A new data model for logistics in furniture collaborations

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Abstract
After several validations of the NIMBLE B2B platform instance with companies in the furniture arena it was decided the need of a new data model for logistics services in the furniture B2B collaborations as lot of concepts and terminology were not available for publishing main characteristics of their logistics services. There was already a detailed ontology regarding furniture products but not on logistics services and eClass taxonomy was extremely detailed but quite difficult to deal with the different levels and topics really needed. It was identified a gap between the used ontology and some properties because of the customization of the logistics services the logistics companies can offer to the industrial ones. A new data model for logistics services was developed and an enriched ontology in furniture sector was completed. In this paper, it is explained the main structure and characteristics of this ontology and its performance after several rounds of validation with experts in logistics.

Keywords 1
NIMBLE, B2B, logistics, furniture, ontology

1. Introduction

The validation activities of the NIMBLE B2B platform (H2020 European funded project NIMBLE, No. 723810) involved a collection of experimentation workshops, some of them focused on logistics services supply. In those workshops, furniture manufacturers and experts in the logistics field took part testing the publication of product (furniture) and service (logistics) catalogs, the search for products and services in the platform, and the collaboration processes between parties, mainly the negotiation of terms and conditions. The testing groups taking part at the workshops pointed the difficulty to publish its own logistics services with the taxonomies offered by the platform at that time: eClass and the furniture sector ontology. They also felt the lack of concepts and terms which did not allow them to publish all the main characteristics of its services.

On one hand, the furniture ontology was detailed on furniture items but not on logistics services. On the other hand, eClass is extremely generic so users found difficult to deal with the different levels and topics of this taxonomy. Indeed, they found also a gap between this categorization and some properties of its services due to the required customization of the logistics services to be offered to the furniture companies.

To overcome these problems, the furniture sector ontology was extended based on a new data model for logistics services. In this paper, the main structure and characteristics of this model as well as its performance after a new validation round with experts in logistics are described.

2. Overview of existing data models

Ontologies enable common understanding of concepts and have been acknowledged as a powerful means to foster collaboration between companies [4]. Although numerous ontologies for production

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systems have been developed in the past years, they mainly focus on manufacturing, while logistics have not received the same attention [5]. It is certain there are studies about this problem [1], [2], [3], [4], [5], but the problem to fit logistics processes and ontologies continues.

In some models there is a lack of formal semantics which prevents automated data integration across organizational boundaries [1], and it is difficult to balance the trade-off between precision and pragmatism in an ontology focused on logistics [4].

eClass is one of the most prominent product classification standards covering a wide range of products and services and grows continuously [6]. It contains thousands of product/service categories and associated properties. The eClass taxonomy was limited in utilization of the NIMBLE use case in terms of both the available categories and properties associated to those properties in relation to logistics services. For instance, eClass does not include classification categories representing warehouse management or reverse logistics. Furthermore, for some other logistics services like rail or road transport, though, eClass has representative categories but with insufficient properties to represent details about those categories in the scope of NIMBLE use case.

Apart from eClass, there exist several product classification standards for classification of products/services. Global Product Classification (GPC) [7], Google Product Taxonomy [8] and UNSPSC [9] are some of the product classification standards. However, they are also not suitable to address problems explained above. Schulten et al. (2001) indicates that UNSPSC is rather shallow, not very intuitive, and not descriptive on an attribute level and it is mainly developed in the US, leaving many European needs behind [10]. Whereas Google Product Taxonomy does not define a category for any type of logistics services, GPC defines a category only for general transport services.

Neither eClass nor other product classification standards are enough to ease the process of publishing/discovering of logistics services in furniture sector. Therefore, a ontology focused on logistics was defined for different types of logistics services having some common properties such as industry specialization and specific properties to the service such as truck load property for road transport.

3. Experimentation methodology

The work was performed in different steps during the continuous user validation carried out in NIMBLE platform (https://www.nimble-project.org/project/furniture-manufacturing-platform/). The problem with the current ontologies available in NIMBLE came out after the first user validation steps described in the introduction.

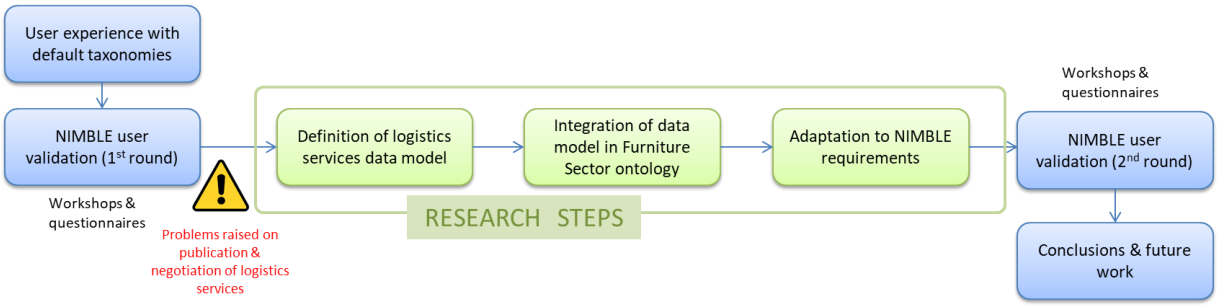

Figure 1: Work methodology

Inputs from previous workshops were considered together with personal interviews with companies to gather requirements. The new data model was then integrated into the furniture sector ontology and adapted to NIMBLE requirements. Further validation activities were arranged, following detailed and personalized agendas indicating the role of the participants at each stage of the experimentation, companies and products to be published, searches to be performed and negotiation pairs for collaborations. Participants tested all the functionalities available on the platform related to the different business processes. Regarding logistics services, they were tested by covering the different parts of the furniture supply chain: transport, warehousing and packaging. Once the platform

had been extensively experimented, users took part in open discussions and filled questionnaires for further evaluation and refinement.

4. Logistics data model for logistics in the furniture sector

This section deals with the activities regarding the definition of the model for logistics services, as well as the consideration of this as an extension of the furniture sector ontology which already covers the representation of the main resources involved in such industry sector. Furthermore, the integration process of this data model and the elaboration of a user interface for the platform are described.

4.1. Brief description of the ontology for logistics services

The logistics data model, was integrated in the Furniture Sector Ontology, based on the International standard for the information exchange FunStep (ISO 10303-236) [11] focused on wood and furniture-related items. This means a common vocabulary and includes the most used concepts and properties in the furniture sector industry as well as its main relationships. This is implemented in OWL and it is based on the knowledge of AIDIMME from the experts as well as furniture cluster regulations, articles and interviews. The ontology covers the following main resources in the furniture industry: furniture products and services, manufacturing processes and techniques, industrial machines, equipment and facilities.

All the elements included in the ontology are annotated with labels in English and Spanish languages. These translations are consumed by the NIMBLE frontend to render all the categories and properties in the UI according to the language selected by the user. Furthermore, many concepts are annotated with RDF comments in both languages to make a clear description available to the users.

4.2. Logistics data model as an ontology extension

The data model for the representation of logistics services was preliminary defined based on graphical user interfaces provided by logistics experts. These mockups enabled the elicitation of service categories as well as its properties and a corresponding tentative rank of values for some of these properties. All these resources were integrated in the furniture sector ontology as an extension.

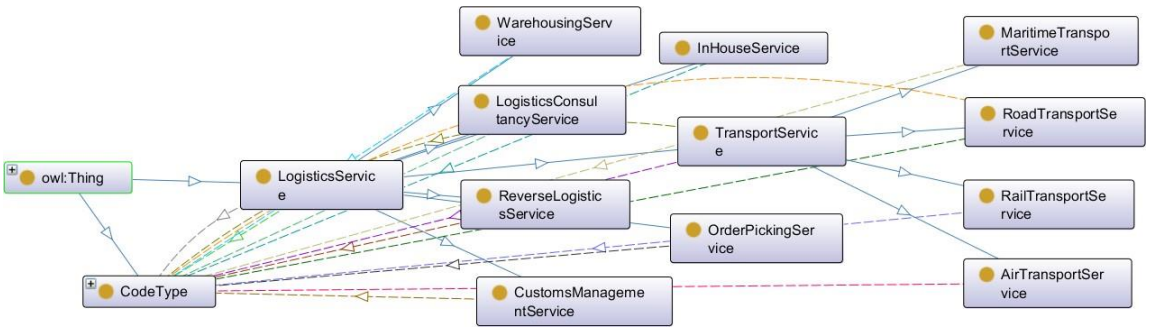

Figure 2: Detail of logistics services defined as an extension of the Furniture Sector Ontology

The picture above illustrates an excerpt of the categorization of logistics services in the furniture sector ontology. The value options available for each service class are represented as individuals through the CodeType property which is explained in the next section.

4.3. Integration with NIMBLE platform (ontology annotations)

In order to achieve a full compatibility between the properties defined in the ontology and the data model used by NIMBLE, additional annotations were included in the ontology. The ontology manages two main annotations for the NIMBLE integration: QuantityType (for the representation of measuring units for properties, such as dimensions or weight) and CodeType (for the representation of values for properties which do not have a numerical range).

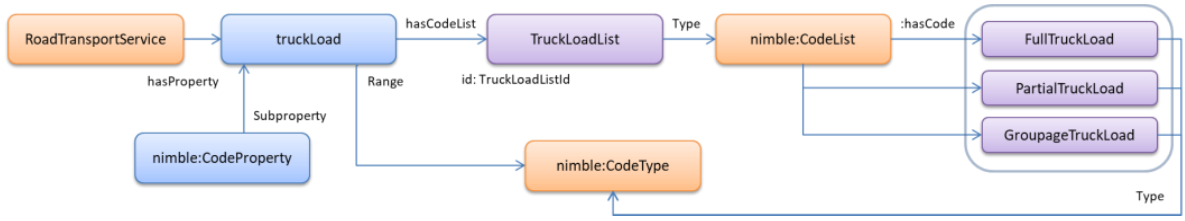

Figure 3: Detail of representation of property values of logistics services in the furniture sector ontology

Firstly, the specific items created for the integration of the logistics data model in NIMBLE should be noticed. They are *CodeProperty*, *CodeList* and *CodeType*, and its full identifier contains the NIMBLE prefix. *CodeProperty* is a property that accepts codes, while *CodeList* is used to define a collection of values that a property may take. Finally, *CodeType* represents the specific code of a value.

The representation of a truck load service can be taken as a short example. The *truckLoad* service is a subclass of *RoadTransportService* and is represented as an object property. This property may take three different values: *FullTruckLoad*, *PartialTruckLoad* and *GroupageTruckLoad*. These values are individuals which are wrapped into the property *TruckLoadList* which belongs to the type *CodeList*. Every element of the list is identified by its code and belongs to the type *CodeType*.

4.4. User interface for logistics publication

The preliminary mockups together with the formal data model were taken as reference to build a user-friendly frontend to enable the publication of comprehensive logistics services by specialized companies.

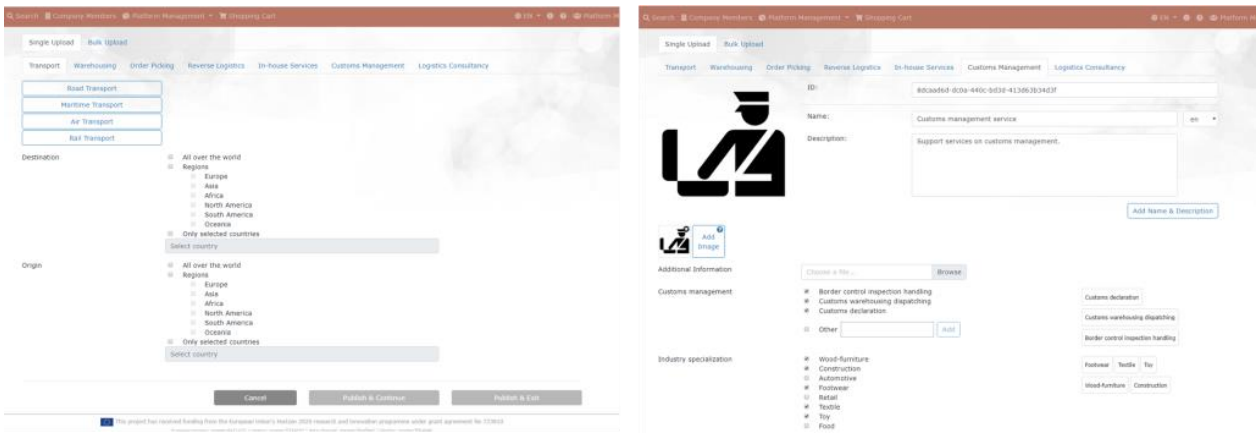

Figure 4: User interface implemented to represent logistics services in NIMBLE

The publication of logistics services is organized in seven tabs: transport (road, maritime, air and rail), warehousing, order picking, reverse logistics, in-house services, customs management and logistics consultancy. Each service allows a particular indication of the origin and destination

capabilities, as well as text descriptions and file attachments to clarify any aspect regarding the service provided by the company.

5. Results and lessons learnt

The new logistics services data model saves time in the publishing and negotiation services in the NIMBLE platform instance for furniture and related industries. Being more specific, these are the specific main benefits: (i) when a company offers global services, they can publish quickly some generic logistics services, and in a specific request or negotiation, they can specify more their conditions, (ii) the logistics companies who offer customized services can publish simple standard services without any complexity, but specify details later during the negotiation process, (iii) the meaning of the properties is clear enough for users, therefore the time needed to publish services is reduced and (iv) the number of properties is suitable for the most common logistics services in the furniture industry.

It can be stated that a formalized testing agenda based on open discussions, feedback from questionnaires and live experimentation with guidelines and technical support, is crucial to reveal undiscovered requirements.

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