Reusing Human Resources Management Standards for Employment Services

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Abstract. Employment Services (ESs) 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 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 [13]. 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 [13]. 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 (ESs) 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 public e-Employment services which encompasses cross-governmental business and decisional

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

processes, interoperability and reconciliation of local professional profiles and taxonomies, semantically enabled web services for distributed knowledge access and sharing. The SEEMP project relies on WSMO [4] that permits to semantically describe Web Services, ontologies and mediators. WSML [3] is the concrete language used in SEEMP for encoding those descriptions. For this purpose, 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 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 [5].

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 public 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 like NACE[2] (Statistical Classification of Economic Activities in the European Community), ISCO-88 (COM)[2] (International Standard Classification of Occupations, for European Union purposes) and FOET[2] (Classification of fields of education and training), among others.

This paper is organized as follows: Section 2 presents some related work. Next section 3 explains the adopted methodological approach to build the SEEMP Reference Ontology from standards/classifications and already existing ontologies, and then in section 4 an overall perspective of the resultant SEEMP Reference Ontology is shown. Then section 5 describes some considerations with respect to the building process of the local ontologies taking as starting point the Reference Ontology and the ES data sources. Finally, section 6 offers some final conclusions, and poses the future work that, among other things, will serve to validate the ideas proposed in this paper.

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.

COKE is described in [9], a three-level ontology containing a top-level Human Resources ontology, a middle-level Business Process ontology and a lower-level Knowledge Objects ontology. PROTON (PROTO-Ontology), a 4-level ontology

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

which specializes in coverage of concrete and/or named entities (i.e. people, organizations, numbers) and is used for HR applications [10]. Bizer et al present in [1] a scenario for supporting recruitment process with Semantic Web technologies but just within German Government. Mochol et al depict in [15] 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 [2] 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).

Regarding main standardization initiatives in the HR sector, the HR-XML consortium has built up a library of more than 75 interdependent XML schemas which define the data elements for particular HR transactions, as well as options and constraints governing the use of those elements [11].

Finally there is an effort described in [12] which mission is to promote technology into HR/e- learning standards and applications. Its current focus topics includes: semantic interoperability, semantic of HR-XML[11], etc.

3 Methodological approach for Reusing Human Resources Management Standards

In this section we describe the adopted approach to build the SEEMP Reference Ontology; a preliminary version is described in [7]. This methodological approach follows and extends some of the identified tasks of the ontology development methodology METHONTOLOGY [6]; this methodological approach consists of:

1. Ontology specification; in this activity we specify, using competency questions, the necessities that the ontology has to satisfy in the new application.
2. Standards selection; in this activity we select the standards and existing ontologies that cover most of the identified necessities.
3. Semantic enrichment of the chosen standard; this activity states how we enrich semantically the chosen standard.
4. Ontology evaluation; in this activity we evaluate the ontology content.

3.1 Ontology specification.

This activity states why the ontology is being built, what its intended uses are, and who the end-users are. For specifying the ontology requirements we used the competency questions techniques proposed in [8].

- *Intended uses of the ontology*. The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that could be used by ESs, more specifically within the ICT (Information and Communication Technology) domain.
- *Intended users of the ontology*. We have identified the following intended users of the ontology: candidates, employers, public or private employment search

service, national and local governments; and European commission and the governments of EU countries.

- *Competency Questions*. These questions and their answers are both used to extract the main concepts and their properties, relations and formal axioms of the ontology. We have identified sixty competency questions; they are described in detail in [14]. An example of the competency questions is: *Given the personal information (name, nationality, birth date, contact information) and the objectives (desired contract type, desired job, desired working conditions, desired salary) of the job seeker, what job offers are the most appropriate?.*
- *Terminology*. 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 (also known as predicates) and the objects in the universe of discourse (instances); they are described in detail in [14].

3.2 Standards selection.

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 from the European context; 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 out coming 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.

Besides, when choosing the standards, we also took into account that the user partners of SEEMP selected the ICT domain for the prototype to be developed in SEEMP. Hence, the chosen standards should cover the ICT domain with an acceptable degree. In the case of the occupation taxonomy, as it will be shown, we have chosen one standard, but then we have taken some concepts coming from other classifications, in order to obtain a richer classification for the ICT domain.

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[3] was chosen.

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

3.3 Semantic enrichment of the chosen standard.

This activity states how we enrich the human resources management standards. In order to make possible the enrichment of the standards, it was necessary to import them into the ontology engineering tool WebODE [6]. This process consists of implementing the necessary conversions mechanisms for transforming the standards into WebODE's knowledge model. For this purpose we have developed for each standard/classification an *ad hoc* translator (wrapper) that transformed all the data stored in external resources into WebODE's knowledge model.

Once we transformed the standards 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, doing the following. We created from scratch the Job Seeker Ontology (models the job seeker and his/her CV information), and the Job Offer Ontology (models the job vacancy, job offer and employer information); following some HR-XML[11] recommendations. Moreover, we defined relationships between the concepts of the Job Seeker and Job Offer Ontologies and the concepts defined on the standard (classification) based ontology.

3.4 Ontology Evaluation.

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[4], 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 3 and with the ontology engineering tool WebODE [6]. 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*. The main subontologies are the Job Offer and Job Seeker, which are intended to represent the structure of a job posting and a CV respectively. While these two subontologies were built taking as a starting point some HR-XML [11] recommendations, the other subontologies were derived from the available international standards (like NACE, ISCO-88 (COM), FOET, etc.) and ES classifications and international codes (like ISO 3166, ISO 6392, etc.) that best fit the European requirements. 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

[4] The Reference Ontology is available at: http://droz.dia.fi.upm.es/seemp/ (Username: seemp and password: employer)

standard/classification, using *ad hoc* translator or wrapper for each standard/classification.

- The connections between the ontologies by means of *ad hoc* relationships.

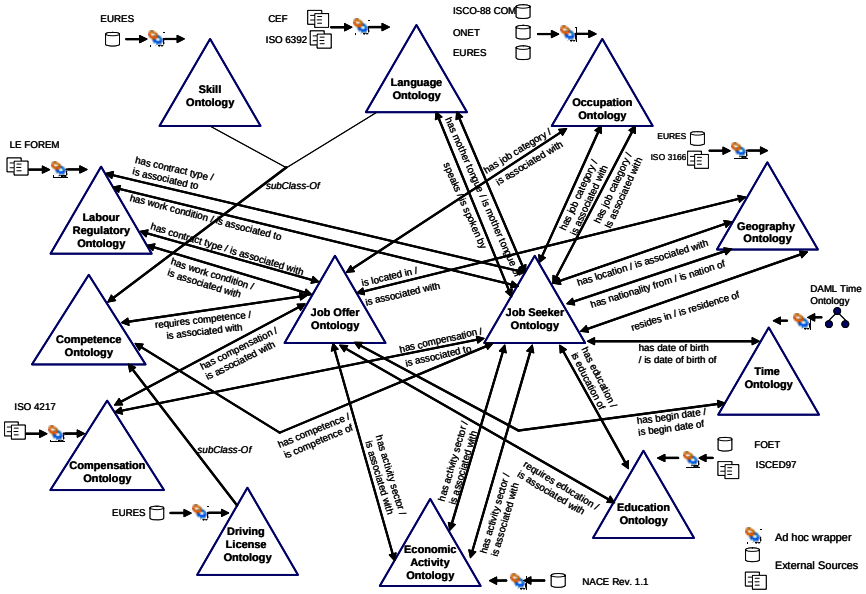

Fig. 1. Main ad-hoc relationships between the modular ontologies.

Next we provide the conceptualization of the mentioned ontologies.

- *Job Seeker Ontology*. This ontology models knowledge of job seeker and CV information used in the SEEMP Project. The Job Seeker Ontology imports concepts from the education ontology, language ontology, economic activity ontology, compensation ontology, geography ontology, driving license ontology, labour regulatory ontology and skill ontology, and these imported concepts are used to connect the Job Seeker Ontology with the other ontologies. **Error! Reference source not found.** shows all the *ad hoc* relationships whose domain is a concept belonging to the Job Seeker Ontology (concepts of the Job Seeker Ontology are drawn in yellow). Examples of the relationships can be: '`Job Seeker` *has driving license* `Driving License`' (with the `Driving License` concept from the Driving License Ontology), '`Job Seeker` *has education* `Education`' (with the `Education` concept from the Education Ontology), '`Job Seeker` *has mother tongue* `Language`' (with the `Language` concept from the Language Ontology), etc.
- *Job Offer Ontology*. This ontology models knowledge of job vacancy, employer and job offer information used in the SEEMP Project. The Job Offer Ontology imports concepts from the education ontology, language ontology, economic activity ontology, compensation ontology, geography ontology, driving license ontology, labour regulatory ontology and skill ontology, and these imported concepts are used to connect the Job Offer Ontology with the other ontologies.

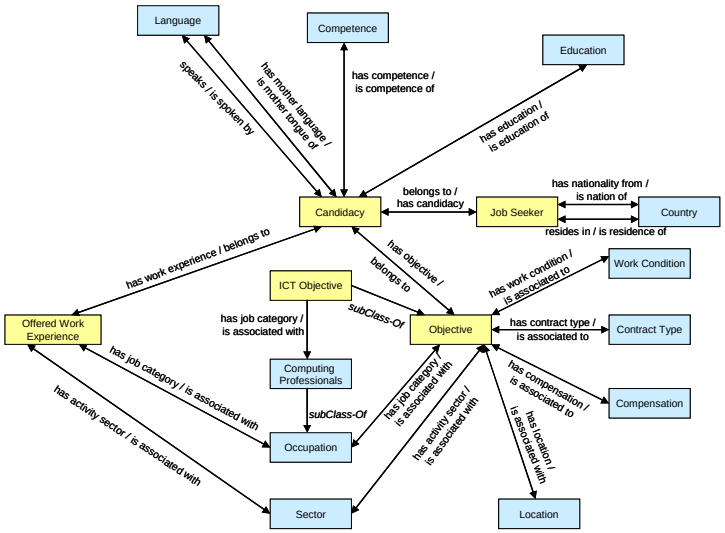

Fig. 2. The ad-hoc relationships of the Job Seeker Ontology

Figure 3 shows all the *ad hoc* relationships whose domain is a concept belonging to the Job Offer Ontology (concepts of the Job Seeker Ontology are drawn in green). Examples of the relationships can be: '`Job Vacancy` *requires driving license* `Driving License`' (with the `Driving License` concept from the Driving License Ontology), etc.

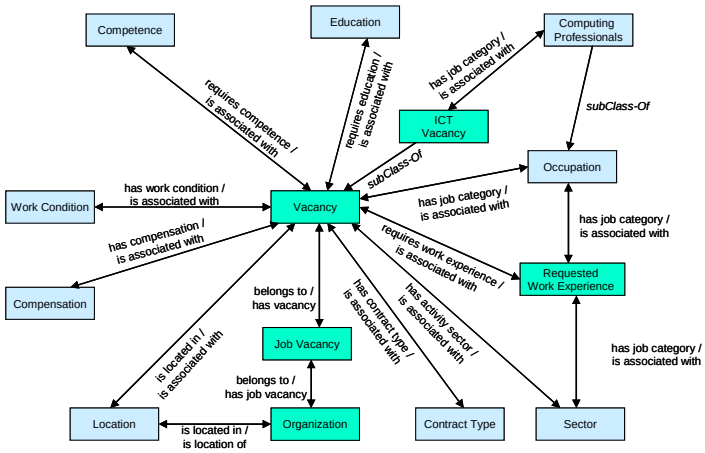

Fig. 3. The ad-hoc relationships of the Job Offer Ontology

- *Compensation Ontology.* This ontology models knowledge of wages and salaries used in the SEEMP Project. It 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

[5] http://www.iso.org/iso/en/prods-services/popstds/currencycodeslist.html

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 instance of the `Currency` concept is `UNITED STATES - US Dollar`. The *ad hoc* relations defined in this ontology are *has currency* between the `Salary` and `Currency` concepts, and its inverse one.

- *Driving License Ontology.* This ontology models knowledge of Driving License domain. It 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 instance of the `Driving License` concept is `A1 - Light weight motorcycle.` The `Driving License` concept has two relations: '`Driving License` *is associated with* `Job Vacancy`' (with the `Job Vacancy` concept from the Job Offer Ontology) and '`Driving License` *is driving license of* `Job Seeker`' (with the `Job Seeker` concept from the Job Seeker Ontology).
- *Economic Activity Ontology.* This ontology models knowledge of economic activities and sectors. It 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. In this case we have defined a concept for every element of the NACE taxonomy in order to preserve the hierarchy. In the Economic Activity Ontology, the most general concept is the `Activity` concept. This concept is organized in the taxonomy based on the NACE. The `Activity` concept has four relations: '`Activity` *is associated with* `Objective`' (with the `Objective` concept from Job Seeker Ontology), '`Activity` *is associated with* `Offered Work Experience`' (with the `Offered Work Experience` concept from Job Seeker Ontology), '`Activity` *is associated with* `Job Vacancy`' (with the `Job Vacancy` concept from Job Offer Ontology) and '`Activity` *is associated with* `Requested Work Experience`' (with the `Requested Work Experience` concept from Job Offer Ontology).
- *Occupation Ontology.* This ontology models knowledge of occupations and job categories. It is based on the ISCO-88 (COM)[8], ONET[8] 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. For this ontology we have extended manually the ISCO-88 (COM) classification with European Dynamics and ONET classifications for ICT

[6] http://ec.europa.eu/transport/home/drivinglicence/

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

[8] http://online.onetcenter.org/

occupations. In this case we have defined a concept for every element of the resulting extended taxonomy in order to preserve the hierarchy. This ontology defines a concept taxonomy based on the aforementioned standards, in which the most general concept is the `Occupation` concept. The `Occupation` concept has four binary relations: '`Occupation` *is associated with* `Objective`' (with the `Objective` concept from the Job Seeker Ontology), '`Occupation` *is associated with* `Offered Work Experience`' (with the `Offered Work Experience` concept from the Job Seeker Ontology), '`Occupation` *is associated with* `Job Vacancy`' (with the `Job Vacancy` concept from the Job Offer Ontology) and '`Occupation` *is associated with* `Requested Work Experience`' (with the `Requested Work Experience` concept from the Job Offer Ontology).

- *Education Ontology*. This ontology models knowledge of education level and education fields. The education fields are based on the FOET[9] and the education levels are based on the ISCED97[10] (International Standard Classification of Education); 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. The concept `Education` has four binary relations: '`Education` *has education level* `Education Level`', '`Education` *has education field* `Education Field`', '`Education` *is associated with* `Job Vacancy`' (with the `Job Vacancy` concept from the Job Offer Ontology) and '`Education` *is education of* `Job Seeker`' (with the `Job Seeker` concept from the Job Seeker Ontology).
- *Geography Ontology.* This 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. 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`. For every country element specified in the ISO 3166 a different instance of the `Country` concept is defined, so the `Country` concept has 244 instances. For every region element specified in the Region classification a different instance of the `Region` concept is defined, so the `Region` concept has 367 regions. Finally for every continent element specified in the Continent classification a different instance of the `Continent` concept is defined. An example instance of the `Continent` concept is `EU – Europe`. An example instance of the `Country` concept is `SPAIN – ES`. An example instance of the `Region` concept is

[9] Available through RAMON Eurostat's Classifications Server at http://ec.europa.eu/comm/eurostat/ramon/
[10] http://www.iso.org/iso/en/prods-services/iso3166ma/index.html

Galicia. The Country concept has four binary relations: 'Country *is nation of* Job Seeker' (with the Job Seeker concept from the Job Seeker Ontology), 'Country *is residence of* Job Seeker' (with the Job Seeker concept from the Job Seeker Ontology), 'Country *is located in* Continent' and 'Country *has region* Region'.

- *Labour Regulatory Ontology.* This 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 instance of the Contract Type concept is Autonomous. An example instance of the Work Condition concept is Partial time. The Work Condition concept has 2 binary relations: 'Work Condition *is associated to* Objective' (with the Objective concept from the Job Seeker Ontology) and 'Work Condition *is associated with* Job Vacancy' (with the Job Vacancy concept from the Job Offer Ontology). The Contract Type concept has two binary relations: 'Contract Type *is associated to* Objective' (with the Objective concept from the Job Seeker Ontology) and 'Contract Type *is associated with* Job Vacancy' (with the Job Vacancy concept from the Job Offer Ontology).
- *Language Ontology.* This 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 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 instance of the Language concept is eng – English. An example instance of the Language Level concept is A2 – Basic User. The Language concept has three relations: 'Language *is mother tongue of* Job Seeker' (with the Job Seeker concept from the Job Seeker Ontology), 'Language *is spoken by* Job Seeker' (with the Job Seeker concept from the Job Seeker Ontology) and 'Language *is evaluated by* Language Proficiency' (with the Language Proficiency concept from the Language Ontology).
- *Skill Ontology*. This ontology models knowledge of Skills and abilities. It is based on European Dynamics Skill classification. This classification has 291 skills and

[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

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 instance of the `ICT Skill` concept is `Hardware programming.` The `Skill` concept has two relations: '`Skill` *is associated with* `Job Vacancy`' (with the `Job Vacancy` concept from the Job Offer Ontology) and '`Skill` *is skill of* `Job Seeker`' (with the `Job Seeker` concept from the Job Seeker Ontology).

- *Competence Ontology*. This ontology defines a concept called `Competence` as a super class of the imported concepts `Skill`, `Language Proficiency` and `Driving License`. The `Competence` concept has three binary relations: '`Competence` *is associated with* `Vacancy`' (with the `Vacancy` concept from the Job Offer Ontology); '`Competence` *is competence of* `Candidacy`' (with the `Candidacy` concept from the Job Seeker Ontology) and '`Competence` *requires* `Education`' (with the `Education` concept from the Education Ontology).
- *Time Ontology.* This ontology is based on DAML ontology[14] and it is expressed in OWL format. The main concepts of this ontology are `Instant` and `Interval`, which are subclasses of `Temporal Entity`. `Instant` is linked to `Interval` through the properties of `begins`, `ends`, `inside` and `begins or in`. `Instant` is also linked to an instant temporal description, which is a concept with the properties of `second`, `minute`, `hour`, `day`, `month`, `year` and `time zone`. `Interval` has the subclass `proper interval`, which is related with itself through the relations '*interval equals*', '*interval before*', '*interval starts or finishes*', etc. Proper intervals can be concatenated through the relation '*concatenation*'.

Finally we present the Reference Ontology statistics. The Reference Ontology is composed of thirteen modular ontologies. The Reference Ontology has 1609 concepts, 6727 class attributes, 60 instance attributes, 94 *ad hoc* relationships, 1674 instances and 20 axioms.

5 Local ontologies building process

In this section we provide some guidelines for the building process of the local ontologies, each ES uses its own Local Ontology, which describes the employment market in its own terms. Based on the proposed SEEMP architecture, the possible options for building the local ontologies are: building local ontologies from the RO, and building local ontologies as a reverse engineering process from ES schema sources. Next, these options will be explained.

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

5.1 Building local ontologies from the Reference Ontology

The building process is structured/guided by the architecture of the Reference Ontology and scoped with applications needs. In this sense, we will need to extend some already defined elements, to remove unnecessary elements, or to add new application dependent elements that appear in each ES schema source. The result of this should be a RO friendly "local" ontology. Thanks to this similarity, mappings between local ontologies and RO will not be complex. But on the other hand, mappings between local ontologies and ES schema sources will be complex. Regarding the evolution and change propagation dimension we have:

- Changes in the RO imply a change in the mappings between local and RO as well as probably changes in the mappings between the local ontologies and the ES schema sources.
- Changes in the RO imply a change in the local ontology; in this case, the mappings RO – local ontology would remain as they were. The mappings between the local ontologies and the ES schema sources should be updated.
- Changes in the ES schema sources imply changes in its local ontology (probably the part that is not a mirror of the RO) and the mappings between local ontologies and ES schema sources, and probably minor changes in the mappings between local ontology and the RO. This last consequence is especially interesting because the changes in the ES schema sources will be the most frequent in the scenario posed by SEEMP.

5.2 Building local ontologies as a reverse engineering process from the ES schema sources

In this case, mappings between local ontologies and schema resources should not be complex. On the other hand, complex mappings will appear between the Local and RO. The building process requires more sophistication of knowledge engineering and good acquaintance of all the data and their structures of the application: not easily found skill set in ES or any other operational/research organizations. Regarding the evolution and change propagation dimension we have:

- Changes in the ES schema sources imply a change in the local ontologies and, consequently, in mappings between sources and local ontologies, but not necessarily in mappings between local and the RO.
- Changes in the RO imply changes in the mappings between local ontologies and the RO, but it is not necessary to modify anything at the ES level.

5.3 Approach followed by SEEMP

In SEEMP project we adopt a different option depending on the part of the local ontology to be built. On one hand, we select option 1 (building local ontologies from the RO) for Job Seeker and Job Offer ontologies and other general purpose ontologies like, for example, the Time Ontology. On the other hand, we select option 2 (building local ontologies as a reverse engineering process from ES schema resources) for Occupation, Education, Economic Activity, Language, Compensation, Labour Regulatory, Skill and Driving License ontologies.

The reason of selecting option 1 for Job Seeker and Job Offer ontologies is because there are not significant differences between these ontologies and the way how each ES structures job seeker and job offer information. Consequently mappings between local ontologies and RO will be simple, but mappings between local ontologies and ES schema sources will be complex. Furthermore, for the job seeker and job offer information local ontologies will share the same vocabulary (see [16]).

The reason of selecting option 2 for the ontologies mentioned above is because each ES may have its own classification systems for the related information. Nevertheless, it may happen that the local ontology shares some classification with the RO (as there will happen in the European scope with the driving license classification). In that case, the reverse engineering process for that classification will be skipped, and that part of the RO will be reused. By using option 2, mappings between local ontologies and RO will be complex, but mappings between local ontologies and ES schema sources will be simple.

6 Conclusions and Future Work

In this paper we have presented the methodological approach we followed for reusing existing human resources management standards/classifications in the SEEMP Project. We also described the resultant RO which acts 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 RO was developed with the proposed methodology and with the ontology engineering tool WebODE. Finally we have provided some guidelines for the building process of the local ontologies, and we conclude that the best option for building the local ontologies is building them following a hybrid approach that employs the best option for each part of the RO.

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. As future work, we will complete the development of the local ontologies for the SEEMP project. This work allows us to confirm that proposed systematic approach not only supports the creation of a RO from

standards/classifications properly, but it also facilitates the creation of the local ontologies related to this RO, since the building process of these local ontologies can take advantage of the already existing RO.

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