

## D31 – SEEMP Platform Specification

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## 1.1 Reference Ontology (UPM)

As it was mentioned before, the main objective of SEEMP is to develop an interoperable architecture for public e-Employment services. 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; a set of *Local Ontologies*, each PES uses its own Local Ontology, which describes the employment market in its own terms; and a set of *mappings* between each Local Ontology and the Reference Ontology.

In this section we describe the adopted approach to build the Reference Ontology. We utilize some of the existing human resources management standards described in detail in section 2.2 of the SEEMP deliverable D2.1 “Semantic and Technical Aspects in e-Gov Software Development”. We will follow some of the identified tasks of the ontology development methodology METHONTOLOGY [Gómez-Pérez et al 2003]. The building process consists of:

- Specifying, using competency questions, the necessities that the ontology has to satisfy in the new application.
- Selecting the standards that cover most of the identified necessities.
- Semantic enrichment of the chosen standard.
- Evaluating the Ontology content
- Integrating the resultant ontology in the SEEMP platform.

### 1.1.1 Specifying, using competency questions, the necessities that the ontology has to satisfy in the application.

The specification 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 will use the competency questions techniques proposed in [Grüninger et al 1995]. Before identifying them, we will identify the intended uses of the ontology and their users.

#### Intended uses of the ontology

The development of the Reference Ontology is motivated by scenarios related to the application that will use the ontology. Such scenarios describe a set of the ontology's requirements that the ontology should satisfy after being formally implemented. The motivating scenarios are described in the SEEMP deliverable D1.1 “User Requirement Definition”. In summary, the purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that could be used by PESs, more specifically within the ICT (Information and Communication Technology) domain.

#### Intended users of the ontology

As it was mentioned before, the Reference Ontology will be the core component of the SEEMP platform; the peers on the SEEMP interoperate with each other from their local ontologies via the Reference Ontology. The analysis of the motivating scenarios described in the SEEMP deliverable D1.1 “User Requirement Definition”, allowed us to identify the following intended user of the ontology:

- U1. Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes.
- U2. Employer who needs more human resources.
- U3. Public or private employment search service which offers services to gather CVs to job postings and to prepare some data and statistics.
- U4. National and Local Governments which want to analyze the situation on the employment market in their countries and prepare documents on employment, social and educational policy.
- U5. European Commission and the governments of EU countries which want to analyze the statistics and prepare international agreements and documents on the employment, social and educational policy.

### Competency Questions

Competency questions are natural language questions used to determine the scope of the ontology to be built. These questions and their answers are both used to extract the main concepts and their properties, relations and formal axioms of the ontology. The competency questions play the role of a type of requirement specification against which the ontology can be evaluated. Specific competency questions can be composed into more general questions that are answered by composing answers associated to the specific competency questions.

The analysis of the SEEMP deliverable D1.1 "User Requirement Definition", allowed us to identify the following competency questions. The sixty competency questions have been grouped into four groups: job seeker, job offer, date management and currencies.

Specific competency questions related to the job seeker are:

- CQ1. What is his/her name?
- CQ2. What is his/her nationality?
- CQ3. What is his/her birth date?
- CQ4. What is his/her contact information?
- CQ5. What is his/her current job?
- CQ6. What is his/her desired job?
- CQ7. What are his/her desired working conditions?
- CQ8. What kind of contract does he/she want?
- CQ9. How much salary does he/she want to earn?
- CQ10. What is his/her education level?
- CQ11. What is his/her work experience?
- CQ12. What is his/her knowledge?
- CQ13. What is his/her expertise?
- CQ14. What are his/her skills?
- CQ15. What publications does he/she have?
- CQ16. What hobbies does he/she have?

Specific competency questions related to the job offer:

- CQ17. What is the employer information?
- CQ18. What kind of job does the employer offer?
- CQ19. What kind of contract does the employer offer?
- CQ20. How much salary does the employer offer?
- CQ21. What is the economic activity of the employer?
- CQ22. What is the description of the job offer?
- CQ23. What is the work condition of the job offer?
- CQ24. What is the required education level for the job offer?
- CQ25. What is the required work experience for the job offer?
- CQ26. What is the required knowledge for the job offer?
- CQ27. What are the required skills for the job offer?

Specific Competency questions related to date management:

- CQ28. When the job seeker completed his/her first degree?
- CQ29. Is the job seeker older than 30 years?
- CQ30. How much time did the job seeker spend completing his/her first degree?
- CQ31. How long is the duration of the contract?
- CQ32. Which job offers were posted in last 24 hours?
- CQ33. Which job offers were posted in last 7 days?
- CQ34. Which job offers were posted in last month?

Specific Competency questions related to currencies:

- CQ35. Is the job offer's salary greater than 14000 zlotos?
- CQ36. Is the job offer's salary lower than 25000 kroner?
- CQ37. The offered salary is given in US dollars?
- CQ38. The offered salary is given in Euros?

Competency questions in each group and between groups could be composed into more general questions. The following non-exhaustive list presents some examples.

Composed competency questions that use job seeker's information for obtaining a job offer:

- CQ39. 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?
- CQ40. Given the personal information (name, nationality, birth date, contact information) and the profile (current job, education level, work experience, knowledge, expertise, skill) of the job seeker what job offers are the most appropriate?

CQ41. Given the objectives (desired contract type, desired job, desired working conditions, desired salary) and the profile (current job, education level, work experience, knowledge, expertise, skills) of the job seeker, what job offers are the most appropriate?

CQ42. Given the personal information (name, nationality, birth date, contact information), the profile (current job, education level, work experience, knowledge, expertise, skill) and the objectives (desired contract type, desired job, desired working conditions, desired salary) of the job seeker, what job offers are the most appropriate?

Composed competency questions that use job offer's information for obtaining a job seeker:

CQ43. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary, work condition), what job seekers are the most appropriate?

CQ44. Given the employer information, economic activity of the employer and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?

CQ45. Given the job offer profile (job, contract type, salary, work condition) and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?

CQ46. Given the employer information, economic activity of the employer, job offer profile (job, contract type, salary, work condition) and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?

Composed competency questions related to date management:

CQ47. When the job seeker completed his/her first degree and how much time did he/she spend completing his/her first degree?

CQ48. When the job seeker completed his/her first degree and is he/she older than 30 years?

CQ49. Is the job seeker older than 30 years and how much time did he/she spend completing his/her first degree?

CQ50. Which job offers were posted in last 24 hours and how long is the duration of their contracts?

CQ51. Which job offers were posted in last 7 days and how long is the duration of their contracts?

CQ52. Which job offers were posted in last month and how long is the duration of their contracts?

Composed competency questions related to currencies:

CQ53. Is the job offer's salary greater than 14000 zlotes and could it be given in US dollars?

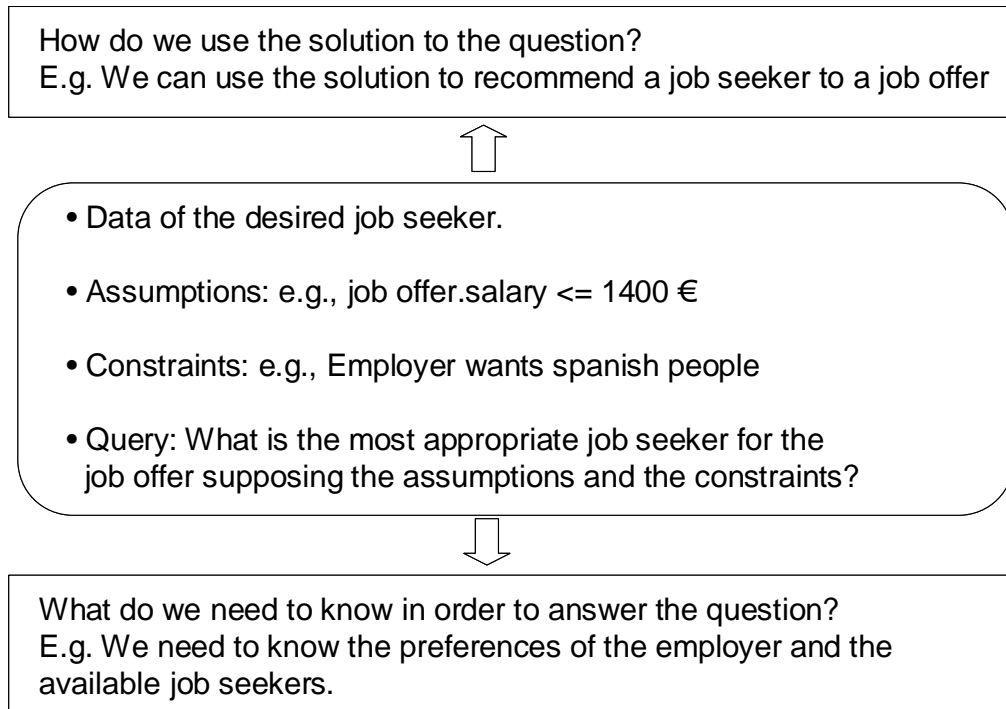
CQ54. Is the job offer's salary lower than 25000 kroner and could it be given in Euros?

Composed competency questions related to job offer, job seeker, currencies and date management:

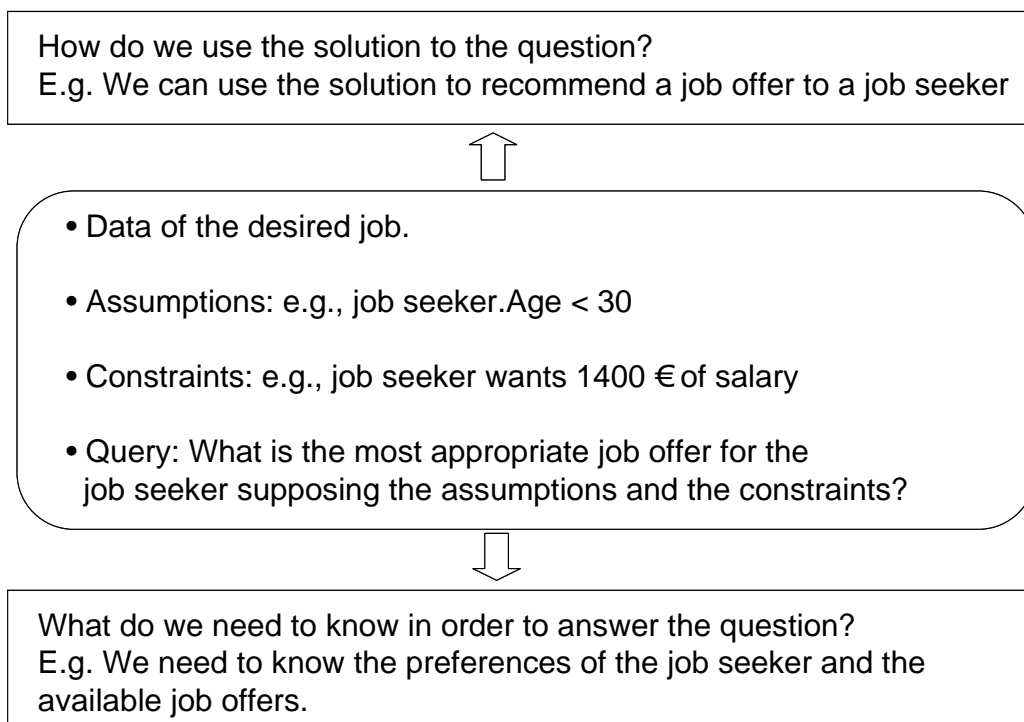
- CQ55. Given the age (30 years old) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers are the most appropriate?
- CQ56. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary, work condition, contract duration), what job seekers are the most appropriate?
- CQ57. Given the age (20 years old) and the desired salary (equal or greater than 14000 zlotos) of the job seeker, what job offers posted in last month are the most appropriate?
- CQ58. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary of 3400 €, work condition, contract duration), what job seekers are the most appropriate?
- CQ59. Given the time spend for his/her degree (8 years) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers posted in last 7 days are the most appropriate?
- CQ60. Given the time spend for his/her degree (8 years) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers posted in last 24 hours are the most appropriate?

As we mentioned before, each competency question is useful as a base for obtaining assumptions, constraints, the necessary input data, etc. Figure 4-3 shows the assumption: job offer's salary is equal or lower than 1400 €, the constraint: the employer wants Spanish people and the necessary input data for the competency question related to the job offer. Figure 4-4 shows the assumption: job seeker's age is lesser than 30 years, the constraint: the job seeker wants 1400 € of salary and the necessary input data for the competency question related to the job seeker.





**Figure 4-3 An example of a competency question (related to the job offer)**



**Figure 4-4 An example of a competency question (related to the job seeker)**

## Terminology

From the competency questions, we extract the terminology that will be formally represented in the ontology by means of concepts, attributes and relations. We have to identify the terms (also known as predicates) and the objects in the universe of discourse (instances).

### *Identifying Term*

They are used for representing concepts, attributes and relations. We have grouped them into groups: job seeker and job offer, date and currency.

Terms related to the job seeker:

Job seeker

CV

Personal Information

- Name
- Gender
- Birth date
- Address
- Nationality
- Contact (phone, fax, mail)
- Objective
  - Job category
  - Activity sector
  - Location
  - Work condition
  - Contract type
  - Salary
- Education and training
- Work Experience
- Competencies
  - Knowledge
  - Abilities (social, organizational, technical, linguistic, driving)
  - Skills
- Publication
- Hobbies
- References

Terms related to the job offer:

## Job Offer

### Employer information

- Name
- Address
- Contact
- Job to offer
  - Job category
  - Activity sector
  - Location
  - Work condition
  - Contract type
  - Work permits
  - Salary
- Candidate profile to seek for
  - Education
  - Work experience
  - Personality
  - Skills
  - Languages

### Terms related to the date:

Year

Month

Day

Hour

Time point

### Terms related to currency:

Money

Amount

### *Identifying objects in the universe of discourse*

Table 4-1 and Table 4-2 show some examples of objects, which are instances of Nationality, Job Category, Activity Sector, Location (Geographic Location), Education, Gender, Languages, Contract Type, Work Condition and Currency. These objects will be used for selecting the standards to be used for building the SEEMP Reference Ontology.

**Table 0-1 Objects in the universe of discourse**

<b>Nationality</b>	<b>Job Category</b>	<b>Activity Sector</b>	<b>Education</b>
Austrian	Computer System Designer	Telecommunication	Life Science
Belgian	Computer System Analyst	Justice and Judicial	Mathematics
Cypriot	Programmer	Public Security and law	Computer Science
Czech	Computer Engineer	Manufacture of machine tools	Computer Use
Danish	Computer Assistant	Research and Development	Statistics
Estonian	Computer Equipment Operator	Hardware Consultancy	Physics
Finnish	Industrial Robot Controller	Software Consultancy and Supply	Chemistry
French	Telecommunication Equipment Operator	Data processing	Earth Science
German	Medical Equipment Operator	Database	Network Administration
Greek	Electronic Equipment Operator	Publishing of Software	Operating Systems
Hungarian	Image Equipment Operator	Maintenance of computing machinery	Informatics
Irish	Software Engineer	Government	Programming Language
Italian	Computer code recorder	Culture, Media, Design	Sports
Latvian	Computer manager	Industrial production	Domestic Services
Lithuanian	Data entry keyers	Sales, Purchases, Marketing	Hotel, restaurant and catering
Maltese	Database administrator	Security work	Electronics and automation
Polish	Database designer	Transports	Chemical and process
Portuguese	System administrator	Publishing of newspapers	Mechanics and metal work
Slovak	Network manager	Reproduction of video recording	Electricity and energy
Slovenian	System operator	Sale of motor vehicles	Building and civil engineering
Spanish	Computer operator	Hotels	Architecture and town planning

Swedish	Hardware designer	Bars	Music and performing arts
Dutch	Designer, electronics/telecom	Motion picture and video production and distribution	Fine arts
British	Radio engineer	Building completion	Medicine

**Table 0-2 Objects in the universe of discourse (cont.)**

Gender	Languages	Currency	Location (Geographic Location)
Female	Czech	Euro	Austria
Male	Danish	Krone	Belgium
	Dutch	Great British Pound	Cyprus
	English	Zlote	Czech Republic
	Estonian	US Dollar	Denmark
	Finnish	Franc	Estonia
	French		Finland
	German		France
	Greek		Germany
	Hungarian		Greece
	Italian		Hungary
	Latvian		Ireland
	Lithuanian		Italy
	Maltese		Latvia
	Polish		Lithuania
	Portuguese		Malta
	Slovak		Poland
	Slovenian		Portugal
	Spanish		Slovakia
	Swedish		Slovenia
			Spain
			Sweden
			The Netherlands
			United Kingdom

Contract type and Work condition depend on the job offer's country. They are not included in the SEEMP deliverable D1.1 "User Requirement Definition", but we will acquire their information.

### 1.1.2 Selecting the standards that cover most of the identified necessities.

In this section we present how we have selected the standards that cover the objects already identified in the above section. We present in different sections how we have selected the human resources management standards, the time ontology, the currency classification, the location (geographic location) classification and language classification.

#### Selecting human resources management standards

We have already described some human resources management standards in section 2.2 of the SEEMP deliverable D2.1 "Semantic and Technical Aspects in e-Gov Software Development" and they are:

Occupation classifications: SOC<sup>1</sup>, ISCO-88<sup>2</sup> and ISCO-88 (COM)<sup>3</sup>.

Classification of Economic Activities: ISIC Rev. 3.1<sup>4</sup>, NACE Rev. 1.1<sup>3</sup> and NAICS<sup>5</sup>.

Apprenticeship classifications: ISCED 97<sup>3</sup> and Classification of Fields of Education and Training (FOET)<sup>3</sup>.

In order to choose the most suitable standards for modeling CVs and job offers, the following criteria have been considered:

C1. *The degree of coverage.* This aspect has been evaluated taking into account the scope and size of the standard. However, a too wide coverage of the standard may move us further away the European reality, therefore we have tried to find a trade off between this aspect and the following one.

C2. *The current European needs.* It is important that standard focuses on the current European reality. The user partners involved in the SEEMP project have a deep knowledge of the European employment market and the outcome prototype will be validated in European scenarios.

Since it has been clearly identified by partners involved in the project that the recommended standard for occupation classifications is ISCO-88(COM), for classification of economic activities is NACE Rev. 1.1 and for apprenticeship classifications is Classification of Fields of Education and Training (FOET).

The following three tables compare the coverage of the previous standards using the set of objects identified in section 4.2.1; Table 4-3 summarizes the comparison between three occupation classifications standards (SOC, ISCO-88 and ISCO-88(COM)). Table 4-4

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<sup>1</sup> <http://www.bls.gov/soc/>

<sup>2</sup> <http://www.ilo.org/public/english/bureau/stat/class/isco.htm>

<sup>3</sup> Available through RAMON Eurostat's Classifications Server at <http://ec.europa.eu/comm/eurostat/ramon/>

<sup>4</sup> <http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17&Lg=1>

<sup>5</sup> <http://www.census.gov/epcd/www/naics.html>

summarizes the comparison between classification of economic activities (ISIC Rev. 3.1, NACE Rev. 1.1 and NAICS) and, finally, Table 4-5 summarizes the comparison between apprenticeship classifications (ISCED 97 and Classification of Fields of Education and Training (FOET)).

**Table 0-3 Comparison between Occupation Classifications**

	SOC	ISCO-88	ISCO-88 (COM)
Computer System Designer		X	X
Computer System Analyst	X	X	X
Programmer	X	X	X
Computer Engineer		X	X
Computer Assistant		X	X
Computer Equipment Operator	X	X	X
Industrial Robot Controller		X	X
Telecommunication Equipment Operator		X	X
Medical Equipment Operator		X	X
Electronic Equipment Operator		X	X
Image Equipment Operator		X	X
Software Engineer	X	X	X
Computer code recorder	X	X	X
Computer manager	X	X	X
Data entry keyers	X		
Database administrator	X	X	X
Database designer		X	X
System administrator	X		
Network manager	X		
System operator	X		
Computer operator	X	X	X
Hardware designer	X		X
Designer, electronics/telecom	X	X	X
Radio engineer			X

**Table 0-4 Comparison between Classification of Economic Activities**

	ISIC Rev. 3.1	NACE Rev. 1.1	NAICS
Telecommunication	X	X	X
Justice and Judicial	X	X	
Public Security and	X	X	

law			
Manufacture of machine tools	X	X	X
Research and Development	X	X	X
Hardware Consultancy	X	X	
Software Consultancy and Supply	X	X	
Data processing	X	X	X
Database	X	X	
Publishing of Software	X	X	X
Maintenance of computing machinery	X	X	X
Government	X	X	X
Culture, Media, Design	X	X	X
Industrial production	X		X
Marketing	X	X	X
Security activities	X	X	
Transports	X	X	X
Publishing of newspapers	X	X	
Reproduction of video recording	X	X	
Sale of motor vehicles		X	
Hotels	X	X	
Bars	X	X	
Motion picture and video production and distribution	X	X	X
Building completion	X	X	X

**Table 0-5 Comparison between Apprenticeship classifications**

	ISCED 97	FOET
Life Science	X	X
Mathematics	X	X
Computer Science	X	X
Computer Use		X
Statistics	X	X
Physics	X	X
Chemistry	X	X
Earth Science		X
Network Administration		X
Operating Systems	X	X



Informatics		X
Programming Language		X
Sports		X
Domestic Services	X	
Hotel, restaurant and catering	X	X
Electronics and automation		X
Chemical and process		X
Mechanics and metal work	X	X
Electricity and energy	X	X
Building and civil engineering	X	X
Architecture and town planning	X	X
Music and performing arts		X
Fine arts		X
Medicine	X	X

We have been compared the standards following criteria C1, now it is time to evaluate the standards following all the criteria (C1 and C2). Table 4-6 summarizes the comparison between occupation classifications; classification of economic activities and apprenticeship classification taking into account the criteria C1 and C2.

**Table 0-6 Comparison between standards**

	Occupation Classification			Classification of Economic Activities			Apprenticeship Classification	
	SOC	ISCO-88	ISCO-88 (COM)	ISIC Rev. 3.1	NACE Rev. 1.1	NAICS	ISCED 97	FOET
C1		X	X	X	X			X
C2			X		X		X	X

After analyzing the results we conclude that the standards that fit best the requirements are: for the classification of economic activities, NACE Rev. 1.1; for the occupation classifications, ISCO-88 (COM); and for the apprenticeship classifications: Classification of Fields of Education and Training (FOET).

### Selecting Time Ontology

A Time Ontology is an agreed time model implemented in a machine-readable language. There are several time ontologies to be used for describing date information. They are:

The time ontology in Upper Cyc Ontology<sup>6</sup>, which is included in the Cyc knowledge base [Lenat et al 1990].

The Unrestricted Time ontology<sup>7</sup>, developed at the Italian National Research Council (CNR).

The Simple Time ontology<sup>8</sup>, which has been considered for developing further time ontologies, like the Reusable Time and the Kestrel Institute Time.

The Reusable Time [Zhou et al 2000], a very detailed ontology time developed at Stanford University.

The Kestrel Institute Time<sup>9</sup> ontology.

The SRI Time ontology<sup>10</sup> developed by the SRI's Artificial Intelligence Center.

The modelling of time in SUMO<sup>11</sup>, developed by the IEEE Standard Upper Ontology working group.

The DAML time ontology<sup>12</sup>, implemented inside the DAML group.

The AKT Time ontology<sup>13</sup>, developed inside the AKT initiative.

We use the criteria presented in [Fernández-López et al 2004] and we choose the DAML ontology to model the time in SEEMP platform. DAML ontology is implemented in OWL.

#### Selecting Currency classification

The following non-exhaustive list presents some examples of currency classifications:

Pacific Exchange Rate Service<sup>14</sup>

ISO 4217<sup>15</sup>

WordAtlas<sup>16</sup>

We choose the ISO 4217 currency names and code elements.

#### Selecting geographic location classification

The following non-exhaustive list presents some examples of geographic location classifications:

- ISO 3166<sup>17</sup> Maintenance agency (ISO 3166/MA) – ISO's focal point for country codes.

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<sup>6</sup> <http://www.cyc.com/cyc-2-1/cover.html>

<sup>7</sup> <http://ontology.ip.rm.cnr.it/onto/ON9.3-OL-HTML/unrestricted-time/>

<sup>8</sup> <http://www-ksl-svc.stanford.edu/>

<sup>9</sup> <http://www.kestrel.edu/DAML/2000/12/TIME.daml>

<sup>10</sup> <http://www.ai.sri.com/daml/ontologies/sri-basic/1-0/Time.daml>

<sup>11</sup> <http://www.ontologyportal.org/>

<sup>12</sup> <http://cs.yale.edu/homes/dvm/daml/time-page.html>

<sup>13</sup> <http://dream.inf.ed.ac.uk/projects/dor/akt/akt.html>

<sup>14</sup> [http://fx.sauder.ubc.ca/currency\\_table.html](http://fx.sauder.ubc.ca/currency_table.html)

<sup>15</sup> <http://www.iso.org/iso/en/prods-services/popstds/currencycodeslist.html>

<sup>16</sup> <http://worldatlas.com/aatlas/infopage/currency.htm>

- Guide to regions of the World<sup>18</sup>.
- Regions of the World<sup>19</sup>

We choose the ISO 3166 country codes and also we will use the following European Dynamics<sup>20</sup> taxonomies: Continent, Country and Region.

### Selecting Language classification

For language classification we use the language taxonomy used by European Dynamics<sup>20</sup> and the ISO 639<sup>21</sup>.

#### 1.1.3 Semantic enrichment of the chosen standard

The selected standards in the previous sections are expressed in different representation formats:

- NACE Rev. 1.1 is expressed in MS Access and HTML format.
- ISCO-88 (COM) is expressed in MS Access, MS Excel and HTML format.
- Classification of Fields of Education and Training (FOET) is expressed in MS Access, MS Excel and HTML format.

These standards are lightweight ontologies that only have concept classifications without properties, relations between concepts, etc. The goal is to transform these standards in ontologies following the process:

- Verifying concept taxonomies; METHONTOLOGY proposes to use the following four taxonomic relations: *SubClass-Of*, *Disjoint-Decomposition*, *Exhaustive-Decomposition*, and *Partition*.
- Establishing ad hoc relationships between concepts of the same (or different) concept taxonomy; and also it is necessary to check that the ad hoc binary relations have no errors.
- Specifying concept attributes; once the ad hoc binary relations have been established, it is time to specify the properties that describe each concept of the taxonomy, and optionally, their instances.
- Defining formal axioms; to perform this task, it is necessary to identify the formal axioms needed in the ontology and describe them precisely. Formal axioms are logical expressions that are always true and are normally used to specify constraints.

In order to make possible the enrichment of the standards it is necessary to import them into an ontology engineering tool, WebODE [Corcho 2002] in this particular case. This process consists of:

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<sup>17</sup> <http://www.iso.org/iso/en/prods-services/iso3166ma/index.html>

<sup>18</sup> <http://www.countriesandcities.com/regions/>

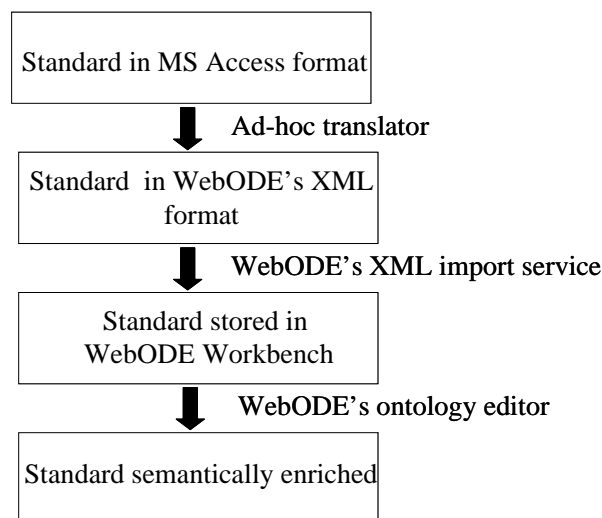
<sup>19</sup> <http://park.org/Regions/>

<sup>20</sup> European Dynamics SA is an user partner of the SEEMP project, <http://www.eurodyn.com/>

<sup>21</sup> <http://www.iso.ch/iso/en/prods-services/iso3166ma/02iso-3166-code-lists/index.html>

- Implementing the necessary conversion mechanisms for transforming the standards into WebODE's knowledge model XML syntax. For this purpose we have to develop an ad-hoc translator that will transform all the data stored in the three MS Access databases into three WebODE's XML files.
- Once the WebODE's XML files are generated, the XML import service of WebODE will be used to upload the standard into WebODE ontology development platform.
- Once the information has been uploaded into WebODE workbench, its ontology editor allows the ontology engineer its integration and its enrichment using WebODE user interface editing facilities.

Figure 4-5 shows the stages of the process.



**Figure 4-5 Import process of the standard into WebODE**

