ESCO: Towards a Semantic Web for the European Labor Market

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ABSTRACT

The Semantic Web has a huge potential when it is used to organize market processes. The labour market is an excellent example where it can add value. By enhancing communication between employers and job seekers in the digital age, market processes become more efficient and more people can find the right jobs for them. The multilingual classification of European Skills, Competences, Qualifications and Occupations (ESCO) is a central building block for an ecosystem of semantic assets on the labour market. In this paper we explain how the ESCO data model was designed, building on the Simple Knowledge Organization System. We further explain how new versions of the datasets are published and how they can be used by applications. Finally, we summarize the next steps in the on-going work on ESCO.

Categories and Subject Descriptors

H.3.1 [**Content Analysis and Indexing**], H.3.3 [**Information Search and Retrieval**], I.2.4 [**Knowledge Representation Formalisms and Methods**], H.3.5 [**Online Information systems**], J.1 [**Administrative Data Processing**].

General Terms

Design, Economics, Standardization, Languages

Keywords

ESCO, Job Labour Market, Linked Open Data, Open Standards, Knowledge Organization System, RDF, DCAT

1. POTENTIAL OF THE SEMANTIC WEB FOR THE LABOR MARKET

When Tim Berners-Lee explained the potential of Linked Data at TED, he predicted that "it will be used by other people to do wonderful things, in ways that they never could have imagined."[1]

And indeed, we saw many applications sprouting that are built on Linked Data: Maps with the live position of underground trains[2], Crime heat maps[3], websites showing you how your government spends your taxes[4] and apps that guide you to the nearest public toilet[5]. While all these applications are useful and qualify as wonderful things, we believe Linked Data will unleash its full potential when it is used to organize market processes. If we can use Linked Data to match supply and demand on markets more efficiently, the economic impact will be huge.

While the Semantic Web has a great potential on the markets for goods and services, it might benefit the labour market even more. The labour market has some characteristics that make it a good case for the Semantic Web to add value. This market is quite different from going to the supermarket and buying potatoes. If you need potatoes to cook dinner, you do not need to describe each potato individually. And even if you need specific ones, it is pretty straightforward. By naming the variety and the size you have described what you want. The labour market is different. People on the labour market need to describe all offers individually. No person is like another one and almost no job is like another one. And it is quite challenging to describe jobs and job seekers, so that in the end you can find the right person for the right job (or the other way round). Unlike with the potatoes, the most important characteristics you need to describe are intangible. How do you explain the company culture and working atmosphere? The communication skills of a person and what role he/she can play best in a team? This is where the semantics come in. Communication on the labour market means that the potential employer and the candidates need to develop a shared understanding of these intangible characteristics.

At the same time, it is very important to get it right, for both, the employer and the job seeker. Once the decision for a transaction has been taken and an employment contract has been signed, correcting a wrong decision is very costly for both sides.

In the past ten to twenty years the Web changed how these processes are organized on the labour market. Exchange between supply and demand on the labour market is now mainly organized

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* The views expressed in this article are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

[1] Tim Berners-Lee: The year open data went worldwide. https://www.ted.com/talks/tim_berners_lee_the_year_open_data_went_worldwide/transcript?language=en

[2] http://traintimes.org.uk/map/tube/

[3] http://crimeview.psi.enakting.org/

[4] http://www.publicspending.gr/

[5] http://greatbritishpublictoiletmap.rca.ac.uk/

through electronic means. Recruitment is done via web based tools: Internet portals and company websites have become the two most important recruitment channels. Social media is still low in market share, but gaining quickly. At the same time, computing power increased so that information technology is prepared to process large amounts of data. It is no longer a limiting factor in job matching or job search over a large number of data records.

The digitization of the labour market also influences the way people search for information. With the rise of social media a large amount of data about individuals, i.e. potential employees, becomes accessible to employers. This changes the traditional, prevalent recruitment model, in which employers explain their requirements and wait for the right candidate to knock on their door. Employers are increasingly looking for candidates themselves: Active sourcing becomes an important recruitment strategy. This requires employers to understand the skills profiles of potential candidates and use this information in their search.

It is still the personal contact and the job interview that counts for the actual recruitment decision, but all the searching and filtering process is being done by electronic tools. In this first step, both, candidates and recruiters narrow down their search from thousands or millions of offers to a few dozen. Modern information technology can help to make a good selection when narrowing down the search, but for that we need to move away from describing job vacancies and job seekers' profiles as documents. The offers on the labour market need to be described as data. And it needs to be done in a meaningful way that creates a common understanding and not confusion.

The Semantic Web can help us to overcome this communication challenge on the labour market. As Tim Berners Lee put it, the "Web does not just connect machines, it connects people."[6] And on the labour market that is what we need in order to revolutionize market processes, to make them more efficient and finally, to improve peoples' lives. This is the Semantic Web at its best.

2. AN ECOSYSTEM OF VOCABULARIES

Describing offers on the labour market requires complex semantics. In order to explain the characteristics of a job offer, employers need to convey a whole array of information. They need to describe the work environment, the products and services they work with, the specific tasks of the future employee, the knowledge, skills and competences that are needed to perform these tasks, salary, characteristics of the employment contract, the location of the company, etc. To describe all this in a machine readable way, we need to use vocabularies covering different domains. This is what we call the "ecosystem of vocabularies". The heart of this system is the multilingual classification of European Skills, Competences, Qualifications and Occupations (ESCO). It covers three different domains – the three "pillars" of ESCO: i) occupations, ii) knowledge, skills and competences, and iii) qualifications. [1] Each of the three pillars contains concepts and terms that help to describe offers on the labour market in a standardized and machine readable manner using Linked Open Data (LOD)[7].

In order to describe concepts, ESCO established a specific data model[8], which expresses sets of types, predicates and their meaning. The model is based on the popular Simple Knowledge Organization System (SKOS) [2] ontology which is used for representing knowledge organization systems, like thesauri, taxonomies and classification schemes[9]. SKOS offers a way to describe and organize concepts (through hierarchical relationships, associative relationships and collections). By defining sets of predicates, the concepts can be enriched with metadata.

The ESCO classification is an extension of the SKOS ontology. Table 1 provides an overview of the different meta layers of the ESCO data model.

ESCO concepts are subclasses of SKOS concepts, with some additional metadata properties allowing to structure the ESCO pillars. The esco:GroupConcept class gives structure to the top level of an ESCO pillar, and is not used to tag any document. In contrast, the esco:MemberConcept is the class of concepts used to tag CVs, job postings and similar documents. Each of the three ESCO pillars has its own specific concept type: "esco:Occupation", "esco:Skill" and "esco:Qualification". These concept types are subclasses of the ESCO concepts. The actual content of ESCO consists of instances of these specific concept types. The occupation "flight attendant" is an example for an instance of the "esco:Occupation" concept. Table 2 provides examples of concepts covered by ESCO.

Finally, each of the more than 10 000 concepts defined by ESCO comes with a group of terms that can be used to refer to the concept. These cover all of the 24 languages of ESCO, adding up to a total of more than 200 000 terms. For each language ESCO defines a preferred term that should preferably be used when referring to the concept (skosxl:prefLabel), but also other terms, such as synonyms, abbreviations or gender-specific names of the occupation ("skosxl:altLabel" and "skosxl:hiddenLabel"). Table 3 shows examples of terms for the ESCO concept "flight attendant".

Table 1 - Meta layers of the ESCO data model

Meta layer	Example of a concept class (or subclasses) and an instance usage	Examples of sub classes (M4 and M3) and instances of this concept
M4	SKOS concept	esco:Concept, esco:GroupConcept, esco:MemberConcept
M3	esco:GroupConcept	esco:Occupation; esco:Skill; esco:Qualification
M2	esco:Occupation	"Flight attendant"; "Baker"; "Veterinary nurse"
M1	"Flight attendant"	Use of the occupation concept to describe a specific job offer
M0	Real life case (description of a job seeker or job offer)	-

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Table 2 - Examples of concept instances covered in ESCO

ESCO concept type	*esco:Occupation*	*esco:Skill*	*esco:Qualification*
Number of concept instances in the ESCO pilot version (ESCO v0)	5 380	5 737	7 examples
Examples	▪ Kitchen assistant ▪ Opera singer ▪ Web designer ▪ Tannery worker ▪ Tax auditor ▪ Editor in chief ▪ Jeweller ▪ Security guard ▪ Sheep breeder ▪ Waiter/waitress	▪ Image editing ▪ Garden landscaping ▪ Gas welding ▪ Vehicle damage inspection ▪ Family law ▪ Hydrology ▪ Cope with pressure ▪ Persuade, Collaborate on tasks	▪ Project Management Professional (PMP) ▪ European Certificate of Floral Design ▪ European/ international Welding Practitioner ▪ Cisco Data Centre Application Services Design Specialist

Table 3 – Examples for terms in the different language variants of the ESCO concept "flight attendant"

Label type	Language	Label
skosxl:prefLabel	English	Flight attendant
skosxl:altLabel	English	Steward
skosxl:altLabel	English	Stewardess
skosxl:altLabel	English	Air cabin crew member
skosxl:prefLabel	German	Flugbegleiter/in
skosxl:altLabel	German	Steward/ess
skosxl:prefLabel	Greek	Αεροσυνοδός
…	…	…

ESCO is organizing the concepts through hierarchical and associative relations. These relations are established between concepts within one ESCO pillar (e.g. occupation – occupation), but also between the different ESCO pillars (e.g. occupation – skill). Within one pillar, ESCO uses hierarchical relations of the type broader (BT) and narrower (NT). By connecting the higher level concepts ("esco:GroupConcept") to member concepts ("esco:MemberConcept"), ESCO builds a hierarchical structure of occupations and of skills and competences. Across the pillars ESCO expresses how the different concepts interrelate. Relations between the occupations and the skills pillar show for instance, which knowledge, skills and competences employers typically request when recruiting for a specific occupation. All these relations are specialisations of "skos:related". Their meaning is specified by using a specializing property or using an instance of esco:Relationship (a detailed relation type specification).

Next to the concepts of the three ESCO pillars, ESCO makes use of other "semantic assets". These semantic assets can be controlled vocabularies, frameworks, classifications, etc. Some of these concepts are created in the context of ESCO, others are reused from existing taxonomies.

While ESCO describes occupations, knowledge, skills, competences and qualifications, it also links to other semantic assets. This allows building on existing work and relating to semantic assets of different domains. When describing job offers or job seekers on the labour market, concepts of ESCO can therefore easily be combined with information from other vocabularies, taxonomies and classifications. ESCO makes use of existing semantic assets in three ways:

1. Mapping to semantic assets of the same domain: Several national classification systems describe occupations and/or knowledge, skills and competences. Usually they cover the labour market of one specific country[10]. ESCO provides a reference vocabulary that allows creating machine-readable correspondence tables ("mappings") between ESCO concepts and the concepts of these classifications. By using mappings of the type skos:closeMatch or skos:exactMatch to ESCO, partners can refer to ESCO when exchanging information. This way they provide meaningful information, even if they use different classification systems on a national level. They achieve semantic interoperability. ESCO occupations of type esco:MemberConcept also map to the International Standard Classification of Occupations (ISCO)[11] versions of 1988 and 2008, a statistical classification maintained by the International Labor Organization (ILO). To this end they use a sub property of skos:broadMatch (esco:memberOfISCOGroup).

2. Tagging to semantic assets of a different domain: ESCO tags its concepts with semantic assets, that are covering different domains, but that can be used as metadata for ESCO concepts. These tagging relations are all specialisations of the Dublin Core Metadata Initiative (DCMI) "dct:subject" property. By tagging ESCO concepts with other classifications and frameworks ESCO indicates for example:

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[10] For example: "Répertoire opérationnel des métiers et des emplois (ROME)" in France: http://www.pole-emploi.fr/candidat/le-code-rome-et-les-fiches-metiers-@/suarticle.jspz?id=15734; "Klassifikation der Berufe" in Germany: https://statistik.arbeitsagentur.de/Navigation/Statistik/Grundlagen/Klassifikation-der-Berufe/KldB2010/KldB2010-Nav.html; "Berufssystematik" of the "Arbeitsmarktservice Österreich (AMS)" in Austria: http://www.ams.at/bis/OnlineHilfe.php?noteid=38.

[11] http://www.ilo.org/public/english/bureau/stat/isco/

- The level of an ESCO qualification by tagging it with a level from the European Qualifications Framework (EQF)[12]. The EQF makes levels of qualification systems comparable across Europe.
- The field of study of an ESCO qualification by tagging it with the Fields of Education and Training (FoET)[13].
- The relevance of an occupation, knowledge, skill or competence for one or more sectors of economic activity by tagging it with the Statistical Classification of Economic Activities in the European Community (NACE) , Rev.2 of 2008[14].

3. Using existing semantic assets to create new ESCO concepts: Classifications or frameworks covering other domains can be useful when defining new ESCO concepts, either by importing them or by using them in facets. An example for this is the implementation of language skills in ESCO. The concepts covering foreign language skills in ESCO make use of two facets that both build on existing semantic assets. The Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR)[15] includes different dimensions of learning a language (reading, listening, speaking, etc.). These are added as a facet "language usage" to the "foreign language" concept in ESCO. At the same time, the concept can be combined with a list of languages, that partly stems from the list of languages maintained by the Publication Office of the European Union[16] and to the library of congress[17] (by using "{skos:exactMatch}") and that is mapped to codes of the ISO 639 standard (by using "{dcterms:identifier}").

By building relations between concepts of different domains and by linking ESCO to other semantic assets, an "ecosystem of controlled vocabularies" for the labour market emerges. This is shown in Figure 1.

In addition to ESCO, other semantic assets can be used to annotate job vacancies or CVs. The Nomenclature of Territorial Units for Statistics (NUTS)[18] can for example be used to specify the location of an employer in a job vacancy. They are, however, not directly related to the ESCO classification.

2.1 Collaborative content creation

The European Commission is developing ESCO together with stakeholders like employment services, employer federations, trade unions, and professional associations. This ensures that the expertise of these various and important organizations feeds into the project and that the end result will meet the needs of key actors in the labor market as well as in the education and training sectors.

The actual content of the ESCO classification along with its supporting taxonomies has been developed by domain experts, which are called the ESCO Reference Groups. These groups bring together experts from different economic sectors and include employers, education and training providers, trade union representatives, job recruiters, and sector skills council members. Each Reference Group is supported by taxonomy creation experts.

The Reference Group's work is complemented by that of the ESCO Cross-sector Reference Group. This group develops a vocabulary for transversal skills and competences, which are subsequently applied by the Reference Groups to transferable elements of occupational profiles.

The remaining editorial work on the ESCO classification will be developed through an "online consultation process" (cf. section 5.2).

3. PUBLISHING ESCO AS LINKED OPEN DATA

In order for ESCO to become a de facto standard and an integral part of an emerging Semantic Web for the labour market, the classification needs to be published in a user friendly way. In particular, ESCO needs to:

- Allow for an easy integration into existing IT systems;
- Be easy to link to other semantic assets so that it can fulfil its role as a reference vocabulary for data exchange;
- Ensure that content is well managed and quality assured before publication;
- Ensure that continuous updates of the classification do not lead to high administrative overhead for ESCO users. This requires a versioning mechanism that ensures backwards compatibility, persistent uniform resource identifiers (URIs) and transparent and machine-readable information about the different ESCO versions.

In order to achieve this, the ESCO platform is built to service a network of Knowledge Organization System (KOS) for publishing Open Data according to the Linked Data methodology [3]. Its main components are the thesaurus management system, data ingestion, Application Programming Interfaces (APIs)[19] , and indexing services. Figure 2 illustrates these components.

The European Commission manages the content of the ESCO classification in a thesaurus management system. Once the European Commission decides to release a new version of ESCO, the publication process starts. The first step is to export the new ESCO version from the taxonomy management system. Through an API service, the system generates and assigns persistent URIs. All entities (i.e. instances of data sets, concept schema, concepts, collections, terms, relations …) receive their own URI that serves as permanent identifier. URIs are maintained throughout all versions of the thesaurus, even if concepts become obsolete or are replaced with other concepts in a later version.

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[12] http://ec.europa.eu/ploteus/search/
site?f[0]=im_field_entity_type%3A97#

[13] http://www.uis.unesco.org/Education/Documents/
isced-fields-of-education-training-2013.pdf

[14] http://data.europa.eu/esco/ConceptScheme/NACErev2/cs
http://ec.europa.eu/eurostat/web/nace-rev2

[15] https://europass.cedefop.europa.eu/en/resources/european-
language-levels-cefr asp

[16] http://publications.europa.eu/resource/authority/language

[17] http://id.loc.gov/vocabulary/iso639-1

[18] http://ec.europa.eu/eurostat/web/nuts/overview
http://data.europa.eu/esco/ConceptScheme/NUTS2008/cs

[19] https://ec.europa.eu/esco/web/guest/escopedia/-
/escopedia/ESCO_API

When a new ESCO dataset version is exported from the taxonomy management system, it is registered in an internal Data Catalog Vocabulary (DCAT)[20] register. The taxonomy management system provides the dataset with a version record referenced by an object property (ds-vers:hasVersionRecord) defined by the Dataset Versioning[21] ontology and the DCMI property referring to the Version History Set (dct:isVersionOf).

The export is followed by an ingest process. During this process the ingest component receives the exported dataset, validates it and applies the rules defined in the ESCO data model, such as inferences, faceting and inheritance. The ingest component then generates a Resource Description Framework (RDF) version of ESCO that can be machine processed at different levels: SKOS, SKOS-XL, ISO-THES[22] and ESCO. The ESCO pillar concepts receive associative relationships between them, are further mapped to supporting taxonomies and finally they are tagged, as explained in section 2. As a result of the ingest process the following datasets are produced:

Master dataset of the new ESCO version;

- Publication of this dataset in the public DCAT register (extended with the Dataset Versioning Ontology) which is available as LOD;
- Indexed HTML pages for each concept that are being published in the ESCO portal[23].
- ESCO data in an RDF store serving a SPARQL endpoint.
- JSON-LD page for every ESCO entity.
- An XML report detailing the difference between the previous published version and the new version.

Thanks to this process, the ESCO platform can provide any type of ESCO data in RDF, HTML, TTL and JSON-LD formats.

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[20] http://www.w3.org/TR/vocab-dcat/

[21] http://purl.org/iso25964/DataSet/Versioning/#objectproperties

[22] http://purl.org/iso25964/skos-thes
http://www.niso.org/schemas/iso25964/

[23] https://ec.europa.eu/esco/home

Figure 1 - Examples of semantic assets in the ecosystem of controlled vocabularies for the labor market
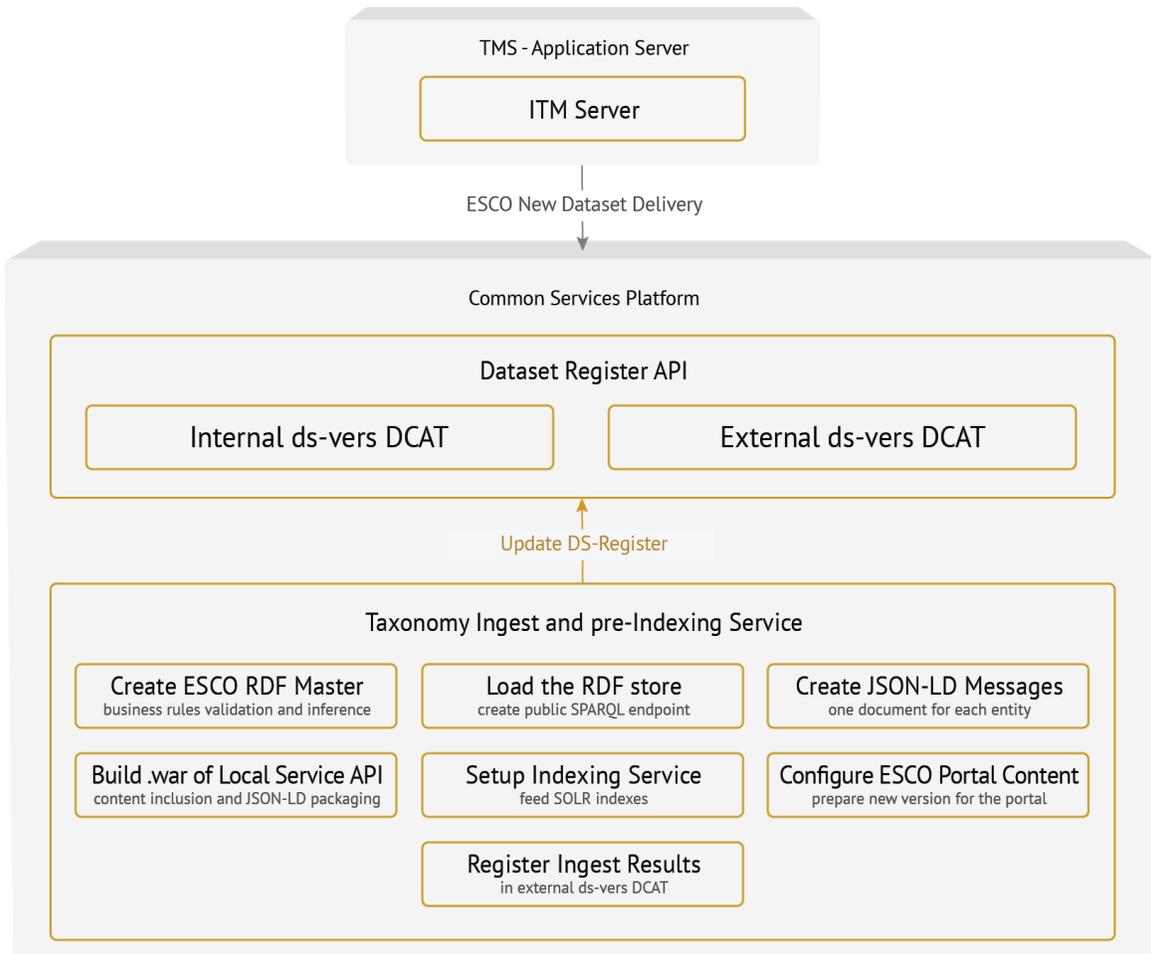

Figure 2 - ESCO Architecture Snapshot of the Linked Open Data Publication Chain

The ingest process also generates a file that includes the indexed content (SOLR[24]) of all JSON-LD files of a specific version of the ESCO dataset, together with its master RDF. This "war" file is available as a DCAT distribution of the ESCO dataset. The file allows users to build local applications using any specific version of ESCO. Each user can take a decision based on its own needs, when to upgrade to the latest version of ESCO.

Except for languages of the Library of Congress, none of the semantic assets used by ESCO (cf. section 2) are currently published as LOD[25]. Even though for some of them LOD publishing efforts are on-going, the publishing strategies for these semantic assets vary and range mainly from PDF, Excel and CSV files to downloadable RDF. In order to be able to link to these classifications within the ESCO ecosystem, the ESCO platform transformed these semantic assets into SKOS format, assigned an ESCO URI to each entity and published a LOD copy of the semantic asset. In cases where a taxonomy is already available in SKOS, ESCO uses "skos:exactMatch". ESCO also provides a mechanism to manage versions of these semantic assets. Their copy in the ESCO ecosystem inherits the versioning functionality. These are explicitly detailed using "ds-vers:VersionHistorySet". There is one instance per concept scheme, holding one "ds-vers:VersionHistoryRecord" for each published dataset version (see earlier in this section).

4. ADDED VALUE OF ESCO

As a result of the publishing process ESCO is available in LOD and free to use for everyone. For ESCO to become a de facto standard it is crucial to maintain the classification over time, so that it keeps pace with new developments on the labour market or in the education and training sector. At the same time, the versioning mechanism of ESCO ensures backward and forward compatibility. This makes it a perfect tool for the semantic annotation of labour market documents, such as job vacancies, curricula vitae or training offers. By annotating these documents with ESCO, the information becomes language independent and machine readable. The annotation transforms the documents into structured data. And thanks to the metadata, descriptions and language variants of ESCO concepts it is easier for market participants to create a shared understanding about the intangible characteristics of job offers and job seekers.

This opens new avenues for cooperation on the labour market. Since the use of ESCO creates a shared understanding about job offers and job seekers, partners on the labour market can exchange information across different languages and information systems. New partnerships on the labour market will form, simply because it is easier to share information. Over time, this will create pressure to tear down isolated data silos and open up the information on vacant jobs.

At the same time, the machine readability of structured data allows for new services. While companies and employment services publish millions of job vacancies, searching this vast information is still difficult. Faceted or semantic search of job vacancies is usually possible within one integrated database, but not across all the job vacancies published on the Internet. That is why aggregators, such as Indeed.com, who integrate data from

several sources flourish, while the major search engines deliver poor results in job search. The use of a standardized terminology to annotate these documents is one step towards a semantic web for the labour market. Coupled with schemata or syntactic standards, such as schema.org or HR-XML, information can be easily exchanged between partners.

Once information on job seekers and job vacancies is published or exchanged as data, it can be used in specialized services and apps. Competence-based online job matching algorithms can for instance help to find the best match between jobseeker and job, based on the individual professional profile of the jobseeker and the employers' needs. Imagine that the information on the several million vacant jobs in Europe is semantically annotated and can automatically be compared with the professional profiles of 26 million unemployed people in order to find the best match.

With its sophisticated vocabulary of knowledge, skills and competences, ESCO will support exactly that. ESCO will enable applications that allow employers to describe their requirements precisely and in a machine-readable format. On the other side of the labour market, it helps to understand the experience of jobseekers: the knowledge, skills and competences they obtained in formal learning, but also "on the job". By putting the knowledge, skills and competences in the centre, ESCO will help to increase opportunities for jobseekers without formal qualifications. It will also make visible, which knowledge, skills and competences are transferable to a different job context and thus promote professional mobility on the labour market.

ESCO will allow building better automated search and matching services for the labour market. Jobseekers can use these as self-services to find the best job themselves. At the same time, this will free up resources of public employment services, to focus on the jobseekers that really need the assistance of human advisers.

However, the possibilities of the semantic web do not stop with job matching and searching. By crossing domains, we can go even further than just finding the best match on the labour market. We can start to analyse skill gaps, both on the level of the economy and on an individual level. In labour market intelligence, the ESCO classification can help to collect and interpret information on skills supply and skills demand, e.g. in real time big data analyses. This can help to identify emerging skills needs as well as skills gaps and surpluses across Europe. On an individual level, e-Services can analyse the professional profile of job seekers and try to identify what skills they are lacking to succeed on the labour market or to progress in their career. They can suggest possible career paths to individuals. Service providers can use this information to provide targeted information on trainings offers that would really pay off for a job seeker. This way, electronic tools can provide information and feedback that helps jobseekers to increase their employability.

5. NEXT STEPS

As these examples of applications building on ESCO demonstrate, the ESCO classification is not developed as a standalone tool. It needs to be used in applications that serve jobseekers, employers or labour market professionals. In the framework of EURES, the network of public employment services, the European Commission proposed a revamped interoperability system that allows for a better cross-border

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[24] http://lucene.apache.org/solr/

[25] http://www.w3.org/TR/ld-bp/#MACHINE
   (Direct URI resolution is missing in most cases)

cooperation of public employment services.[26] For ESCO to best support these applications, the on-going work is focusing on the following steps:

5.1 Assessment of ESCO in "fit-for-purpose" applications.

The current version of ESCO needs to demonstrate its added value in practical applications. From pilot and test applications we can learn if ESCO is "fit-for-purpose" and how it can be improved further. The implementation of the first ESCO APIs as central and local service supports building such applications. Examples include an undergoing pilot application within the scope of the Interoperability Solutions for European Public Administrations (ISA)[27] initiative and a pilot project with four European public employment services[28].

5.2 Finalising the full content of ESCO

While a pilot version of ESCO (ESCO v0) was published in October 2013 [4], the full content of ESCO is still under development. A large part of the content has been finalized through editorial work supported by field experts. Some demo releases of the finalized parts of the refined classification are planned for 2015. The European Commission aims to complete the remaining content of the classification until end of 2016. Stakeholders will contribute to this process through an "open consultation", similar to a "crowd sourcing" [5] approach.

5.3 Continuous update of the classification

Once the full version of ESCO is published, it needs to be continuously updated to keep pace with new developments on the labour market and in the education and training system. Emerging occupations, changing skill needs and new qualifications need to be reflected in ESCO so that it can fulfil its role as reference terminology for the European labour market. ESCO will need to put in place a system that allows to further develop the content in line with changing realities, but also a continuous development process. Such a system could combine different methodologies for updating content, such as machine learning, crowdsourcing and editorial work carried out by experts.

6. ACKNOWLEDGEMENTS

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[27] https://joinup.ec.europa.eu/

[28] https://ec.europa.eu/esco/escopedia/-/escopedia/ESCO_mapping_pilot