An Ontology for Modelling Human Resources Management based on standards

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Abstract. Employment Services (ES) are becoming more and more important for Public Administrations where their social implications on sustainability, workforce mobility and equal opportunities play a fundamental strategic importance for any central or local Government. The EU SEEMP (Single European Employment Market-Place) project aims at improving facilitate workers mobility in Europe. Ontologies are used to model descriptions of job offers and curricula; and for facilitating the process of exchanging job offer data and CV data between ES. In this paper we present the methodological approach we followed for reusing existing human resources management standards in the SEEMP project, in order to build a common "language" called Reference Ontology.

Keywords: Human Resources Management Standard, Human Resources Ontologies.

1 Introduction

Nowadays there is an important amount of investment in human capital for economic development. Human resources management refers to the effective use of human resources in order to enhance organisational performance [8]. The human resources management function consists in tracking innumerable data points of each employee, from personal records (data, skills, capabilities) and experiences to payroll records [8]. Human resources management has discovered the Web as an effective communication channel. Although most businesses rely on recruiting channels such as newspaper advertisements, online job exchange services, trade fairs, co-worker recommendations and human resources advisors, online personnel marketing is increasingly used with cost cutting results and efficacy.

Employment Services are becoming more and more important for Public Administrations where their social implications on sustainability, workforce mobility and equal opportunities play a fundamental, strategic importance for any central or local Government. The goal of the SEEMP[1] (Single European Employment Market-Place) project is to design and implement an interoperability architecture for e-

[1] http://www.seemp.org/

Employment services which encompasses cross-governmental business and decisional processes, interoperability and reconciliation of local professional profiles and taxonomies, semantically enabled web services for distributed knowledge access and sharing. The resultant architecture will consist of: a Reference Ontology, the core component of the system, that acts as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting or a CV (Curriculum Vitae); a set of local ontologies, so that each ES (E-Employment Services) uses its own local ontology, which describes the employment market in its own terms; a set of mappings between each local ontology and the Reference Ontology; and a set of mappings between the ES schema sources and the local ontologies [4].

A major bottleneck towards e-Employment applications of Semantic Web technology and machine reasoning is the lack of industry-strength ontologies that go beyond academic prototypes. The design of such ontologies from scratch in a textbook-style ontology engineering process is in many cases unattractive for two reasons. First, it would require significant effort. Second, because the resulting ontologies could not build on top of existing community commitment. Since there are several human resources management standards, our goal is not to design human resources ontologies from scratch, but to reuse the most appropriate ones for e-Employment services developed on the framework of the SEEMP project. In this paper we present the methodological approach we followed for reusing existing human resources management standards such as NACE[2], ISCO-88 (COM)[2] and FOET[2], among others.

This paper is organized as follows: Firstly, some related works are briefly explained in section 2. Then, section 3 explains the adopted methodological approach to build the SEEMP Reference Ontology from standards and already existing ontologies. Next, section 4 describes the resultant SEEMP Reference Ontology. Finally, section 5 offers some final conclusions.

2 Related Work

Currently the Human Resource Semantic Web applications are still in an experimental phase, but their potential impact over social, economical and political issues is extremely significant. Bizer et al presents in [2] a scenario for supporting recruitment process with Semantic Web technologies but just within German Government. Mochol et al gives in [9] a brief overview of a Semantic Web application scenario in the Human Resources sector by way of describing the process of ontology development, but its final goal is to merge ontologies. In [3] it is described a competency model and a process dedicated to the management of the competencies underlying a resource related to e-recruitment (mainly CV or a Job Offer). L. Razmerita et al propose in [10] a generic ontology-based user modeling architecture, applied in the context of a Knowledge Management System. E. Biesalski et al explains in [1] some dependencies between Human Resources Management and Knowledge Management in a concrete scenario. Finally, there is an effort described in [1] whose mission is to promote semantic web technology into HR/e-learning

[2] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/

standards and applications. Its current focus topics includes: semantic interoperability, semantic of HR-XML[3], etc.

3 Methodological approach for Reusing Human Resources Management Standards

In this section we describe the adopted approach to build the SEEMP Reference Ontology. This methodological approach follows and extends some of the identified tasks of the ontology development methodology METHONTOLOGY [5]. This methodological approach consists of: specifying, using competency questions, the necessities that the ontology has to satisfy in the new application; selecting the standards and existing ontologies that cover most of the identified necessities; semantic enrichment of the chosen standard; and finally evaluating the ontology content. The steps of this methodology will be explained briefly below:

3.1 Specifying, using competency questions, the necessities that the ontology has to satisfy in the new application.

This activity states why the ontology is being built, what its intended users are, and who the end-users are. For specifying the ontology requirements we used the competency questions techniques proposed in [6]. These questions and their answers are both used to extract the main concepts and their properties, relations and formal axioms. We have identified sixty competency questions. From the competency questions, we extracted the terminology that will be formally represented in the ontology by means of concepts, attributes and relations. We have identified the terms and the objects in the universe of discourse (instances).

3.2 Selecting the standards and existing ontologies that cover most of the identified necessities.

In order to choose the most suitable human resources management standards for modeling CVs and job offers, the following aspects have been considered: *The degree of coverage of the objects identified in the previous task*, this aspect has been evaluated taking into account the scope and size of the standard. However, a too wide coverage may move us further away the European reality, therefore we have tried to find a tradeoff between this aspect and the following one: *the current european needs*, it is important that standard focuses on the current European reality, because the user partners involved in SEEMP are European, and the outcoming prototype will be validated in European scenarios; and the *user partners recommendations,* in order to asses the quality of the standards, the opinion of the user partners is crucial since they have a deep knowledge of the employment market.

[3] http://www.hr-xml.org

When specifying job offers and CVs, it is also necessary to refer to general purpose international codes such as country codes, currency codes, etc. For this aim, the chosen codes have been the ISO codes, enriched in some cases with user partners classification.

Finally, the representation of job offers and CVs also require temporal concepts such as interval or instant. So, in order to represent these concepts in the final Reference Ontology, the DAML time ontology[4] was chosen.

3.3 Semantic enrichment of the chosen standard.

This activity states how we enrich the human resources management standards, the time ontology, the currency classification, the geographic location classification and language classification. For that, all the concept taxonomies were verified; then, ad hoc relationships among concepts of different taxonomies were established; next, concept attributes for describing concept features needed were specified; and finally some formal axioms were defined.

3.4 Evaluating the Ontology content.

The evaluation activity makes a technical judgment of the ontology, of its associated software environments, and of the documentation. We will evaluate the Reference Ontology using the competency questions identified in the first task.

4 SEEMP Reference Ontology

The Reference Ontology described in this section will act as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting and the CV of a job seeker. The Reference Ontology was developed following the process described in detail in section 2 and with the ontology engineering tool WebODE [5]. The Reference Ontology is composed of thirteen modular ontologies: *Competence, Compensation, Driving License, Economic Activity, Education, Geography, Job Offer, Job Seeker, Labour Regulatory, Language, Occupation, Skill* and *Time*. Figure 1 presents:

- These thirteen modular ontologies (each ontology is represented by a triangle). Ten of them were obtained after wrapping the original format of the standard/classification, using *ad hoc* translator or wrapper for each standard/classification that transformed all the data stored in external resources into WebODE's knowledge model.
- The connections between the ontologies by means of *ad hoc* relationships. These relationships are defined between specific concepts inside these ontologies.

[4] http://cs.yale.edu/homes/dvm/daml/time-page.html

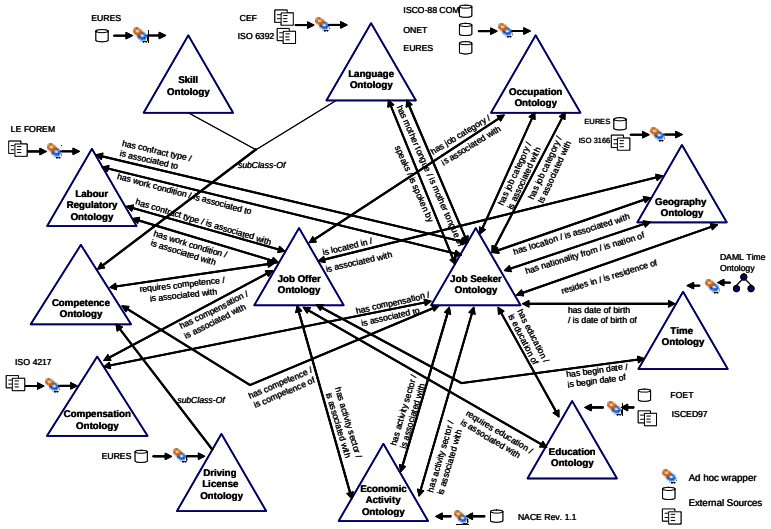

Fig. 1. Main ad-hoc relationships between the modular ontologies.

4.1 Wrapping human resources management standards

As it was mentioned before, these ontologies have been developed following existing human resources management standards and systems classifications, and they are:

- *Compensation Ontology* which is based on the ISO 4217[5]. The ISO 4217 is expressed in HTML format. It is a list of 254 currency names and codes. The resultant Compensation Ontology has 2 concepts: `Currency` and `Salary`. For every currency element specified in the ISO 4217 a different instance of the `Currency` concept is defined. So, the `Currency` concept has 254 instances. An example of instance of the `Currency` concept is `UNITED STATES - US Dollar`.
- *Driving License Ontology* which is based on the levels recognized by the European Legislation[6]. This classification is expressed in HTML format and it is a list of 12 kinds of driving licenses. The resultant Driving License Ontology just has the `Driving License` concept; and for every kind of driving license specified in the European Legislation a different instance of the `Driving License` concept is defined. An example of instance of the `Driving License` concept is `A1 - Light weight motorcycle.`
- *Economic Activity Ontology* is based on the NACE Rev. 1.1[7]. This standard is expressed in MS Access database format and it is a classification of 849 economic activities. The resultant Economic Activity Ontology has 849 concepts.

[5] http://www.iso.org/iso/en/prods-services/popstds/currencycodeslist.html
[6] http://ec.europa.eu/transport/home/drivinglicence/
[7] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/

In this case we have defined a concept for every element of the NACE taxonomy in order to preserve the hierarchy.

- *Occupation Ontology* is based on the ISCO-88 (COM)[8], ONET[9] and European Dynamics classification of occupations. ISCO-88 (COM) and ONET are expressed in MS Access database format; European Dynamics classification of occupations is stored in an ORACLE database table. ISCO-88 (COM) is a classification of 520 occupations; ONET is a classification of 1167 occupations and the European Dynamics classification has 84 occupations. The resultant Occupation Ontology has 609 concepts.
- *Education Ontology,* the education fields are based on the FOET[8] and the education levels are based on the ISCED97[8]; both of them are expressed in MS Access database format. FOET has 127 education fields and ISCED97 has 7 education levels. The resultant Education Ontology has 130 concepts. For the education levels we have defined the `Education Level` concept; and for every education level specified in ISCED97 a different instance of the `Education Level` concept is defined. For the education fields we have defined a concept for every element of the FOET taxonomy in order to preserve the hierarchy.
- *Geography Ontology* is based on the ISO 3166[10] country codes and the European Dynamics classifications: Continent and Region. The ISO 3166 is expressed in XML format; Continent and Region classifications are stored in ORACLE database tables. The ISO 3166 has 244 country codes and names; Region classification has 367 regions and Continent classification has 9 continents. The resultant Geography Ontology has four concepts, a `Location` as main concept, which is split into three subclasses: `Continent`, `Region` and `Country`. *Labour Regulatory Ontology* is based on the LE FOREM[11] classifications ContracTypes and WorkRuleTypes, both of them expressed in XML format. ContractTypes classification has ten contract types and WorkRuleTypes has 9 work rule types. The resultant Labour Regulatory Ontology has 2 concepts. For every type of work condition or contract type considered by LE FOREM, a different instance of one of these two concepts (`Contract Type` or `Work Condition`) is included in the ontology. An example of instance of the `Contract Type` concept is `Autonomous`. An example of instance of the `Work Condition` concept is `Partial time`.
- *Language Ontology* is based on the ISO 6392[12] and the Common European Framework of Reference (CEF)[13]. The ISO 6392 is expressed in HTML format and CEF is a description in PDF format. The ISO 6392 has 490 language codes and CEF has 6 language levels. The resultant Language Ontology has 3 concepts: `Language`, `Language Level` and `Language Proficiency`. For every language element specified in the ISO 6392 a different instance of the

[8] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/
[9] http://online.onetcenter.org/
[10] http://www.iso.org/iso/en/prods-services/iso3166ma/index.html
[11] LE FOREM is an user partner of the SEEMP project, http://www.leforem.be/
[12] http://www.iso.org/iso/en/prods-services/popstds/languagecodes.html
[13] http://www.cambridgeesol.org/exams/cef.htm

`Language` concept is defined, so the `Language` concept has 490 instances. For every language level element specified in the CEF a different instance of the `Language Level` concept is defined, so the `Language Level` concept has 6 instances. An example of instance of the `Language` concept is `eng – English`. An example of instance of the `Language Level` concept is `A2 – Basic User`.

- *Skill Ontology* is based on European Dynamics Skill classification. This classification has 291 skills and it is stored in an ORACLE database table. The resultant Skill Ontology has 2 concepts: `Skill` concept with its subclass `ICT Skill`. For every skill element specified in the European Dynamic classification a different instance of the `ICT Skill` concept is defined. An example of instance of the `ICT Skill` concept is `Hardware programming.`
- *Competence Ontology* defines a concept called Competence as a superclass of the imported concepts `Skill`, `Language Proficiency` and `Driving License`.
- *Time Ontology* is based on DAML ontology[14] and it is expressed in OWL format.

In order to make possible the enrichment of the standards/classifications, it was necessary to import them into the ontology engineering tool WebODE [5]. This process consisted in implementing the necessary conversions mechanisms for transforming the standards/classifications into WebODE's knowledge model.

4.2 Enriching the ontologies

Once we transformed the standards/classifications into ontologies, the next step is to enrich them introducing concept attributes and *ad hoc* relationships between ontology concepts of the same or different taxonomies. We perform this task by doing the following

- We created from scratch the Job Seeker Ontology and the Job Offer Ontology, which models the job seeker and his/her CV information, and the job offer and employer information, respectively.
- We defined relationships between the concepts of the Job Seeker and Job Offer Ontologies and the concepts defined on the standard (classification) based ontologies.

5 Conclusions

In this paper we have presented the methodological approach we followed for reusing existing human resources management standards in the SEEMP Project. We also described the resultant Reference Ontology which acts as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting and

[14] http://cs.yale.edu/homes/dvm/daml/time-page.html

the CV of a job seeker. The Reference Ontology was developed with the proposed methodology and with the ontology engineering tool WebODE.

An important conclusion of the work that we have carried out is that we can reuse human resource management standards in new applications following a systematic approach. Moreover, it is clear such a reuse can save time during the development of the whole system. However, it is not always possible to reuse a standard in a straightforward way, because sometimes the ideal standard does not exist for different reasons (different scope, outdated, etc.), and it is necessary to extend some "imperfect" standard with additional terminology coming from other standards or *ad hoc* classifications.

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