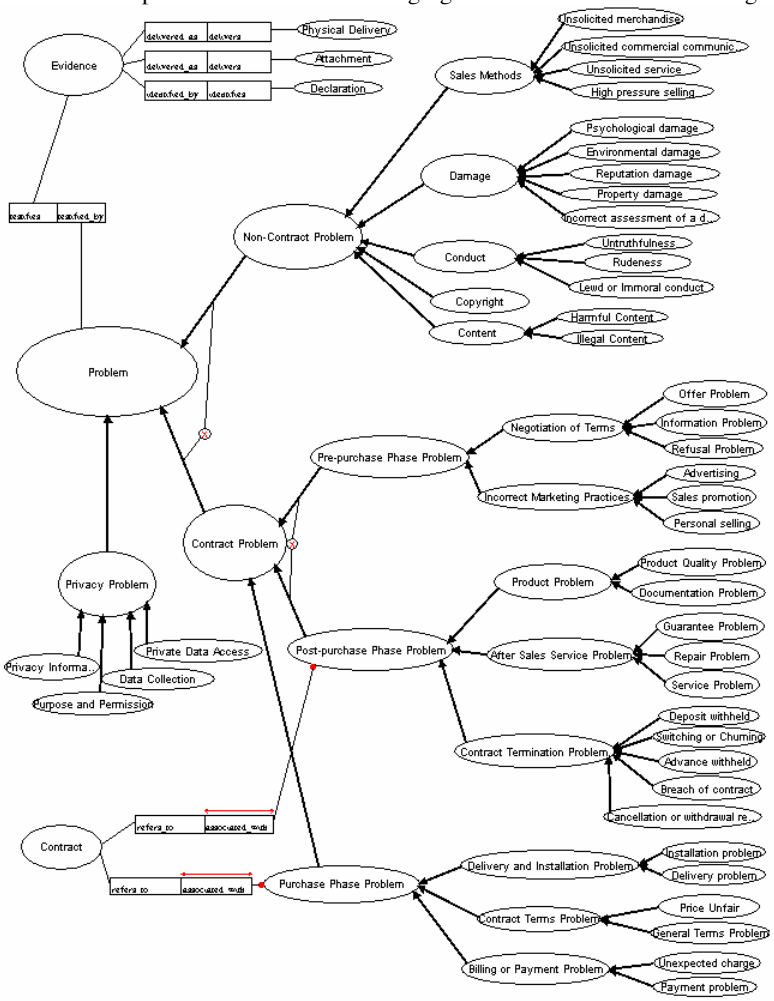


Fig. 5 : The ``Complaint Problems'' ontological commitment module

Fig. 5 shows the ``Complaint Problems'' commitment module. The content of this commitment is based mainly on the research that has been carried out by some of the other topic panel members, reported in [VS03]. A `Complaint Problem' can be a

`Privacy Problem', or either a `Contract Problem' or a `Non-contract Problem'. `Contract Problems' maybe `Purchase Phase Problems', `Pre-purchase Phase Problems' or `Post-purchase Phase Problems'. If a problem is a `Purchase Phase Problem' or a `Post-purchase Phase Problem' the necessary information about the `Contract' should be provided. `Complainants' who register a `Complaint' can optionally provide some `Evidence' of the reported `Problem'.

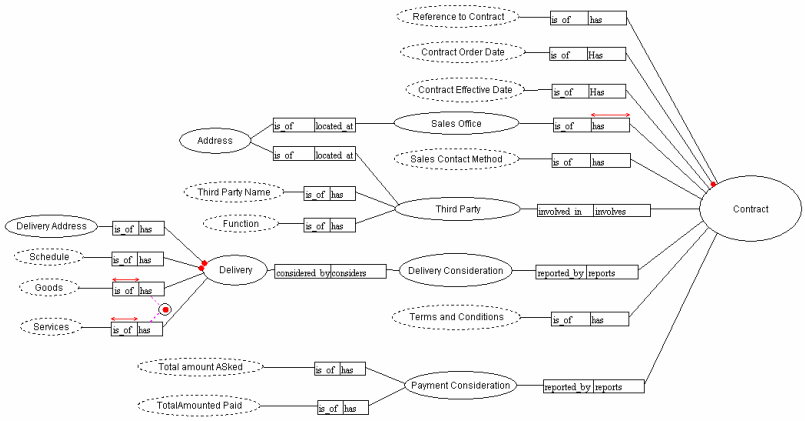


Fig. 6 : The ``Contract'' ontological commitment module

Fig. 6 illustrates the ``Contract'' commitment module. `Contract' is a wider concept than "a piece of paper with on it a written agreement signed by two parties''. In CCFORM we speak of a `Contract' from the moment there is a `Contract Order Date' provided. Extra information about the `Contract', such as `Reference to Contract', `Contract Effective Date' (Start date from which the contract is applied), the `Sales Office', `Terms and Conditions', etc. can also be provided.

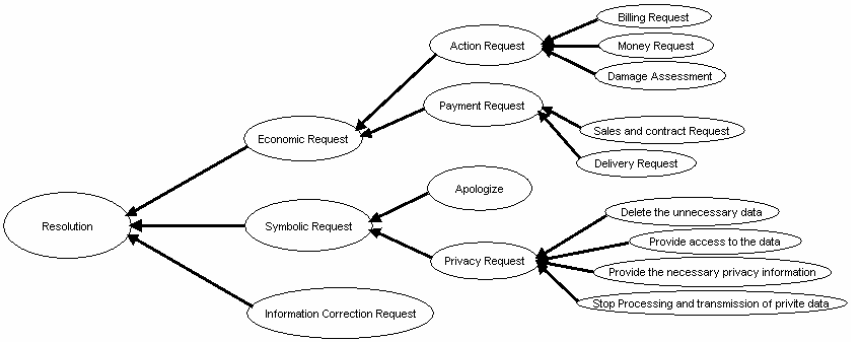


Fig. 7 : The ``Resolution'' ontological commitment module

Fig. 7 illustrates the ``Resolution'' commitment module. A `Resolution' requested by a `Complainant' can be an `Economic Request', a `Symbolic Request' or an `Information Correction Request'. Etc.

3. Modularization and Extensibility

Modularizing the ontology into a set of commitment modules ,such as above, leads to extensibility, one of the main requirements for CC-form. Such extensibility of CC-form content may be required and performed by individual CC-form client companies. Once the CC-form is implemented as a centralized complaint portal between customers and companies, client companies may wish to extend "their" CC-form to inquire more specific complaint details, e.g. delivery conditions, product attributes, or they might wish to offer the customer a particular resolution, etc. Such extensions may be a necessity not only for individual companies but also in so called vertical markets applications (covered in the "vertical market" topic panel, TP7). In the CCFORM project, one of the main goals is to provide companies a method to extend the CC-form content themselves, within given (e.g. legal) constraints on those extensions. On the one hand, this will help to achieve a wider adoption of complaint mechanisms in e-commerce applications, but on the other hand this will create new challenges: keeping the new extensions consistent with the existing CC-form and preventing misuse of the CC-form. For example, a company might try to misuse the CC-form by inquiring private information which violates the privacy regulations, or it may introduce new terminology and rules that are semantically inconsistent with the existing content terminology and rules.

In our solution the CC-form must not be altered directly; instead extensions are introduced into the CContology, the base of CC-form. Moreover, our modularization of the ontology -into a set on the ontological commitment modules- offers simplified methodologies for extending, maintaining and managing the CContology :

- *Extensions will not be allowed on all commitment modules*. For example, the "Complainant" and "Address" commitment modules may be locked, so companies will be prevented from e.g. asking privacy-rule-violating questions. Or perhaps, we can only allow extensions to be made into the "Problem" and "Resolution" commitments. In this way, we can achieve a "relatively" systematic management of the kinds of extensions allowed.

- *Extensions can be made and treated as separate modules.* If a company wishes to extend a certain commitment to inquire details about e.g. a certain kind of product, a new ontological commitment can be constructed to capture these details. In addition to that an inclusion composition relationship can be declared between the target commitment modules and the new commitment module.

- *Efficient maintenance and management*. CC-form may need to manage a large amount of extensions that target many dimensions of the CContology. Modularizing these extensions will make managing, maintaining and indexing them more scalable.

- *The development of the modules can be distributed among ontology experts, domain experts and application-oriented experts*. In the case of e.g. a vertical market application, where one wishes to develop a set of extensions (i.e. modules),

the development and the review processes could be distributed according to the expertise of the developers and the subject of the modules.

For example, during the development of the core CContology we have distributed the development and review of the set of commitment modules to the specialized topic panels. Bistra Vassilev acted as domain expert for the development of the Problem and Resolution commitments even though she was based at several thousand kilometers distance. Members from TP1 (legal affairs) have reviewed the "Complaint", "Complainant", "Recipient", "Address" and "Contract" commitments. Members from TP2 "Consumer affairs" have reviewed the "Complaint", "Complainant", "Problem" and "Resolution" commitments. Reviewing the CCglossary[5] has been done by several members, etc.

- *Reusability issues*. One may wish to reuse some of the commitment modules in a broader context than the domains of complaints and complaint management. For example, the `Address' commitment can easily be reused for tasks in other domains: Mailing, Marketing, Sales Force Automation, etc. The `Complaint Problems' commitment module in the domains of market analysis, qualitative statistics, etc.

4. Multilingual lexicalization of the CContology

This section proposes a methodology for lexicalizing the CContology (as obtained so far) in several natural languages. This methodology may be useful when one wishes to provide "multilingual" extensions to the CContology, or wants to translate the CContology "terms" into other natural languages. Lexicalizing the CContology into several natural languages supports the development of a software platform providing cross-language customer complaint form management. A multilingual lexicalization of the CContology assists a consistent and systematic translation of the terms expressing the concepts in the ontology. For complaint platforms, this allows the systematic translation of all elements of the generated and filled in customer complaint forms that do not contain "free" text.

Terms in human languages in general can be ambiguous in that a term can have two or more distinct meanings. For example the term "bank" in English can have several meanings: a financial institution, sloping land (beside a body of water), etc. When humans communicate they usually have the capability and intuition to disambiguate the intended meanings of terms depending on the context in which these terms are used. However, ontologies are being used -in computing technology- to represent knowledge formally at the conceptual level; so that by sharing a conceptualization (i.e. an ontology) computer programs can interoperate meaningfully. See e.g. [G95][GG95] for further details about what is an ontology. In short, ontologies are intended to represent concepts rather than terms, implying a certain level of independence from natural language.

Before we introduce our methodology, we need to present some further basic principles of the DOGMA ontology engineering approach ([JM02a] [JDM03]) that we have adopted in this paper. In the DOGMA approach, ontologies are structured into an *ontology base* and a layer of *ontological commitments*. When developing an ontology according to DOGMA, the ontology base is constructed first, *then* a set of ontological commitments can be defined literally "in terms of" this ontology base. *Notice that for simplicity of presentation in this paper, we have presented the set of CC ontological commitments in section 2 before formally introducing its ontology base*. In short, an ontology base consists of context-specific binary conceptual relations, called lexons. In the CContology, only one context has been declared: "Complaining". Within this context, the set of all complaining conceptual relations are defined. Table 1 shows some lexons of the CContology base.

Context	$Term_1$	Relation	$Term_2$
Complaining	Complaint	has / is of	Compliant Number
Complaining Complaining	Complaint Complaint	is_made_by / registers describes / described_by	Complainant Problem
…	…	…	…
Complaining	Complainant	subtype_of / supertype_of	Legal Person
…	….	…	…
Complaining	Problem	supertype_of / subtype_of	Privacy Problem
Complaining	Problem	upertype_of / subtype_of	Contract Problem
…	**…**	**…**	**…**

Table 1 : Example lexons of the CContology's ontology base

The CContology commitment modules –presented in section 2– are defined within the "Complaining" context: the set of conceptual relations in each commitment are lexons in the "Complaining" context in the CContology base. In other words, the lexons and the intended meanings of their terms are shared among the set of ontological commitments. In DOGMA, each Term within a Context refers to a Concept. For example, since both the "Complaint" and the "Complainant" commitment modules are defined within the same "Complaining" context, the term 'Complainant' refers to the same concept in both commitments. By doing so, not only the modularization of the ontology is enabled, but also the "semantically safe" composition of a set of commitment modules is made possible [JM02b] through the inclusion interrelationship. Notice that when computer programs interoperate, they do not directly access and share the ontology base lexons, but they share and commit to the intended meaning of these lexons through ontological commitments, which are formal knowledge (i.e. logical theories).

In the ontology base, each term within a given context [6] (i.e. each concept) should have an informal description; this description[7] –also called gloss– should provide a

[6] More about the notion of context in the DOGMA approach can be found in [JDM03].

sufficient explanation for humans (who understand the specific language) to intuitively understand its intended meaning. Fig. 8 shows an example of glosses in English, defined within the CContology. "ConceptID" uniquely identifies a concept.

DogmaModeler CCForm Glossary CForm Glossary

ConceptID	Context	Term	Gloss
102176	Complaining	Complaintant	A legal person who addresses a complaint against a recipient.
102178	Complaining	Complaint	A pleading issued by a complainant against a recipient describing wrong or
102182	Complaining	Problem	A state of difficulty or dissatisfaction that needs to be resolved; an expressi
102198	Complaining	Legal Person	Legal entity with legal rights and responsibilities (e.g. Natural Person, Comp

Fig. 8 : Example glosses of the concepts that are used in the CContology

Accordingly, expressing concepts by terms within different natural languages is made easier *through the use of contexts*. Hence, we can translate terms (which are the lexical representation of concepts) in language A into terms in language B within a given context. For example, within the "Complaining" context, the English term "Complaint" can be translated into "Klacht" in Dutch or "Réclamation" in French. Notice that the term "Complaint" in English can have different other meanings in other contexts, e.g. "a loud cry (or repeated cries) of pain or rage or sorrow", or "the first pleading of the plaintiff setting out the facts on which the claim for relief is based" in the context of civil law. In short, we seek *conceptual equivalence translations*.

Table 2 shows English-Dutch-French conceptual equivalence translations within the "Complaining" context of the terms presented in Fig 8.

ConceptID	Context	English (Native)	Dutch	French
102176	Complaining	Complainant	Klager	Plaignant
102178	Complaining	Complaint	Klacht	Réclamation
102179	Complaining	Recipient	Ontvanger	Destinataire
102181	Complaining	Complaint Number	Klachtnummer	Numéro de Réclamatio
102198	Complaining	Legal Person	Rechtspersoon	Personne Morale
..	..	..	..	..

Table 2: English-Dutch-French conceptual equivalence translation within the "Complaining" context

To harmonize the different translations of the ontology our approach requires *an ontology to be build and lexicalized completely in at least one language*, the ontology's *native language*. In the case of the CContology, English is chosen to be the native language. This native language then acts as *the* reference for translating the ontology into other languages.

Our conceptual equivalence translation approach yields sometimes imperfect translations but is scalable and easy to use. The CC-form can easily switch between different natural languages by substituting the terms with their conceptual equivalence translations from the ontology (assuming the contexts are sufficiently well

[7] For documentation purposes.

circumscribed, of course). Fig. 9 shows a simplified complaint form in English, Dutch and French.

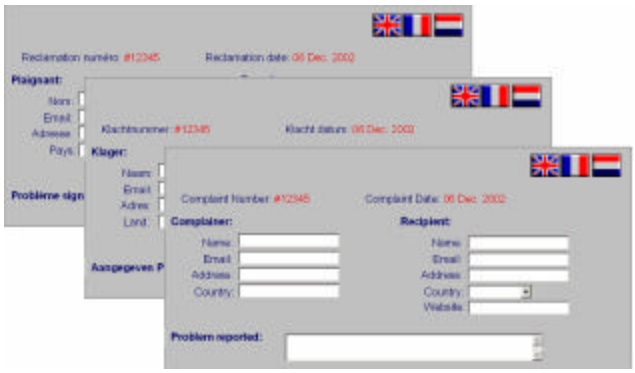


Fig. 9 : Simplified multilingual (English-French-Dutch) form

While it is a pragmatic approach, the conceptual equivalence translation is not as trivial as it appears. Acquiring more elegant translations demands the translator to perform further investigation. In what follows, we present some issues and guidelines towards further convenience and high accuracy in the multilingual lexicalization of ontologies:

- *Cultural issues.* There is a high dependency between the language of people and their culture (social activities, religion, region, weather, interests, era etc.) Thus, within a community of people speaking the same language we can find different usage of terms, even within the same context. For example, within the "Complaining" context, when translating the term "Complaint" into Arabic there are two conceptually equivalent terms : "Mathalem" and "Shakaoa". In Palestine, the most commonly used term is "Shakaoa", while in Saudi Arabia people prefer the term "Mathalem". Seemingly, the ideal solution for such a problem is providing a set of rules for the usage of each term, considering *all* cultural issues [C98]. However, this does not yield a scalable approach for our purposes. Thus we advise that if such cultural variations are important for a context, it is better to treat e.g. English-UK, English-USA, Dutch-Belgium, Dutch-Netherlands, Old-Arabic, Modern-Arabic, etc. as distinct languages.

- *Word to word translation is not our goal*. Usually, the purpose of building an ontology is to formally represent an agreed conceptualization of a certain domain, and share it among a community of users. Thus, lexicalizing the concepts in an ontology into multiple languages is a manner of maximizing the *usability* of this ontology[8], and not to play the role of multilingual lexicon. In lexicons or dictionaries, the purpose is to list only the common words –e.g. based on corpus- of a language with a description and lexical information. In ontologies it is normal to find a concept lexicalized by an expression. For example, "Total Amount Paid",

[8] In principle, it is possible to refer to the ontology concepts by e.g. numbers, symbols, etc.

"Trying to obtain data improperly", etc. Such concepts cannot in general be lexicalized in one word, in this case at least not in English.

To conclude, the methodology we have presented in this paper intends to maximize the usability of an ontology among several cross-language applications. Obviously, this methodology is useful and easily applicable in information systems that comprise forms, databases, XML and RDF tags, etc. Our methodology is however not suited in case of ontology-based natural language processing applications. For such applications we suggest the development of *multilingual ontologies*: developing formal representation (i.e. an ontology) for each human language considering all its concepts, and then a alignment layer to map between these ontologies. Further details on how to develop multilingual ontologies will be discussed in future papers.

5. Conclusion

In this paper we have presented our experience and main achievements in the Ontology, Extensibility and Integration topic panel, a special interest group in the EU Thematic Network project CCFORM.

Using ontologies as a foundation for cross-border online complaint management platforms can greatly improve the effectiveness, scope and extensibility of such platforms. While offering individual companies and organizations, or associations of them, advanced customization abilities by extension capabilities for the ontology, semantic consistency through the complaint management terminology is maintained. Furthermore, by restricting extensions to certain parts of the ontology, some legal constraints such as privacy regulations may be enforced systematically.

The proposed methodology for the multilingual lexicalization of ontologies is a pragmatic one. It offers a scalable manner for offering multilingual services, a necessity for cross-border complaint management within the EU. An important goal in future research is a formal approach for developing multilingual ontologies, which would allow computers to interpret and disambiguate terms in different languages through the ontology.

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