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Quantifying skill needs in Europe

Occupational skills profiles: methodology and application

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Foreword

How are skills profiles in different jobs evolving in response to technological progress and the shift to a knowledge economy? Should qualifications profiles be adapted to reflect changes in the demand for skills? Is it possible to anticipate and quantify trends in the supply and demand for specific skills?

Addressing these questions demands comprehensive information on workers' occupational skills profiles and job requirements.

Analysing skill needs in Europe is currently constrained by lack of data and appropriate classifications. The European statistical information system provides information on occupations and qualifications, which can only act as proxies for skill demand and supply. The European skills, competences and occupations taxonomy (ESCO) will be a valuable tool to link qualifications to skills and competences to occupations. It will bridge the information gap between the worlds of work and education and training. However, ESCO is only under development.

In the meanwhile, it is possible to develop skills profiles by making the most of available statistical sources at national, European and international levels. For this, Cedefop has set up an experimental methodology to define occupational skills profiles suitable for analysing the European labour market. This has been done by largely using the European social survey and the O*NET – the US primary description of knowledge, skills and abilities in occupations – as well as information drawn from German, Italian and Czech skills surveys. Cedefop's approach is consistent with the European qualifications framework.

The occupational skills profiles developed by Cedefop can be used to summarise the most essential characteristics of a given occupation: not only the level and field of education and training required, but also requirements in terms of knowledge, skills, abilities and attitudes. They allow deeper analysis of skills requirements by sector and occupation across countries and over time. Their area of application extends to skill needs forecasting and the investigation of skill mismatch between qualifications and job requirements.

I trust that this methodological report will open avenues for further research and analysis on skill needs in Europe and complement the efforts made to develop Europe's own taxonomy of skills, competences and occupations.

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Acting Director

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Executive summary

Statistical information on skill and qualification requirements for occupations is fragmented, inconsistent, difficult to compare across European countries, and usually not detailed enough to reflect the specific characteristics of a given occupation. The occupational skills profile approach aims at integrating several available European sources and supplementing them with data gathered from EU and US surveys. This has been made possible by developing specific methods of data mapping, matching and integration. As a result, the skill requirements of occupations can be not only defined at a detailed level and further aggregated at higher levels as required, but also compared across sectors, countries and over time.

What is an occupational skills profile?

An OSP summarises essential characteristics required for a given job: the level of education and training required (and hence the complexity of the occupation); the field of education and training required; and other requirements in terms of knowledge, skills, competence, occupational interests, and work values.

The approach developed in this study allows aggregation of OSPs of specific occupations into OSPs of occupational groups, of sectors, of national economies, and up to the pan-European level. As they are focused on job requirements, OSPs represent the demand side of skill needs and can be compared with the supply side focused on the number and qualification of job holders.

Possible use of OSPs

OSPs have been developed for several purposes: analysing, projecting and forecasting skill needs; determining and measuring education/skills matches and mismatches in different countries, sectors or occupations; and comparing and monitoring differences among European countries, including determining change over time, identifying past and future developments.

Construction of individual OSP

Given their purpose, OSPs have to be defined at a level of occupational classification that allows both identification of distinct, occupation-specific

features, and transposition to other classification levels/systems. They have to be not only measurable and quantifiable, but also are regularly measured with available statistics and data sets, allowing the creation of time series and identification of changes over time. OSPs have to be consistent as far as possible with concepts, classifications, and instruments used in Europe, in particular with the international standard classification of occupations (ISCO), the NACE classification of industry, and the European qualifications framework (EQF).

For all these reasons, OSPs should be determined at the lowest level possible, where the job structure and characteristics are sufficiently detailed and specific to identify important differences between groups of jobs. At the same time they have to be supported by empirical data, covered by statistics and handled in a comparable way across Europe.

OSPs aggregation throughout the occupational structure

It is necessary not only to establish OSPs at a detailed level of individual occupations (occupational units) but also to make it possible to aggregate them to higher levels as needed. However, aggregation to higher levels of classification and mapping to sectors cannot be realised by simply adding together the values determined at a lower, more detailed level of individual occupations. Their specificity would be lost, as a range of different values would be substituted by their average, and considerable differences in their distribution across sectors would not be respected.

A way to maintain specific features of OSPs even after their aggregation to a considerably higher level, and to overcome limitations and lack of comparable statistical data, has been found by considering the sector-specific occupational structure (that is the different proportional representations of individual occupations in different sectors). The aggregation of OSPs determined at a more detailed level of occupations has to be sector-specific: it is necessary to carry it out for each sector separately rather than across all sectors.

The reason is obvious: at higher levels of aggregation occupational groups contain several different occupations, and the mix of occupations (their proportion, prevalence or domination) is different in each sector. Consequently there has to be a different sector-specific OSP for each sector where the occupational group in question is represented. In this way, two crucial criteria can be met: sufficiently detailed level of analysis and consistency with data availability.

Statistics and data sources

More than 20 surveys in Europe and beyond (especially in the US) have been examined. However, only six surveys remained after assessing availability, usability, accessibility and suitability, and have been included into the model developed for the construction of OSPs the European social survey, ESS 1-5, (conducted in 2002-11 in about 30 European countries); the O*NET 2000-11 (the US occupational information network); the US Bureau of Labour Statistics (BLS) education and training requirements categories 1996-2012 (the US); the BIBB/BAuA Erwerbstätigenbefragung 2006 (Germany); the Indagine sulle professioni 2007 (Italy), and the Kvalifikace 2008 (the Czech Republic).

OSPs have been constructed making use of both European (the European social survey) and US (the O*NET) sources. The use of US data for constructing OSPs for European countries has been justified by a correlation analysis. Information from other surveys has been included whenever possible.

Structure of OSPs

The structure of OSPs is consistent with the European qualifications framework, with seven dimensions forming three main groups.

The first group, called ‘coordinating characteristics’ contains two basic dimensions:

(a) the level of qualification requirements.
Its structure, with eight levels of work complexity, was initially taken from the EQF, where the levels are described by generally applicable descriptors, but it has been aggregated into a three-level scale used by Cedefop to forecast skill needs. Descriptors are taken mainly from the European social survey, but carefully balanced with other sources and approaches: employee surveys, employer requirements (e.g. the European job mobility portal (EURES)) and expert analyses;

(b) the field of education/training which contains 14 groups defined according to the international standard classification of education (ISCED).

The second group, called ‘main characteristics’, contains three dimensions based on learning outcomes, describing what the worker should know, understand and be able to do:

(a) knowledge is structured according the O*NET model, which has been adapted to the ISCED structure;

(b) skills, which follows the EQF distinction between cognitive and practical skills, but is more detailed and includes generic skills (communication, both

in mother and foreign languages, numeracy and ICT skills, and learning to learn);

(c) competence, defined according to the EQF in terms of responsibility and autonomy, and further structured into three areas: personal, social, and methodological abilities.

The third group, called ‘supplementary characteristics', focuses on the match between the job and the job holder and uses two dimensions which are important for choosing a job:

(a) occupational interests, linking work environment preferences to six distinct personality types. It can be used to describe both persons and work environment;

(b) work values, which is important both for the satisfaction of the job-holder and for his satisfactory performance.

Illustrative results

OSPs have been used within the project Forecasting of skill supply and demand in Europe to 2020. OSPs have been calculated for each of 33 European countries included in the forecast ([1]) as well as for the EU-27 as a whole, for each of 38 sectors and 37 occupations, and for the three years 2000, 2010 and 2020.

At the aggregate level – that is for all jobs in the whole EU-27 economy – all seven dimensions of OSPs have been projected from 2010 to 2020. The results show that average length of education required is expected to increase by 0.12 years. The highest growth of the employed is expected in economics, commerce, business and administration. The highest increases are expected for knowledge in engineering, technology, production and processing, and health services; the highest skills increases are expected in numeracy plus basic SMT (science, mathematics, and technology) concepts and ICT/digital, and for competence in methodological abilities. For occupational interests the personality type ‘enterprising’ will experience the highest increase, together with working values ‘recognition’ and ‘achievement’.

Analyses of three selected sectors (agriculture, motor vehicles, health and social work) showed that occupational structures and qualification requirements can differ much among and within European countries.

([1]) EU-27 Member States and Croatia, FYROM, Iceland, Norway, Switzerland and Turkey.

Future development

To enable a more precise and usable international comparison of changes in skills structures, it is necessary to modify the existing OSPs to be country-specific as well. Current work on a European standard classification for skills and competences (ESCO) will provide a valuable tool linking skills and competences to occupations and will contribute to bridging the existing information gap across countries. Also, data collected for the Organisation for Economic Cooperation and Development (OECD) project programme for the international assessment of adult competences (PIAAC) can be used to validate and improve the methods for generating OSPs, including the generation of country-specific coefficients in the models.

By adopting a job requirement approach, PIAAC attempts to assess the level and distribution of adult skills in a coherent and consistent way across 23 countries. It focuses on the key cognitive and workplace skills that are needed for successful participation in the economy and society and required in a specific job identified by sector and occupation. The size of the PIAAC database, with more than 100 000 respondents in employment, ensures a rich source of information about country differences (around 5 000 cases in each country). Results from the study will be available in autumn 2013.

The PIAAC data could contribute to further development of OSPs, especially for their quantification and validity at the individual country level (all sectors and occupations for a given country). They may also bring a deeper understanding of mismatches between labour market requirements and actual qualification of employment. Equally important is that PIAAC will be conducted in the US as well. Its data may also serve to verify further the suitability of US data sources (particularly the O*NET) for determining qualification requirements in European countries, thus making OSPs even more robust.

CHAPTER 1.

Concept of occupational skills profiles

This first chapter defines OSPs, explains the underlying concepts of job and occupation, presents an overview of international and national classifications of occupations and of international classifications of economic activities (sectors or industries). Basic requirements for data sources are defined: according to their availability, usability, accessibility, and suitability; six international or national data sources that crucial for the development of occupational skills profiles are described. Finally, the degree of their consistency and comparability with other European classifications (as the European qualifications framework) is examined.

1.1. Definition

An OSP summarises essential characteristics required for a given job: the level of education and training (and hence the complexity of the occupation); the field of education and training; and other main and supplementary requirements concerning knowledge, skills, competence, interests and values.

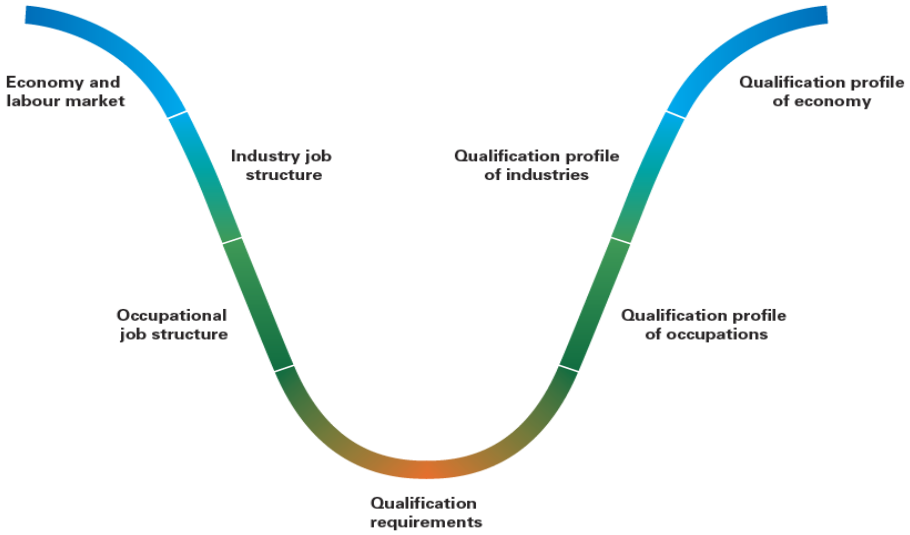
In this study OSPs have been developed for analysing, projecting and forecasting skill needs, for defining and measuring education/skills matches and mismatches in different countries, sectors or occupations, and for comparing and monitoring differences among European countries. They also determine change over time, identifying past and future developments ([2]).

To do this, a complex process of transition has been developed from the macro-level of a national economy down to the level of individual jobs, where OSPs are defined, and then up to the macro-level again: that is of disaggregation followed by aggregation (Figure 1). It begins by clarifying general economic relationships and factors of labour market development, based on analysing industry and occupational job structures and their mutual relationship. It goes on by defining vertical and horizontal dimensions of qualification requirements which characterise each job (as opposed to education which characterises the labour force). Then occupational skills profiles of specific occupations are determined by

([2]) Details about OSP structure and relationship to the projections produced in the core project Forecasting of skill supply and demand in Europe to 2020 are described in Chapter 2. The technical process of how they have been generated is described in the Annex.

combining quantitative and qualitative approaches and assessments. Finally, they can be aggregated into OSPs of occupational groups, further into OSPs of sectors, then into OPSs of national economies, and up to pan-European level.

Figure 1 **Labour market, job structures and qualification requirements: conceptual framework**



Source: Author.

To serve their key purpose at both European and national levels, OSPs have simultaneously to meet certain specific requirements, which make them quite unique:

(a) they are defined at such a level of occupational classification that allows identification of distinct, occupation-specific features adequately, yet they can be transposed both to other classification levels and to other classification systems as necessary;

(b) their characteristics are not only quantifiable and measurable, but also regularly measured with available statistics and data sets, allowing the creation of time series and identification of changes over time;

(c) they are consistent, as far as possible, with other relevant concepts, classifications and instruments used in Europe, in particular with the international standard classification of occupations, the NACE classification of industry, and the European qualifications framework.

To meet all the requirements at the same time is not simple. Many problems have to be dealt with including how to define the appropriate level of classification, how to find suitable data, how to transpose safely from one level

and/or system of classification to another, and how to achieve reasonable consistency between conceptual frameworks and data sources coming from different sources.

1.2. Appropriate level of classification and availability of data

An OSP of an individual occupation (sometimes the term occupational unit is used) sums up the characteristics of all similar jobs, classified under the given occupation. At higher levels of classification, individual occupations are aggregated into corresponding occupational groups, thus representing all occupations with a certain degree of similarity.

An OSP makes sense only on condition that the respective occupational unit is not too broad or, in other words, it is still possible to take it as an individual occupation or a relatively homogenous group of occupations. Otherwise it would be 'contaminated' by other occupations and the resulting skill needs would come too close to the average. OSPs have to be elaborated at a level where the job structure and job characteristics are sufficiently detailed and specific to identify important differences between groups of jobs and to make them sufficiently visible; they must also be supported by empirical data. It is obvious that both aspects are mutually limiting – the more one is respected, the less the other one is met – and that a best possible trade-off has to be sought. Both aspects are vital: the choice of the most suitable level of classification and the availability of empirical data at European level. This difficult proposition is central to the approach applied.

When choosing the level of the most suitable classification, we have to consider the varying relationships between a job, an occupation and an occupational group, at different levels of aggregation (Box 1).

For example, in the US about 150 million jobs in the labour market are classified. These jobs are described by 12 000 occupational titles and clustered into about 1 000 individual occupations classified by the US standard occupation classification system (SOC); their exact number is changes over the time. Individual occupations are further clustered at several levels into still broader occupational groups (e.g. US Department of Labour, 2010). The number of jobs and employed in all individual occupations classified by the SOC is monitored by the occupational employment statistics (OES).

Box 1 **Job/occupation**

A job (a work place) represents a basic unit covering a certain set of work activities performed by one working person. Strictly taken, each job has a specific, slightly different OSP. Nevertheless, there exist jobs with very or quite similar OSPs and negligible differences. Those jobs then make up individual occupation.

An occupation (sometimes the term 'a profession' is used) is then defined as a group of jobs with sufficiently similar characteristics to have one OSP. Classifications of occupations are thus a means for grouping jobs by their similarity. Definitions of occupations vary in different countries, and classification systems are different.

The new German classification KldB introduced in 2010 (Bundesagentur für Arbeit, 2010) contains five levels, the most detailed one having more than 1 000 occupations, and identifying almost 3 000 concrete jobs (*Berufs*).

The Polish classification of occupations and specialisations for labour market needs (KZiS) is a national adaptation of the ISCO-08, introduced by the Minister of Labour and Social Policy in April 2010 (MPiPS, 2010). KZiS is a hierarchical classification comprising five levels. To avoid losing comparability with ISCO-08, the ambition has been to minimise changes on the three highest levels.

The Czech classification of occupations (KZAM) was established in 1991 by adopting almost without change all four levels of the ISCO-88, with about 500 groups of occupation. The Czech classification has gone beyond the fourth level of ISCO, supplementing it by the fifth more detailed national level consisting of about 3 200 individual occupations. The CZ-ISCO, a quite recent classification of occupations in the Czech Republic introduced in 2010, also follows the same principles, taking over the four levels of ISCO-08 and adding to them the fifth one (ČSÚ, 2010).

The Italian classification of occupations, developed during the last decade as a part of the project Indagine sulle professioni, contains, at the fifth classification level, more than 800 basic (individual) occupations, all having their own OSPs (ISTAT, 2009). After five years the survey was repeated by ISFOL and ISTAT (Franceschetti, 2012).

Table 1 contains the overview of international and some national classifications, indicating the number of groups of occupation and occupational units at different levels of the classification hierarchy.

Table 1 **International and national classification of occupations: number of occupations or their group in the different level of classification**

	ISCO-88	ISCO-08	Germany KldB 2010	Poland KZiS 2010	Italy 2006	CZ 2010	US SOC 2010
1 level	10	10	10	10	9	10	23
2 level	28	43	37	43	37	43	97
3 level	116	130	144	132	121	130	461
4 level	390	436	700	444	519	434	840
5 level	–	–	1 286	2 360	811	1 362	1 110

Source: Author.

A decisive role is played by the classification system employed. The Eurostat database on occupations – as well as most comparisons of occupational structures among individual European countries – is based on ISCO (Box 2). As the ISCO-88 was used by Eurostat till end 2010, and all available data have been based on it since the beginning of the 1990s, it was adopted in this study for the construction of OSPs.

Box 2 **ISCO-88**

The international standard classification of occupations 1988 (ISCO-88) is based on two main concepts: the concept of the kind of work performed or job, and the concept of skill.

Job – defined as a set of tasks and duties executed, or meant to be executed, by one person – is the statistical unit classified by ISCO-88. A set of jobs whose main tasks and duties are characterised by a high degree of similarity constitutes an occupation. Persons are classified by occupation through their relationship to a past, present or future job.

Skill – defined as the ability to carry out the tasks and duties of a given job – has, for the purposes of ISCO-88 the two following dimensions:

- skill level, which is a function of the complexity and range of the tasks and duties involved;
- skill specialisation, defined by the field of knowledge, the tools and machinery used, the materials worked on or with, as well as the kinds of goods and services produced.

On the basis of the skill concept thus defined, ISCO-88 occupational groups were delineated and further aggregated at four levels:

1st ISCO level: major groups with 10 occupation group titles,

2nd ISCO level: submajor groups with 27 occupation group titles,

3rd ISCO level: minor groups with about 110 occupation group titles,

4th ISCO level: unit groups with about 500 occupation group titles.

The ISCO-88 also contains a complete list of more than 5 000 occupational titles grouped under corresponding unit groups (at the 4th ISCO level).

Nevertheless, ISCO is limited to the four-digit level with only about 500 occupational groups. Only about a third of European countries provides data at this level, while comparable data for most European countries are available only at the ISCO three-digit level which defines rather broad occupational groups. It is not surprising, therefore, that their OSPs are not clear-cut, as they include some quite similar but also some quite different occupations.

ISCO-08 was introduced in 2008. Since 2011 it has been used for labour force surveys in European countries. It is based on the same principles and constructed in the same way as ISCO-88. A new list of occupational titles for ISCO-88 is under preparation. However, the project Forecasting of skills supply and demand in Europe has been naturally based on ISCO-88. The transition of OSP from ISCO-88 to the ISCO-08 will be an important objective to be achieved in the next stage of our work.

Very important, however, is the fact that when adopting ISCO-08, many countries have also adopted and further applied its fifth level (and sometimes even the sixth national level). Some countries – although not adopting ISCO-88 – have constructed their new national classification so as to maintain the transferability of both classifications; among them is the new British classification SOC 2010. This justifies our hope that the comparability of data coming from national classifications – so far quite limited – will markedly increase.

An example is a new Polish classification KZiS, which like the ISCO-08 is based on two main concepts. These are the kind of work performed – defined as a set of tasks or duties designed to be executed by one person – and skill, defined as the skill level – the degree of complexity of constituent tasks – and skill specialisation, the field of knowledge required for competent performance of the constituent tasks.

Four skill levels are defined at the most aggregate level, the major groups, and are made operational in terms of the educational categories and levels of the international standard classification of education (ISCED 97). The use of the ISCED categories to define skill levels does not imply that the skills necessary to perform the tasks and duties of a given job can be acquired only through formal education. The skills may be, and often are, acquired through informal training and experience.

It is very important to consider that European labour force surveys (EU-LFS) identify each job not only by ISCO occupation, but also by sector (or industry). The Eurostat database uses NACE (Box 3) to identify sectors.

Box 3 **NACE**

The statistical classification of economic activities in the European Community (NACE) Rev. 1.1 is the classification of economic activities corresponding to the international standard industry classification (ISIC) Rev.3 at European level, though it is more disaggregated.

NACE Rev 1.1 is structured at four levels:

Level 1: 17 sections identified by alphabetical letters A to Q;
(an intermediate level: 31 subsections identified by two-character alphabetical codes);

Level 2: 62 divisions identified by two-digit numerical codes (01 to 99);

Level 3: 224 groups identified by three-digit numerical codes (01.1 to 99.0);

Level 4: 514 classes identified by four-digit numerical codes (01.11 to 99.00).

As the outcome of a major revision work of the international integrated system of economic classifications which took place between 2000 and 2007, the present NACE Rev. 2 (which is the new revised version of the NACE Rev. 1.1) has been introduced.

NACE Rev. 2 is based on ISIC Rev. 4 and adapted to the European context by a working group of experts on statistical classifications from the Member States, candidate countries and EFTA countries, with the support and guidance of the classification section at Eurostat (European Commission, 2008b).

The transition from NACE Rev. 1 to NACE Rev. 2 will be another major objective in the next stage of our work.

In Cedefop forecasting, the E3ME-CE model is based on the second level of classification NACE Rev. 1.1, and the number of sectors has been reduced by different aggregations from 62 to 41. In this study we use the same classification but the number of sectors has been reduced to 38 due to data limitations. Aggregation concerns pharmaceuticals (10) and chemicals (11), electricity (22) and gas supply (23), and professional services (36) and other business services (37).

1.3. Finding suitable sources

The next stage analysed the main conceptual, methodological and empirical ways of determining skill needs in various countries. This stage is important from three aspects: theoretical background and conceptual approaches to define elements of skill needs, grouping them into dimensions and links, and acknowledging the impact of external factors; methodological approaches to make operational concepts (dimensions, elements) used for definition of skill

needs; and assessing data availability, suitability and usability for the new concept of OSPs.

Data sources (surveys) have to meet certain stringent stipulations to be used for constructing OSPs. First, data from the survey have to be structured both by sector and by occupation. Second, occupations must be defined on the basis of the ISCO or any classification convertible to the ISCO; sectors must be defined on the basis of the NACE or any classification convertible to the NACE. Third, data from the survey must be robust and cover the bulk of the labour market.

Defining and quantifying OSPs started with more than 20 surveys in Europe, the US and OECD. Many proved to have no, or only a limited, potential for use, and only few surveys have passed the selection process consisting of the following four steps:

(a) availability. All available documents, studies and other information (e.g. webpages) concerning the concept, methodology and survey in question have been thoroughly studied to find all necessary characteristics: what is its framework or conceptual model; its main focus and scope; how the survey is conducted; whether it is periodic and at what interval it is repeated; and how the information gathered generally fits into our conceptual framework. Only where the result of the first step proved positive, was the second step taken;

(b) usability. Data from the survey were analysed to determine how they would enlarge the empirical database of our project, whether and to what degree they can be mapped into a common European database; particular important is what level of classification is used and whether it can be transposed to required levels of classifications used by Eurostat, NACE and ISCO (national classifications often cause problems). Again, only if results have been positive, has the next step been followed;

(c) accessibility. Communication with experts on the country in question (or directly of the institution conducting the survey) was established. Its objective was to find out whether and under what conditions it is possible to obtain their data (sometimes they have been paid for) and also whether it is possible that those who had carried out the survey could assist us in solving problems mentioned in previous steps. Again, only if our negotiations resulted in gaining access to the data, sometimes with advice and recommendations, was it possible to proceed to the final step;

(d) suitability. The final step consisted in thorough analyses of data obtained: the statistical behaviour of variables and of their role in the overall concept; transforming national classifications to Eurostat ones; and including new data to the final empirical model. During this stage the survey in question could have been abandoned should its previous positive assessments have

proved to be too optimistic. Table 2 lists all selected surveys that have been examined and analysed.

The large and periodic German surveys (BIBB-IAB-BAuA Erwerbstätigenbefragung, 1978-2006, 2012), with about 20 000 respondents, can only partly be used as their time series is not quite consistent due to changes in the questionnaires so that only some characteristics (and some occupations too) are comparable and can be used. Currently, only the latest survey of 2006 can be fully exploited ([3]).

The British skills survey (periodically conducted since the mid-1980s) is beset with even more problems: matching the British SOC to the ISCO is difficult, its consistency and hence comparability over time is not clear, and the survey comprising only about 6 000 respondents is not sufficiently robust for the ISCO 3-digit level. Surveys similar to those conducted in the UK up to 2006 will probably not be repeated. On the other hand, it is important that some concepts used in British surveys have been applied also in the OECD project PIAAC, to be conducted in about 30 countries in 2011-12 with international data available in the autumn of 2013.

When the selection process described above had been completed (Table 2), only the following six surveys met all criteria and were included into the model serving for the construction of OSPs:

- European social survey, ESS 1-5, conducted in 2002-11 (international);
- O*NET 2000-11 (the US);
- US BLS education and training requirements categories 1996-2012 (the US);
- BIBB/BAuA Erwerbstätigenbefragung 2006 (Germany);
- indagine sulle professioni 2007 (Italy);
- Kvalifikace 2008 (Czech Republic).

The six surveys are briefly characterised in the following sections. Although it has not been considered suitable for the purposes of this study, the potential of the EURES database is also described.

([3]) Data of the new 2012 survey will become available probably in 2014.

Table 2 **Surveys examined and analysed**

Name of the survey	Years	Coordinator/country	Availability	Usability	Accessibility	Suitability
International projects						
IALS	1993	OECD	Yes	No		
SIALS	1998		Yes	No		
ALL	2005		Yes	Yes	No	
PIAAC	2011-12		Yes	Yes	Only 2013	
European social survey, ESS 1-5	2002-11	City University London	Yes	Yes	Yes	Yes
CHEERS	1998	UNI Kassel	Yes	Yes	Partly	
Reflex	2005-06	UNI Maastricht	Yes	Yes	Partly	
HEGESCO	2008-09		Yes	Yes	Partly	
Reflex 2010	2010	Charles Uni.	Yes	Yes	Partly	
Advertisements for job vacancies (annually)	2007-12	EURES	Yes	Partly		
National projects						
Skill survey	1997	Great Britain	Yes	No		
Skill survey	2006		Yes	No		
BIBB/IAB-Erhebung	1999	Germany	Yes	No		
BIBB/BAuA – Erwerbstätigenbefragung	2006		Yes	Yes	Partly	Yes
BIBB/BAuA – Erwerbstätigenbefragung	2012		Yes	Yes	Only 2012	
Kooperationsprojekt Absolventenstudien – KOAB	2010		Yes	Yes	Partly	
Absolventenstudie – ARUFA	2010	Austria	Yes	Yes	Partly	
Indagine sulle professioni	2006-07	Italy	Yes	Yes	Yes	Yes
Advertisements for job vacancies (NIVE)	1999-10	Czech Republic	Yes	Yes	Partly	
Kvalifikace (EPC)	2007-08		Yes	Yes	Yes	Yes
Uplatnění (NIVE)	2002-03		Yes	Yes	Partly	
Složitost práce (CAS)	2000-05		Yes	Yes	Partly	
Tarify (Trexima)	2008-12		Yes	Yes	Partly	
DOT	1950-96	US	Yes	Yes	No	
O*NET	2000-12		Yes	Yes	Yes	Yes
BLS	1996-2012		Yes	Yes	Yes	Yes

Source: Author.

1.3.1. European social survey (ESS)

The European social survey has been an important source for defining some of the main dimensions of occupational skills profiles, the level and the field of education.

The ESS is a research programme of the European Science Foundation focused particularly on value orientation and the social structure of current European societies. Although the ESS is not primarily focused on skill needs and job holder qualifications, it contains relevant information in this respect. Its major advantage is its continuing nature and opportunity to obtain data for relatively extensive samples of the adult population across a wide age span; it has almost 200 000 respondents in about 30 European countries. The ESS surveys take place every two years, with five rounds implemented so far: the ESS-1 in 2002/03, the ESS-2 in 2004-05, the ESS-3 in 2006-07, the ESS-4 in 2008-09 and the ESS-5 in 2010-11.

The most interesting stages in identifying skill needs were the ESS-2 and ESS-5; both contain an additional special module, focused on education, qualification, work and employment. Only data coming from countries participating in the project as well as in the ESS-2 and ESS-5 have been used for the analysis. The ESS-2 and ESS-5 data sets developed and analysed for the purpose of this study cover nearly 100 000 respondents from 20 European countries (Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the UK).

The characteristics of the respondents (job holders) also include identification of the sector where they work, in line with the 2-digit NACE/ISIC, and identification of the occupation performed according to the 4-digit ISCO. It also carries the level of educational attainment (in most countries it is possible to define 6-8 comparable levels of education, though some countries do not have all the levels), and the field of education (the ESSs distinguish 14 fields of education and training defined on the basis of ISCED).

In 2010, however, a new classification was prepared which amalgamated existing distinct systems and defined new common educational levels. It was carefully constructed using an elaborate methodology (Schneider, 2009) in cooperation with experts on individual countries. The new classification, applied in the ESS-5 and also used for reclassifying data gathered in all previous surveys forming the ESS database, defines educational levels in various ways depending on how detailed they are (compare the three columns in Table 3).

The ESS-ISCED classification (second column of Table 3) has been adopted in this study. However, the seven levels as defined were supplemented with the eighth doctoral level (ISCED 6) indicated in the more detailed classification ESS-ISCED subgroups (see the third column). Our new eight-level classification is closer to the new ISCED 2011. In some countries where the new classification has not been used, exceptionally all levels – that is the entire classification of education – have been re-calculated.

Table 3 **Highest level of education, ESS-ISCED**

EU-LFS	ESS-ISCED	ESS-ISCED subgroups (for ESS-5 only)
Low	ESS-ISCED I, less than lower secondary	Not completed ISCED 1
		ISCED 1, completed primary education
		Vocational ISCED 2C < 2 years, no access ISCED 3
	ESS-ISCED II, lower secondary	General/pre-vocational ISCED 2A/2B, access ISCED3 vocational
		General ISCED 2A, access ISCED 3A general/all 3
		Vocational ISCED 2C ≥ 2 years, no access ISCED 3
		Vocational ISCED 2A/2B, access ISCED 3 vocational
		Vocational ISCED 3C < 2 years, no access ISCED 5
Middle	ESS-ISCED IIIb, upper secondary, vocational or no access V1	General ISCED 3 ≥ 2 years, no access ISCED 5
		Vocational ISCED 3C ≥ 2 years, no access ISCED 5
		Vocational ISCED 3A/3B, access 5B/lower tier 5A
	ESS-ISCED IIIa, upper secondary, general and/or access to V1	General ISCED 3A/3B, access ISCED 5B/lower tier 5A
		General ISCED 3A, access upper tier ISCED 5A/all 5
		Vocational ISCED 3A, access upper tier ISCED 5A/all 5
	ESS-ISCED IV, advanced vocational, subdegree	General ISCED 4A/4B, access ISCED 5B/lower tier 5A
		General ISCED 4A, access upper tier ISCED 5A/all 5
		ISCED 4 programmes without access ISCED 5
		Vocational ISCED 4A/4B, access ISCED 5B/lower tier 5A
		Vocational ISCED 4A, access upper tier ISCED 5A/all 5
High		ISCED 5A short, intermediate/academic/general tertiary below
		ISCED 5B short, advanced vocational qualifications
	ESS-ISCED V1, lower tertiary education, BA level	ISCED 5A medium, bachelor/equivalent from lower tier tertiary
		ISCED 5A medium, bachelor/equivalent from upper/single tier
	ESS-ISCED V2, higher tertiary education, >= MA level	ISCED 5A long, master/equivalent from lower tier tertiary
		ISCED 5A long, master/equivalent from upper/single tier tertiary
		ISCED 6, doctoral degree

Source: ESS.

1.3.2. O*NET

Analyses of available sources have shown that the most suitable information about qualification and other skill needs is to be found in the US occupational information network.

O*NET is a comprehensive online system for collecting, organising and disseminating occupational data. It was launched in 1998 by the US Department

of Labour, replacing the dictionary of occupational titles (DOT), developed more than 50 years ago and existing in a printed form up to the mid-1990s. O*NET data inform of important activities in workforce development, economic development, career development, academic and policy research, and human resource management.

A new version of the O*NET database is usually published annually in late June. After some structural changes and the introduction of version 5.0 in April 2005, data have been consistent, the characteristics of about 750 individual occupations have remained quite stable, and they every year 100-120 occupations have been updated. Thus it is possible to monitor and analyse their development and change. The O*NET 17.0 database, published in July 2012, represents the most recent update of the data collection programme.

The two O*NET core elements are a content model and an electronic database fed by a data collecting programme.

The content model ([4]) provides a framework for more than 400 variables describing about 1 100 occupations based on the SOC. The descriptors are organised into six major domains, which enable the user to focus on areas of information that specify the key attributes and characteristics of workers (the first three domains) and of jobs (the last three domains), and are either cross-occupational or occupation-specific:

(a) worker characteristics, comprising enduring characteristics that may influence both work performance and the capacity to acquire knowledge and skills, such as abilities, occupational interests, work values and work styles;
(b) worker requirements, representing attributes developed and/or acquired through experience and education, such as work-related knowledge and skills, which are divided into basic skills and cross-functional skills;
(c) experience requirements, including information about the typical experiential background of workers including certification, licensure, and training data;
(d) occupational requirements, describing typical activities required across occupations, as generalised and detailed work activities occurring on multiple jobs, plus contextual variables (factors physical, social and organisational);
(e) labour market characteristics, linking descriptive occupational information to statistical market information (including compensation and wage data, employment outlook and industry size information);

([4]) More details at http://www.onetcenter.org/content.html [accessed 24.10.2012].

(f) occupation-specific information, applying to a single occupation or a narrowly defined job family.

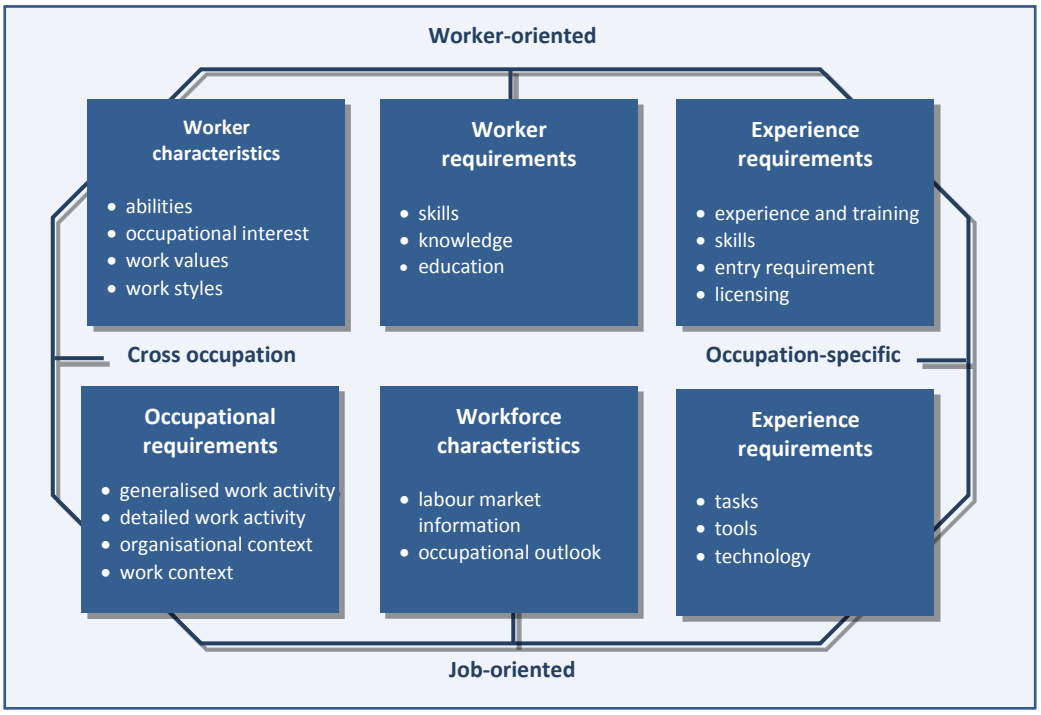
Table 4 **O*NET release history**

O*NET 98	October 1998	Release of the original 'analyst database' based on the occupational employment statistical (OES) classification
O*NET 3.0/3.1	August 2000/ June 2001	Database classification converted to conform to the new standard occupational classification system (SOC)
O*NET 4.0	June 2002	Release of the final 'analyst database' with a revised database structure consistent with the OMB-approved data collection programme
O*NET 5.0	April 2003	First update of database from data collection programme with a comprehensive update of 54 occupations
O*NET 5.1	November 2003	Occupational- and item-level metadata added to the O*NET database
O*NET 6.0	July 2004	Second update of database from data collection programme with a comprehensive update of 126 occupations
O*NET 7.0	December 2004	Third update of database from data collection programme with a comprehensive update of 100 occupations
O*NET 8.0	June 2005	Fourth update of database from data collection programme with a comprehensive update of 100 occupations
O*NET 9.0	December 2005	Fifth update of database from data collection programme with a comprehensive update of 100 occupations
O*NET 10.0	June 2006	Sixth update of database from data collection programme with a comprehensive update of 100 occupations; release of the updated O*NET taxonomy – O*NET-SOC 2006
O*NET 11.0	December 2006	Seventh update of database from data collection programme with a comprehensive update of 101 occupations
O*NET 12.0	June 2007	Eighth update of database from data collection programme with a comprehensive update of 100 occupations
O*NET 13.0	June 2008	Ninth update of database from data collection programme with a comprehensive update of 108 occupations
O*NET 14.0	June 2009	10th update of database from data collection programme with a comprehensive update of 117 occupations; release of the updated O*NET taxonomy – O*NET-SOC 2009
O*NET 15.0	June 2010	11th update of database from data collection programme with a comprehensive update of 120 occupations
O*NET 15.1	February 2011	Release of the updated O*NET taxonomy – O*NET-SOC 2010, based on the SOC 2010
O*NET 16.0	July 2011	12th update of database from data collection programme with a comprehensive update of 107 occupations
O*NET 17.0	July 2012	13th update of database from data collection programme with a comprehensive update of 108 occupations

Source: Bureau of Labour Statistics (BLS).

Although the O*NET has been used as a prime source for several characteristics, other sources have been used whenever possible. Among them, two European surveys on occupation have closely followed the O*NET approach: the Italian survey Indagine sulle professioni and the Czech survey Kvalifikace 2008.

Figure 2 **The O*NET content model**



Source: O*NET resource center, http://www.onetcenter.org/content.html [accessed 13.11.2012]. Prepared by the National center for O*NET development for the US Department of Labour.

1.3.3. US BLS education and training requirements categories

The *Occupational outlook handbook* ([5]), produced by the Office of Occupational Statistics and Employment Projections of the Bureau of Labour Statistics, gives detailed descriptions of the education and training requirements of about 750 occupations of the SOC 2000. Each of them is classified by education and training categories, enabling estimates of the education and training needs for the population as a whole and of the outlook for workers with various types of educational and training attainment. Since 1994, this classification system has been used for all employment projections that are carried out by the BLS every second year, always following the publication of a new US BLS projection.

Up to the projection published at the end of 2009, the BLS identified 11 education and training categories defined as the most significant source of education or training needed to become qualified in an occupation, also including non-educational paths of entry, such as on-the-job training and work experience. By construction, these categories were intended to be mutually exclusive and

([5]) http://www.bls.gov/ooh/ [accessed 8.11.2012].

exhaustive, and BLS economists and other relevant experts were asked to assign each occupation to one of these categories based on their knowledge and judgment. In consequence, the system did not show that an occupation might have multiple entry requirements, both on-the-job training and education.

This system has proved confusing, as it combines different dimensions of education, training, and work experience in a related occupation into one classification system. For example, in some occupations both post-secondary education and a long-term on-the-job training are important, but in the existing system these are two distinct and mutually exclusive categories. Other examples are occupations where both education and work experience in a related occupation are important. Also, the system does not include any category for education below secondary level ([6]).

At the end of 2011 a new system was published, eliminating the problems and presenting a more complete picture of the education and training needed for entry into a given occupation. All occupations are assigned an education category, a training category, and a related work experience category, and the education categories include both high school level and below ([7]):

(a) entry level education; this represents the typical education level needed to enter an occupation. There are eight possible assignments for this category.
    (i) doctoral or professional degree,
    (ii) master degree,
    (iii) bachelor degree,
    (iv) associate degree,
    (v) post-secondary non-degree award,
    (vi) some college, no degree,
    (vii) high school diploma or equivalent,
    (viii) less than high school,

(b) work experience in a related occupation; this indicates if work experience in a related occupation is commonly considered necessary by employers for entry into the occupation, or is a commonly accepted substitute for formal types of training. Assignments for this category will be more than five years, one to five years, less than one year, or none;

([6]) At the same time we have to be aware of the fact that American high schools are very different and have different goals from various types of secondary education institutions in Europe.

([7]) Detailed definitions for the categories are available at http://www.bls.gov/emp/ep_definitions_edtrain.pdf [accessed 24.10.2012].

(c) typical on-the-job training; this indicates the typical on-the-job training needed to attain competence in the occupation. Assignments for this category include internship/residency, apprenticeship, long-term, moderate-term, or short-term on-the-job training, or none.

Under the new system an education assignment for several occupations could be naturally different from the prior system. The new system assigns a typical entry level education, while the prior system assigned the most significant source of education or training, so some occupations will have a different education level assigned than previously.

Some occupations could have more than one way to enter. The assignments under the new system describe the typical education needed to enter, and the typical type of on-the-job training required to be competent. The work experience in a related occupation assignment represents what is commonly considered necessary by employers or is a commonly accepted substitute for formal training. The three assignments complement each other in that they would represent a typical path of entry into the occupation, but they are not necessarily equal in importance for entry into the occupation.

1.3.4. BIBB/BAuA Erwerbstätigenbefragung (Germany)

Periodic employment surveys on qualification and working conditions have been conducted in Germany every five to seven years since 1979 by the Federal Institute for Vocational Education and Training (BIBB). The last (2006) survey was conducted by the BIBB in cooperation with the Federal Institute for Occupational Safety and Health (BAuA). A new survey BIBB/BAuA-Erwerbstätigenbefragung 2012 is under preparation but data will not be available before 2013 and most probably not even before 2014.

It was possible to have access to the database of the last survey – BIBB/BAuA Erwerbstätigenbefragung 2006 – that was focused both on the job and on the match between current job skill requirements and respondent qualification. The representative sample of 20 000 respondents was selected from employed persons over 15 years of age having paid work for more than 10 hours weekly (this definition covers 96% of the active labour force). The size of the sample allowed differentiation by occupational groups and the identification of diverse target groups (such as old age, female, non-formally qualified workers).

The 2006 survey had four main research themes: activities and requirements of, and access to, jobs; changing a job and job flexibility; use of qualification attained, job satisfaction and success; and participation in lifelong learning., The questionnaire was structured into four corresponding parts: job characteristics (job tasks, job skills requirements, other specific requirements,

work load, working conditions, health, employment status, wage, changes and innovation); job holder characteristics (e.g. educational and career history); match between the job and the job holder characteristics (i.e. to what degree does the job holder meet job requirements); and supplementary questions relating to the respondent and the firm.

1.3.5. Indagine sulle professioni (Italy)

The Italian survey on occupations was conducted in 2006-07, and involved interviews with a sample of 16 000 respondents from the Italian population in employment. Its final objective was to construct an information system capable of describing the characteristics of all existing occupations in the Italian labour market. A great advantage of the Italian survey lies in the fact that it was modelled on the O*NET system, thus making it possible to test the degree of similarity between the American O*NET and the Italian system (and, to a lesser degree, the Czech survey Kvalifikace) and to verify the suitability of using the O*NET database for dimensions three to seven in the European context.

The survey is focused on measuring the importance and complexity level of about 400 variables for 810 individual occupations of a new occupational classification (derived from the official classification of the Italian Statistics Office) that can be mapped onto the third level of ISCO. The questionnaire is divided into 10 sections covering what is required of the worker to perform the job (education and training, occupation, knowledge, skills, abilities), what would affect his performance (aptitudes, values, work styles), and further characteristics of the job (transversal activities common to many different occupations, environmental conditions, specific activities not adequately represented in the questionnaire).

A new survey Indagine sulle professioni 2012, again organised by ISTAT together with ISFOL, will be carried out in 2012-13.

1.3.6. Kvalifikace (Czech Republic)

An extensive survey on qualification was also conducted in the Czech Republic at the turn of 2007-08 with a sample of nearly 6 000 working active respondents. It followed a similar survey carried out in 2002-03 and research into the employment situation of graduates implemented in 1997-98 and again in 2011. It was informed by indicators used as part of the US O*NET and the British skills survey, and took account of questions used in the ESS-2 as well as three EQF dimensions (knowledge, skills, competence). In the Czech Republic both regular surveys (e.g. the Czech LFS) and one-off research projects (e.g. the Kvalifikace project) use the valid ISCO classification of occupation to identify the respondent’s job.

A substantial part of the survey Kvalifikace was concerned with qualification requirements for each job, the qualification of each job holder and the extent to which school education and other skills contributed to the acquisition of the qualification. The information about various aspects or dimensions of qualification requirements for a job includes some 30 characteristics and about 50 indicators. This is why it has been possible to use the survey Kvalifikace not only for constructing dimensions one and two of OSPs, but also – together with the Italian survey Indagine sulle professioni – for testing the degree of similarity between the outcomes of the US O*NET and both European surveys; this was able to verify the suitability of the O*NET database for constructing dimensions three to seven in the European context.

1.3.7. EURES database and further potential sources

Along with sources classified as employee surveys and/or expert surveys, EURES data sets, which indicate employer requirements, have also been analysed.

The European job mobility portal EURES (European employment services) was established by the European Commission in 1993. Its partnership includes public employment services, trade unions, and employer organisations. Its main function is to advertise vacancies entered into the system by employers; its main objectives are to inform, guide and provide advice to potentially mobile workers on job opportunities and living and working conditions in the European Economic Area (EEA), to assist employers wishing to recruit workers from other countries, and to provide advice and guidance to workers and employers in cross-border regions. In recent years the EEA has made between 600 000 and 800 000 vacancies available from more than 20 000 employers. Data has been gathered from the EURES web page every May since the year 2007, capturing the structure of educational requirements of employers across Europe.

Use of EURES has both positive and negative aspects. Despite the considerable size of the EURES database, its use is limited to about 10% of the original sample many advertisements do not specify education required. Also, the occupations presented are only classified at the ISCO 2-digit level. To disaggregate the EURES data from the ISCO 2-digit to the ISCO 3-digit, more detailed national analyses of employer advertising have been used. Still, the EURES data is appropriate for international comparison of qualification as required by employers within various groups of occupations, and the analyses carried out have confirmed a relatively high level of consistency in qualification requirements for jobs belonging to the relevant occupational groups in various countries.

During recent years the quality of EURES data (on occupation and particularly on education required) has gradually deteriorated. The economic crisis has confirmed that employer requirements are highly dependent on the phase of the economic cycle and so are not reliable for long-term predictions of skills requirements. In 2007, when labour demand for labour was very high, advertisements were numerous; education was required less often and usually of a not such a high level. In 2009, that is during the first wave of the financial and economic crisis, demand for labour fell markedly, far fewer advertisements were published (and the proportion of web ads increased) but education was required more often and of a much higher level. Analysing the EURES database has suggested that it is not possible to include it in the model but it has been most interesting to use its results to compare with results from other surveys.

As well as EURES, other extensive surveys of employer requirements based on advertisements in newspapers, journals and on the web, carried out in the Czech Republic in 2000, 2005, 2007 and 2009, have been analysed. A sufficient number – almost 28 000 advertisements – contained qualification requirements for occupations at the ISCO 3-digit. The level of education, defined on a five-point scale (as in EURES), was translated into the eight-point scale. The existence of a comparatively long time series it has made possible to formulate some interesting conclusions concerning the relationship between qualification requirements and the economic cycle. They have confirmed that employer requirements are less demanding during economic boom times with a workforce shortage.

Other international surveys and projects – such as the international social survey programme (ISSP), the OECD international adult literacy survey (IALS and SIALS) from the 1990s, or the new OECD programme for international assessment of adult competences just under way in many OECD countries – have also been analysed. The results of the OECD project PIAAC, available in the autumn 2013, will be important for developing further the concept of OSPs as well as for gaining more adequate data. They will enable not only verification and, if necessary, modification of the current model of OSPs, but also creation and testing of country-specific versions.

1.4. Consistency of OSP with other European classifications

To achieve a reasonable degree of consistency, the proposed structure of OSPs basically conforms to the EQF (Box 4). Their most important dimensions (the level of qualification requirements and the three dimensions of main characteristics) are defined exactly as in the EQF. All available information on

their characteristics has been restructured accordingly. Also, other important European documents have been considered, notably the recommendations on key competences for lifelong learning (European Parliament and Council of the EU, 2007; 2008).

Box 4 **European qualifications framework**

The EQF is a common European reference framework which links national qualification systems. It has three main structural features. First, it defines eight reference levels spanning the full scale of qualifications, from basic to the most advanced levels. Second, the eight reference levels are defined in terms of learning outcomes described by generally applicable descriptors. Third, learning outcomes – that is what a learner knows, understands and is able to do on completion of a learning process – are specified in three categories as knowledge, skills and competence.

CHAPTER 2.

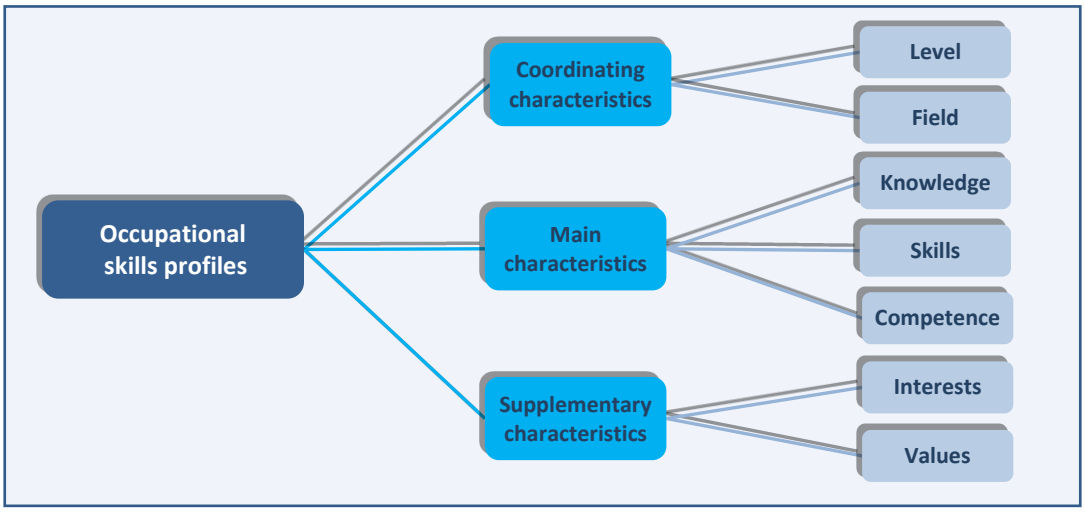
Structure and contents of occupational skills profiles

This study uses data and information from various sources: international and national classifications of occupations and of sectors, data gathered by the European social survey, the US Bureau of labour Statistics and German BIBB data, and those contained in the US information system O*NET and in the Italian and Czech surveys. None of them describe all jobs in a given occupation; when the same occupation is present in different sources it can have slightly different contents and qualification requirements, even within regions or enterprises of a country. This is why we consider that information from the US describing the contents and complexity of different jobs and occupations is not necessarily less relevant than information from an individual European country or even from an international European survey.

To use O*NET data for Europe, a correspondence table for classifications of occupations has been completed with information from the US BLS. It has thus been possible to use the O*NET system, that is able to define and quantify 700-800 occupational units, far more than European sources where the only data available at ISCO 3-digit level is in 110-120 occupational groups.

On this basis, OSPs summarise qualification requirements of occupations in a standard and comparable way. The OSP structure is based on seven occupational dimensions forming three main groups (Figure 3). The first two dimensions – grouped together as coordinating characteristics – relate to the level and field of education and training required. Three further dimensions – together referred to as main characteristics – contain what is required to perform the job in terms of theoretical and factual knowledge, cross-functional skills, and personal, social and methodological abilities. They are defined and structured according to the EQF (European Commission, 2008a). The last two dimensions – under the heading of supplementary characteristics – add information relating to the profile and orientation of work, such as occupational interests (preferences for work environment) and work values (important to job satisfaction). They are important on the individual level as they allow us to compare job and job holder characteristics and matching.

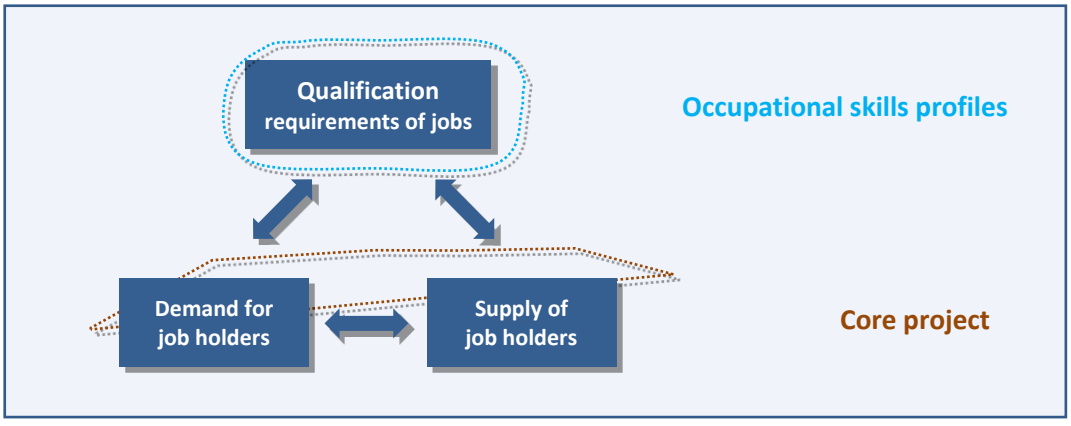
Figure 3 **Occupational skills profile: main dimensions**



Source: Author.

OSPs focus on the requirements of jobs, not on the qualification of job holders. Dynamically linking the characteristics of OSPs with Cedefop labour market forecasting, in terms of number of jobs in sectors and occupations, allows to project individual dimensions and characteristics of OSPs. What is important is the possibility of choosing different levels of aggregation: EU as a whole, selected countries, selected sectors, etc. By comparing the estimates of labour demand with the estimates of labour supply by qualification it is possible to compare job requirements with the qualifications of job holders (Figure 4).

Figure 4 **OSPs and the core projections of supply of and demand for qualifications**



Source: Author.

The structure of OSPs is basically consistent with the EQF. The definition and contents of the most important dimensions correspond directly to the EQF. Eight levels of reference were originally used for the first dimension, although later they have been aggregated into three broad levels corresponding to those used in the Cedefop forecast, and the third to the fifth dimensions are defined in terms of learning outcomes (knowledge, skills and competences).

The basic content structure has been filled with data taken mainly from two groups of major sources. The first includes the European social survey and other European surveys, whose data have been used for the elaboration of coordinating characteristics. The second source is the O*NET database, used for information that could not be covered by European sources, and specifically for the elaboration of the three dimensions included in the main characteristics and the two dimensions of supplementary characteristics. It also contributed to the determination of the first dimension.

Of the six O*NET domains (Figure 1) only those that concern general qualification requirements have been used (those that correspond to generic skills). Three domains included in the O*NET – labour market characteristics, occupation-specific information and experience requirements – have been excluded from our analysis (together with detailed work activities, education, abilities (partly), and organisational context from other domains).

The same approach was followed by the Italian survey, Indagine sulle professioni. This only used the relevant parts of the O*NET, defining them as knowledge, skills, abilities, work values, work styles, and generalised work activities. A similar approach has also been applied to selected characteristics in the Czech survey, Kvalifikace.

To achieve a reasonable degree of consistency, the proposed structure of OSPs basically conforms to the EQF. The most important dimensions (the level of qualification requirements and the three dimensions of main characteristics) are defined exactly as in the EQF, and all available information on their characteristics has been restructured accordingly. Other important European documents have also been considered, notably the recommendations on key competences for lifelong learning.

2.1. Coordinating characteristics

2.1.1. Dimension I: level of qualification requirements

Dimension I describes the level of qualification requirements, not of job-holders. It is defined for all groups of jobs at the level of ISCO 3-digit occupations (about

110-120 groups of occupations) and 38 industries. As it changes in time, it is defined for three years: 2000, 2010 and 2020.

Originally the eight-level scale as defined by the EQF was used, serving as the vertical axis of the profile. Subsequently, the eight-level scale has been aggregated into a three-level scale corresponding to the three broad levels (low, medium and high) adopted in Cedefop forecast. Low level includes level 1 and 2 of the eight-level scale, medium level includes level 3 to 5 of the eight-level scale, and high level includes the original levels 6 to 8. The degree of aggregation in the Cedefop projection has also determined that dimension I is defined for groups of jobs at the level of ISCO 2-digit occupations (only 27 groups of occupations) per 38 industries.

Two values for each occupation are indicated: the percentage distribution of individual characteristics (making together the profile of the occupation) across all levels of complexity (their total equalling 100%); and the required average years of education. All available relevant data sources have been used to develop a single vertical indicator of the required level of qualification.

2.1.1.1. *Data sources used*

Available data sources are relatively limited and use three different approaches. In job holder (employee) surveys, job holders are questioned and surveyed, and in that way a description of qualification requirements of a given job is obtained. Research studies and surveys of this type are perhaps the most numerous and enjoy the longest tradition. It is, therefore, possible to acquire, in addition to extensive evidence from national projects, some interesting international data. Both international and main supplementary national sources used in this study – the ESS, the US O*NET, the German Erwerbstätigenbefragung, the Czech Kvalifikace and the Italian Indagine sulle professioni – belong to this category.

Further supplementary sources have a different character. Expert analyses define qualification requirements of every job in a given area based on qualified judgment by a selected group of experts. This approach has been used for the US BLS education and training requirements categories (and partly also for the O*NET).

Employer requirements vary from employers advertising new jobs or vacancies to special surveys concerning their current or possible future employees, or expert studies of various recruitment agencies. However, most of them are not as systematic as the other two approaches, and can be used only exceptionally. Our analyses indicate further arguments as to why employer requirement surveys are not suitable for long-range projections (Section 1.3.7. on EURES, European employment services).

All sources define the level of qualification requirements in terms of the education level attained (alternatively as the required number of years of education or the certificate obtained), and this information has to be transposed into the vertical EQF scale.

2.1.1.2. *European social survey*

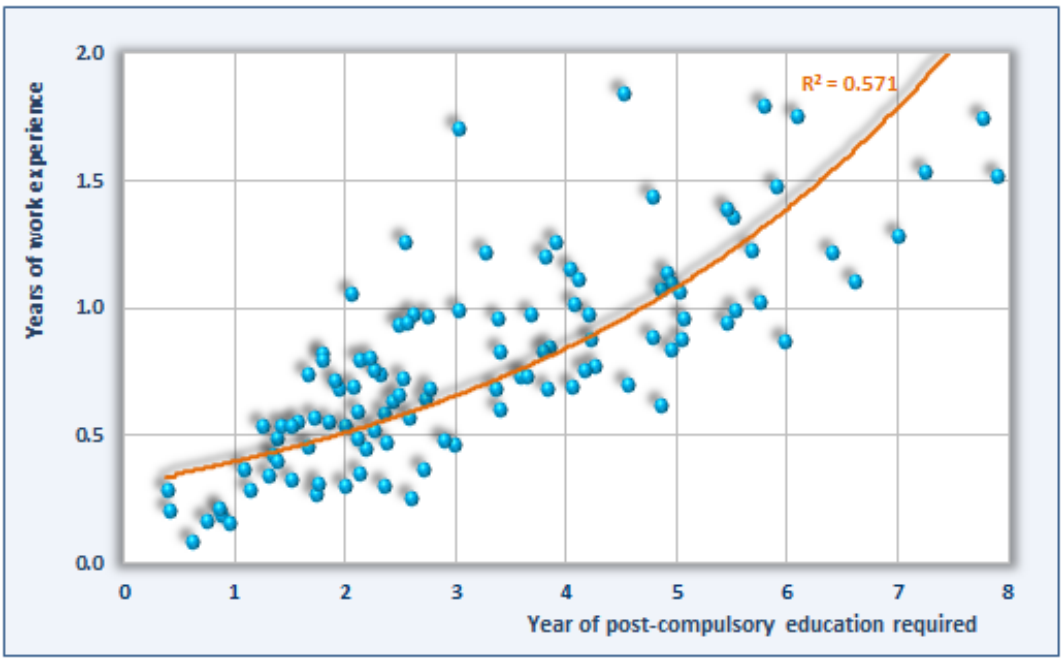
The special module of the ESS-2 and ESS-5 contained three questions influenced mainly by the British skill survey and US research. They focused on identification of skill needs and other job characteristics, defined by the length of post-compulsory education and by the length of work experience. This has made it possible to develop an overall indicator of the level of qualification requirements defined as a sum of both time-related data. It has also enabled analysis of the relationship between length of necessary education or vocational training and length of necessary practical experience. Although the two characteristics are related, there are jobs characterised by strong demands in terms of length of education and vocational training which do not require extensive practical experience, and vice versa. However, requirements for formal initial education also match about 57% of the requirements for practical experience (Figure 5).

A significant advantage of ESS-2 and ESS-5 is that they make it possible to analyse consistently changes in time within individual occupations. As the time-lag is only six years, it is necessary to extrapolate them to a 10-year period used in the model (2000-10). Data from the O*NET and the BLS can be used to test resulting changes.

The ESS-2 and ESS-5 data also allow us to explore the relationship between education attained by employees and education required by the job (Table 5 for ESS-2 and ESS-3). For example, ESS data confirms that between years 2004/05 and 2010/11 the level of education of workers has increased markedly whereas qualification requirements have increased little, as indicated by job holders.

Even so, the relationship between education attained and required is relatively strong, as around two thirds of the employed do jobs that roughly correspond to their education. This proportion has not changed much in the period under scrutiny. Some changes, however, have occurred regarding both the groups employed with mismatched education. The undereducated rate declined from 24% to 18% of employed, while the overeducated rate rose from 11% to 16%, suggesting that the proportions for both groups are becoming similar.

Figure 5 **Relationship between education and experience required**



Source: Author.

Data about education required can be linked with data about occupation performed. As an example, the distribution of education required in respective occupational groups at ISCO first level is indicated. Results of both surveys have confirmed a relatively high dispersion of education required as assessed by job holders, which differs from the assessment by experts.

The comparison of new ESS data (ESS-5, 2010-11) containing a module that explores education required and attained in 25 European countries and ESS-2 data (2004-05) makes it possible to carry out not only detailed analyses of mismatches and imbalances among European countries involved in ESS, but also analyses of changes during the six-year period.

Data about qualification requirements generated on the basis of both characteristics as defined in the ESS-2 and ESS-5, were translated into the eight-degree scale as defined by the EQF. Based on the data from the EU-LFS 2004-05 and from the EU-LFS 2010-11 the characteristics of individual jobs are weighed again for the purpose of further analyses and assigned to groups of occupations in line with the ISCO 3-digit and to groups of sectors in line with the NACE 2-digit.

Table 5 **Relationship between education and qualification required**

Highest level of education	Years of education beyond compulsory needed by applicant for your job (%)									
	No education needed	Less than 1 year	About 1 year	About 2 years	About 3 years	About 4-5 years	About 6-7 years	About 8-9 years	10 years or more	Total
ESS-2 (2004/05)										
ESS-ISCED I, less than lower secondary	1	0	0	0	0	0	0	0	0	3
ESS-ISCED II, lower secondary	2	1	1	1	1	1	0	0	0	7
ESS-ISCED IIIb, lower tier upper secondary	3	2	2	3	11	4	0	0	0	26
ESS-ISCED IIIa, upper tier upper secondary	2	2	2	3	5	10	1	0	0	27
ESS-ISCED IV, advanced vocational, subdegree	1	1	1	1	3	3	1	0	0	11
ESS-ISCED V1, lower tertiary education, BA level	0	0	0	1	2	4	3	1	0	12
ESS-ISCED V2, higher tertiary education, MA level	0	0	0	0	1	3	3	4	2	13
ESS-ISCED V3, highest tertiary education, PhD level	0	0	0	0	0	0	0	0	1	1
Total	10	6	7	10	24	25	9	6	3	100
ESS-5 (2010/11)										
ESS-ISCED I, less than lower secondary	1	0	0	0	0	0	0	0	0	2
ESS-ISCED II, lower secondary	2	1	1	1	1	1	0	0	0	7
ESS-ISCED IIIb, lower tier upper secondary	3	2	2	3	9	3	0	0	0	21
ESS-ISCED IIIa, upper tier upper secondary	3	3	3	3	5	9	1	0	0	26
ESS-ISCED IV, advanced vocational, subdegree	1	1	1	2	3	3	1	0	0	13
ESS-ISCED V1, lower tertiary education, BA level	0	0	1	1	3	4	2	1	0	12
ESS-ISCED V2, higher tertiary education, MA level	1	1	1	1	1	5	3	4	2	19
ESS-ISCED V3, highest tertiary education, PhD level	0	0	0	0	0	0	0	0	0	1
Total	11	8	8	9	23	24	8	6	4	100

Source: Author.

Table 6 **Qualification requirement and group of occupation (ISCO-88)**

Highest level of education	Years of education beyond compulsory needed by applicant for your job (%)									
	No education needed	Less than 1 year	About 1 year	About 2 years	About 3 years	About 4-5 years	About 6-7 years	About 8-9 years	10 years or more	Total
ESS-2 (2004/05) and ESS-5 (2010/11)										
ISC0 1	0	0	0	0	1	3	1	1	0	6
ISC0 2	0	0	0	0	1	6	3	3	1	15
ISC0 3	0	0	0	1	4	8	2	1	0	17
ISC0 4	1	1	1	1	3	4	0	0	0	11
ISC0 5	3	1	1	2	6	2	0	0	0	15
ISC0 6	0	0	0	0	1	0	0	0	0	3
ISC0 7	1	1	1	1	7	2	0	0	0	14
ISC0 8	2	3	2	1	3	1	0	0	0	13
ISC0 9	4	1	0	0	0	0	0	0	0	6
Total	13	7	7	8	28	25	6	4	2	100

Source: Author.

2.1.1.3. *US BLS education and training requirements categories*

The US BLS classification system can be used to estimate the number of jobs that will fall into each education and training category; this provides information on the current and future workforce training needs. Categorisation of occupations by qualification requirements based on expert analyses significantly differs from the results of surveys of qualification requirements based on job holders. The most important difference is that job holder surveys usually put each occupation into more categories indicating their average, median and variation; expert surveys indicate only one exclusive category, differing estimates of individual experts are not usually published. It is thus possible to provide for each level of qualification requirements the list of corresponding occupations, in contrast to job holder surveys where an occupation is often listed under more levels.

Table 7 provides the current employment distribution for 11 education and training categories ([8]). It includes not only the data from the last (2010-20) BLS employment projection published in 2012 but also from the previous ones starting in 1996 ([9]). The total numbers of occupations by education and training category are also listed.

([8]) Detailed definitions for the categories are available at: http://www.bls.gov/emp/ep_definitions_edtrain.pdf [accessed 25.10.2012].

([9]) The next BLS projection for the 2012-22, containing analogous data for 2012, will be published in November 2013.

Table 7 **Number of occupations by education and training category, 1996-2010**

Most significant source of education and training	1996	2002	2004	2006	2008	Typical education needed for entry	2010*
First professional degree	8	9	13	13	13		
Doctoral degree	6	8	9	10	11	Doctoral or professional degree	25
Master degree	9	32	35	33	32	Master degree	29
Bachelor degree, plus work experience	15	32	35	35	33		
Bachelor degree	69	102	107	114	112	Bachelor degree	153
Associate degree	15	37	42	41	42	Associate degree	47
Post-secondary vocational award	31	47	51	50	55	Post-secondary non-degree award	40
Work experience in a related occupation	36	47	45	48	48	Some college, no degree	6
Long-term on-the-job training	83	86	89	91	87	High school diploma or equivalent	353
Moderate-term on-the-job training	119	186	189	183	179	Less than high school	97
Short-term on-the-job training	119	138	139	135	138		
Total	510	724	754	753	750	**Total**	750

* A new system was finalised in 2011 and is now available for use with the 2010-20 employment projections. It replaces the earlier 11-category education or training system.
Source: Author.

The basic advantage of the BLS database is the possibility of analysing information on changes to qualification requirements within occupations since 1996 up to the present. The BLS database is one of the three main sources for tracking inherent changes of qualification requirements of all occupations over time.

2.1.1.4. *O*NET*

Four questions from the O*NET questionnaire directly concern the level of qualification required for the job. They relate to required level of education, required related work experience, required on-site or in-plant training, and required on-the-job training. They cover all facets of qualification as well as their mutual relationship, which is only illustrated by Table 8.

Table 8 **Average length of practical training/experience by required level of education**

Required level of education	Average length in months		
	On-site or in-plant training	On-the-job training	Related work experience
Less than a high school diploma	9	11	22
High school diploma	28	35	69
Post-secondary certificate	14	17	35
Some college courses	8	10	26
Associate degree	10	11	31
Bachelor degree	22	28	89
Post-baccalaureate certificate	2	3	8
Master degree	6	7	27
Post-master certificate	1	1	3
First professional degree	2	2	5
Doctoral degree	3	4	13
Post-doctoral training	3	3	8
Total	9	11	28

Source: Author.

A great advantage of the O*NET is the fact that its database was created in 2003 and, at least since 2005, it is consistent in time both from the point-of-view of job characteristics examined and from the point-of-view of the classification of occupations. It is thus possible also to use the O*NET database to analyse changes in qualification requirements within occupations.

2.1.1.5. *BIBB/BAuA Erwerbstätigenbefragung*

Data from the German 2006 employment survey (Section 1.3.4.) have also been used to define the 1st and 2nd dimensions of the OSP. The data of active respondents are transformable both to the NACE classification (38 sectors) as

well as to the ISCO 3 digits (about 110-120 groups of occupations). Table 9 illustrates only one aspect of this approach; the match between qualification required and actually achieved has been acceptable for more than two thirds of respondents.

Table 9 **Relationship between qualification required and achieved BIBB/BAuA Erwebstätigenbefragung**

What is the highest level of education you have attained?	Comparison of last qualification with present job			Total
	Present job matches with what the qualification prepares for	Present job is related to the qualification	Present job has nothing to do with the qualification	
Primary – ISCED 0+1	0	0	0	0
Lower secondary – ISCED 2	0	0	0	0
Upper secondary – ISCED 3C	15	17	19	52
Upper secondary – ISCED 3AB+4	3	4	3	10
Tertiary – ISCED 5B	4	5	3	13
Higher short – ISCED 5A short	4	5	2	10
Higher long – ISCED 5A long + 6	5	7	3	15
Total	32	37	31	100

Source: Author.

2.1.1.6. *Kvalifikace*

One of the objectives of the Czech survey Kvalifikace 2008 was to develop, test and make an empirical map of job qualification profiles. The survey replicated the three questions about qualification contained in the ESS-2 in 2004-05 and added further two questions: what education do you consider to be the most appropriate for the job you are currently doing (the answers involved 12 different levels of education or types of school ranging from incomplete basic education to a doctoral degree so as to cover the widest possible spectrum of options); and how does your qualification meet your current job requirements (adequate qualification, over-qualification, and under-qualification)?

The data provided by Kvalifikace 2008 have also made it possible to explore the relationship between education attained by the respondent and education required by the job. Although the analysis has confirmed a close relationship between the two characteristics, at the same time it has pointed to certain stereotypes in assessing qualification requirements that are influenced by specific traditional features of the Czech education system. This is not exclusively a Czech situation, as similar stereotypes also exist in other countries. These stereotypes are partly characterised by a degree of helplessness among respondents in the choice of less traditional levels or types of education about which they might not have enough information: follow-up courses, post-secondary studies, tertiary professional schools, bachelor programmes. However,

specific levels of education are traditionally linked to a specific length of study leading to their attainment, and post-compulsory education lasting three and four to five years is required far more than in other European countries.

Table 10 **Relationship between education required and its length (Kvalifikace 2007/08, Czech Republic)**

What level of education do you think is adequate for your job?	How many years of post-compulsory education does your job require?								Total	Average length
	0	< 1 year	2 years	3 years	4-5 years	6-7 years	8-9 years	10+ years		
Basic education	5.9	0.5							6.4	0.1
Upper secondary up to 3 years	3.0	2.5	3.1	3.7					12.3	1.6
Upper secondary without maturita, 3+ years	2.5	2.8	2.2	20.6	1.9				30.0	2.6
Upper secondary with maturita – vocational		0.7	0.9	3.7	4.8				10.1	3.5
Upper secondary with maturita – technical		1.3	0.7	2.5	15.3	0.5			20.3	4.1
Upper secondary with maturita – general		0.7	0.2	0.4	2.0	0.1			3.4	3.5
Maturita study for apprentices			0.2	0.2	0.2	0.1			0.7	3.6
Post-maturita programmes			0.2	0.2	1.1	0.4			1.9	4.5
Tertiary not higher education					0.5	0.5	0.2		1.2	6.0
Higher education – bachelor					1.2	0.8	0.8		2.8	6.3
Higher education – master						1.6	7.1	1.8	10.5	8.5
Higher education – doctoral or similar							0.1	0.3	0.4	10.0
Total	11.4	8.5	7.5	31.3	27.0	4.0	8.2	2.1	100.0	3.6

Source: Author.

The data provided were translated into an eight-degree scale corresponding to EQF definitions, and then weighed to become representative of the working population in the Czech Republic. A comparison of the results of both the Czech ESS-2 and Kvalifikace 2008 provided conclusions similar to those from other analyses. When jobs are divided into eight levels of qualification requirements, the resulting curves expressing the intensity levels are very similar. Also virtually identical is the overall average level of qualification requirements of around four in both cases.

2.1.1.7. *The synthesis*

The final step in defining the level of qualification requirements was a synthesis of all approaches under review and the development of a resultant vertical indicator on the eight-degree scale as described by the EQF. However, in this report the eight-degree scale has been transformed (aggregated) to a three-degree scale (low, medium and high qualification) as required by the Cedefop projection.

The main problem has concerned the weight that the individual approaches represented in the synthetic indicator should have, since their relevance within the Europe-wide context varies significantly. A factor analysis performed with this specific purpose highlighted some important findings.

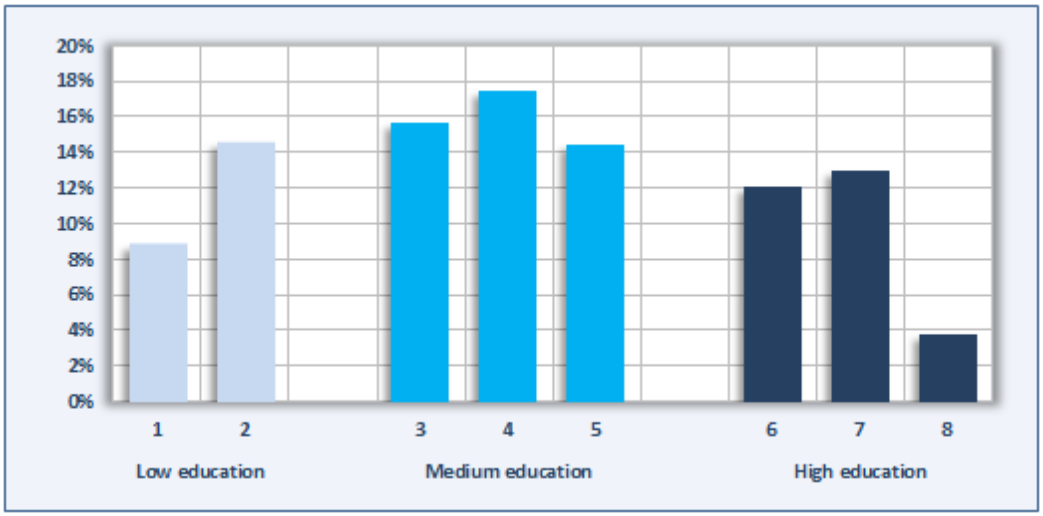
First, the relationship between the five approaches applied (ESS, O*NET, BLS, BIBB, Kvalifikace) is so close that they may be expressed by a single, very robust factor covering, en bloc, 86% of all information about the qualification requirements. This confirms a high level of consistency for this model and enables us to establish an overall (synthetic) indicator of qualification requirements for each occupational group. The analysis has also shown the weight of respective surveys in the factor model which has become very important in determining the weight of each of the surveys in the final model of the first dimension of the OSP. Further criteria include the robustness of respective surveys, their international/national character, and the possibility of their use for tracking changes of qualification requirements within occupations.

In the final model of the first dimension of OSPs the most important role is played by the data from the ESS; these account for 25% of the information in the resultant indicator and are at the core of the cluster. They are followed by the data from the German and both American surveys (20%), and the Czech survey (15%).

Figure 6 illustrates the proportion of respective levels of qualification requirements for EU-27 Member States corresponding to the jobs structure for all 38 NACE sectors and for all occupations (ISCO 3-digit) and their qualification requirements in 2010. The colour coding indicates the aggregation of the eight-level scale to the three-level scale (low, medium and high) adopted in the core project.

Second, various approaches have led to different results in ranking qualification requirements of groups of occupations on the eight-degree scale. These differences are smaller for some occupational groups (the smallest size of the span is only 0.03 points), while for others they are larger (the largest size of the span is 1.56 points). However, the differences do not impair the consistency of the evaluation of all occupational groups and their ranking on the scale (the average size of the span is 0.61). Further, the average level and length of education attained by job holders is closely related to the resultant indicator of qualification requirements for their jobs. This relatively strong relationship is yet another confirmation of a high degree of consistency and credibility of the synthetic indicator.

Figure 6 **Level of qualification requirements**



Source: Author.

To illustrate what difference the sector-specific approach makes when determining an OSP, the same example is used throughout in this chapter and in Chapter 3. It compares three OSPs: for the sector NACE 22 publishing, printing and reproduction of recorded media across all occupational groups; for the occupational group ISCO 245 writers and creative or performing artists across all sectors; and for the occupational group ISCO 245 specific in the sector NACE 22 (the result concerning the first dimension level of qualification requirements is indicated in Figure 7).

Figure 7 clearly indicates the effect of the sector-specific approach as applied by OSP. The proportion of eight EQF levels of qualification requirements taken for the whole NACE 22 sector – that is irrespective of occupational group required – is indicated in light blue, and for whole occupational group ISCO 245 – again irrespective of the sector required – in dark blue. However, when both parameters are considered at the same time, and qualification requirements are determined for one occupational group (ISCO 245) within one sector (NACE 22) only, that is when the sector-specific approach is applied, the results change markedly as indicated in orange (the same colour scheme is also used for other figures).

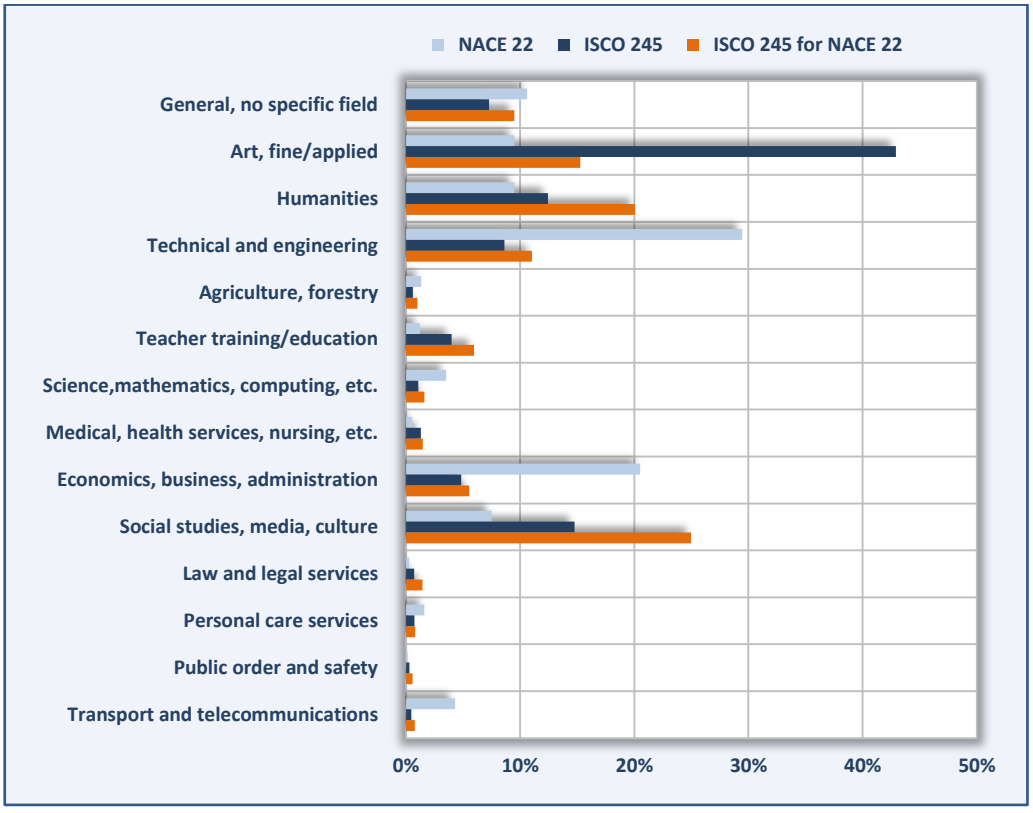
2.1.2. Dimension II: field of education/training

The second dimension describes the field of education/training. Again, a relative, percentage distribution of the given occupation across various fields is indicated (i.e. the total making 100%). The 14 groups of fields of education and training have been defined according to the ISCED. The difference made by the sector-specific approach is shown in Figure 8.

Figure 7 **Dimension I, level of qualification requirements (EU-27, 2010)**

Source: Author.

Figure 8 **Dimension II, field of education/training (EU-27, 2010)**



Source: EPC.

Box 5 **Fields of education/training**

General, no specific field
Art, fine/applied
Humanities
Technical and engineering
Agriculture/forestry
Teacher training/education
Science/mathematics/computing, etc.
Medical/health services/nursing, etc.
Economics/commerce/business/administration
Social studies/administration/media/culture
Law and legal services
Personal care services
Public order and safety
Transport and telecommunications

2.2. Main characteristics

The EQF describes qualification requirements in terms of learning outcomes (Cedefop, 2009). The basic structure of qualification profiles follows the structure of the EQF not only vertically, by using its eight levels, but also horizontally by structuring relevant O*NET data into three dimensions – knowledge, skills and competence – as defined by the EQF.

Although learning outcomes have been differentiated into three categories (each described in a separate column), they still form a continuum, and should be 'read across': 'this is the knowledge that is used with the skills in this area of competence' (Coles, 2007, p. 2). 'Reading across the EQF descriptors for the (given) level we find the knowledge acquired is first defined. This knowledge is used in ways described in the second column where cognitive and practical skills depend on it. The application of these skills (and knowledge) is carried out in contexts defined in the third column in terms, for example, of the level of autonomy and responsibility that has to be exercised' (Coles, 2007, p. 13).

The structuring of O*NET data has been relatively straightforward for the first category, knowledge. For the other two categories, it has been necessary to differentiate between skills and competence, and to handle adequately generic skills, stressing their importance.

2.2.1. Dimension III: knowledge

As defined by the EQF, 'knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles and theories and practices that is related to a field of work or study. In the context of the EQF, it is described as theoretical and/or factual'.

This dimension is structured into eight main areas of knowledge, further subdivided to 32 subareas (Box 6). Its structuring is based on the corresponding part of the O*NET model (originally containing 10 areas subdivided to 33 subareas), but adapted to the structure of the ISCED (originally eight areas further subdivided to 25 subareas).

Box 6 **Dimension III, knowledge, eight main areas and 32 subareas**

- Education and training:
  education and training.
- Humanities and art:
  fine arts, communications and media, design, English language, history and archaeology, philosophy and theology.
- Social science, economics and law:
  psychology, sociology and anthropology, economics and accounting, law and government.
- Science, mathematics and informatics:
  biology, physics, chemistry, geography, mathematics.
- Technology, production and construction:
  production and processing, food production, computers and electronics, engineering and technology, mechanical, building and construction.
- Business, administration and management:
  administration and management, clerical, sales and marketing, personnel and human resources.
- Health and social care:
  medicine and dentistry, therapy and counselling.
- Service:
  customer and personal service, public safety and security, telecommunications, transportation.

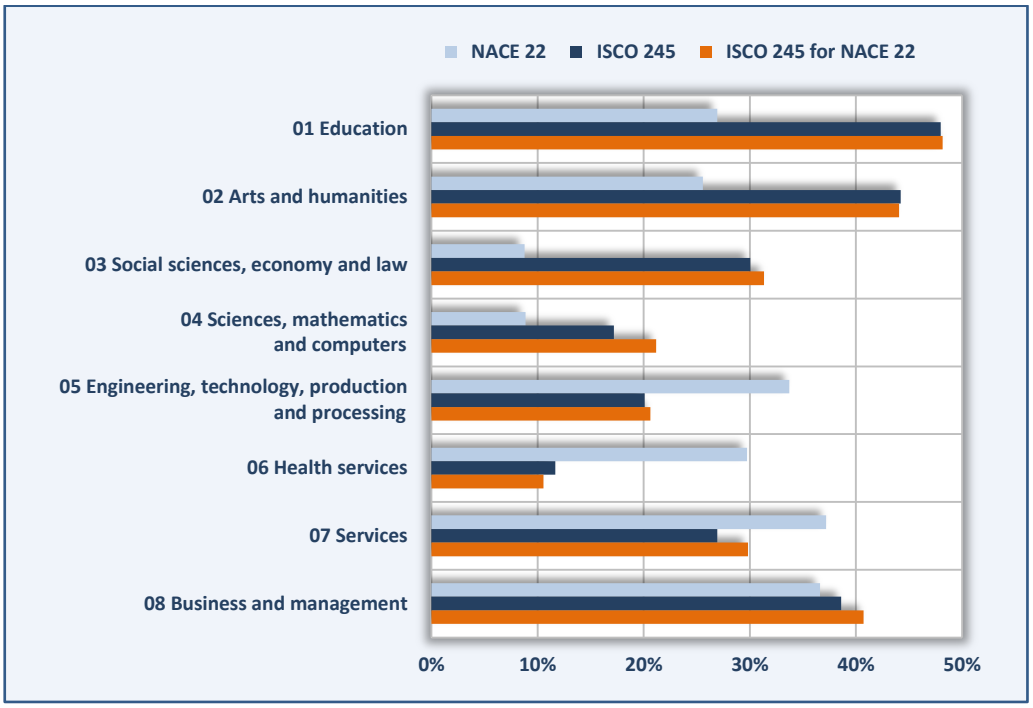
Two characteristics (as defined in O*NET) are indicated for knowledge: the level required (relating to the complexity of the occupation), and the importance for the given occupation. Both characteristics are indicated as percentage values and shown in Figure 9 and Figure 10.

2.2.2. Dimension IV: skills

As defined by the EQF, 'skills mean the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments)'.

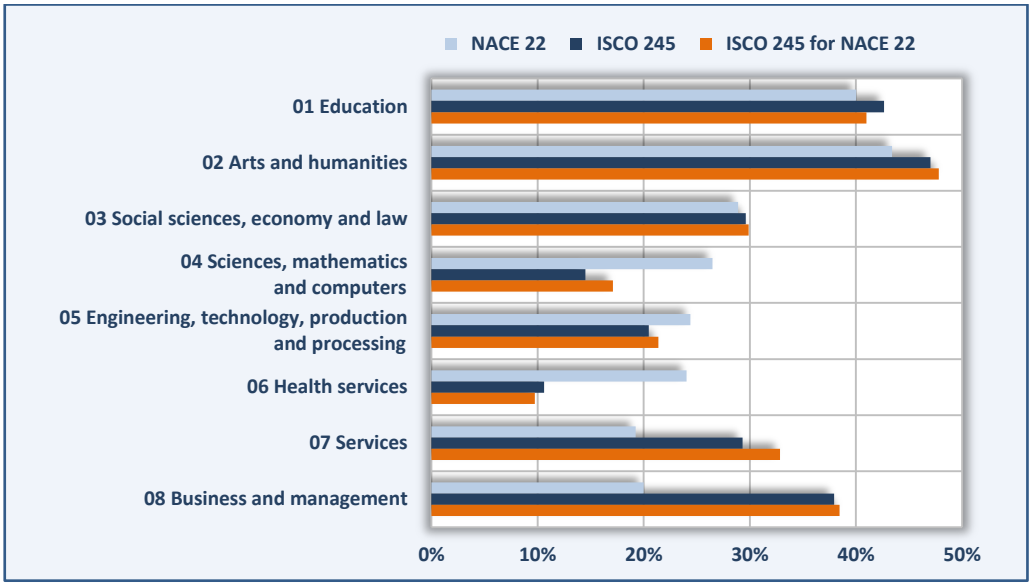
While the EQF makes distinction only between cognitive and practical skills, the structuring of this category has to be more detailed and explicitly focused on relevant generic skills. Therefore key competences for lifelong learning (Box 7) have been considered, unless they are already included under the category Competence or are not considered by O*NET.

Figure 9 **Dimension III, level of knowledge (EU-27, 2010)**



Source: Author.

Figure 10 **Dimension III, importance of knowledge (EU-27, 2010)**



Source: Author.

Box 7 **Key competences for lifelong learning**

Recommendation of the European Parliament and of the Council, of 18 December 2006

The recommendation defines eight main domains:

- skills: communication in the mother tongue, communication in foreign languages, ICT/digital competences, numeracy and competences in mathematics, science and technology, and learning to learn;
- competence: sense of entrepreneurship and initiative, and interpersonal/social and civic competences;
- one domain is not supported by O*NET: general culture/cultural awareness and expression.

Source: European Parliament and Council of the EU, 2007, p. 13.

As a result, the dimension IV, skills, is structured as follows: cognitive skills, communication in the mother language; communication in foreign languages; numeracy and basic SMT concepts; ICT (information and communication technologies)/digital skills; learning to learn; and practical skills.

Relevant O*NET parts basic skills and cross-functional skills have been used. Two characteristics are indicated, the level required (relating to the complexity of the job/occupation) and the importance for the given job

(occupation), both as percentage values. Figure 11 illustrates dimension IV, skills, and dimension V, competence.

2.2.3. Dimension V: competence

As defined by the EQF, 'competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities in work or study situations and in professional and personal development. In the context of the EQF, competence is described in terms of responsibility and autonomy'.

Although the term competence is in some cultural contexts used in a narrower sense, meaning skills (and then used also in the plural), especially in European countries (e.g. Germany, France and the Netherlands) 'competence is defined as "capacity" in relation to a broad occupational field. It is a multidimensional concept, combining different forms of knowledge and skills, as well as social and personal qualities. It relates to a person's ability to draw on multiple resources to deal with a given work situation' (Cedefop, 2009, p. 19).

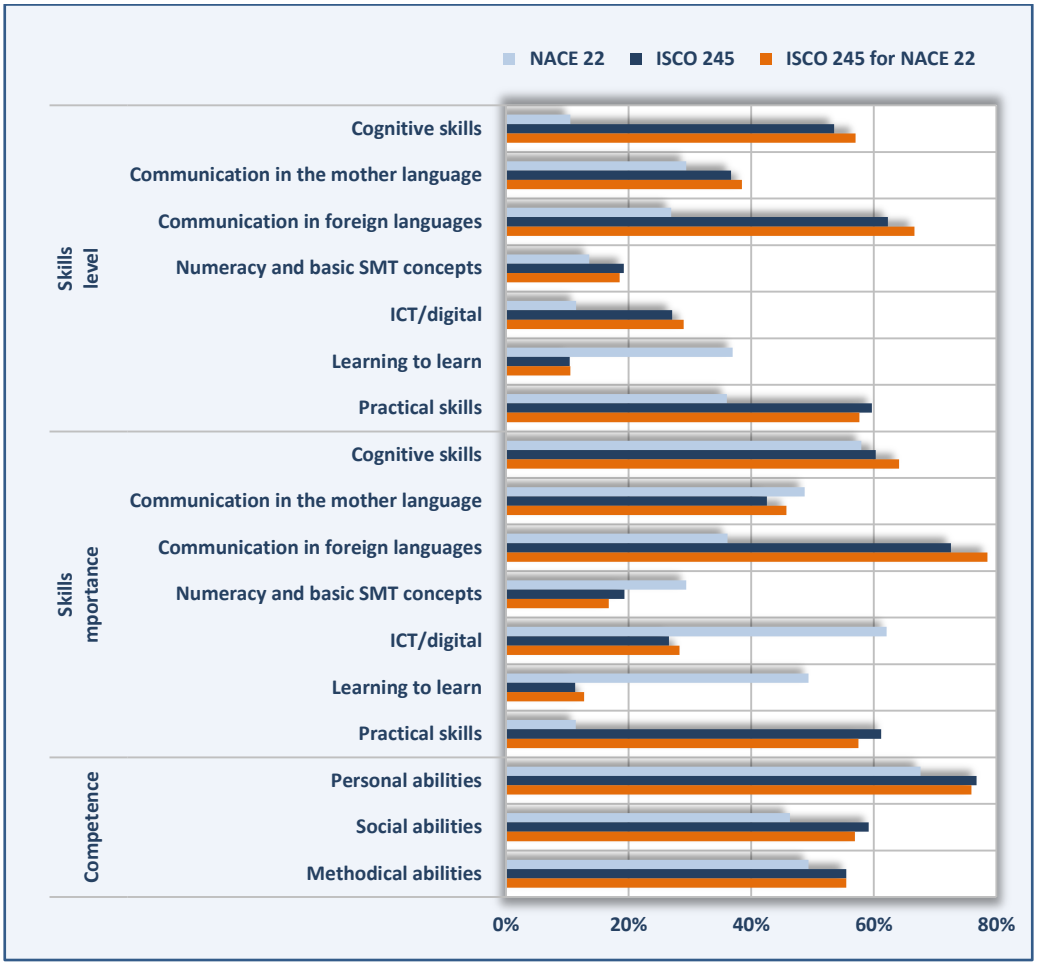
This broad definition has been reached through long development. Compare, for example, two short quotations: 'Competence can generally be understood as knowledge times experience times power of judgment' and 'competences generally imply complex action systems encompassing not only knowledge and skills, but also strategies and routines needed to apply knowledge and skills, as well as appropriate emotions and the effective self-regulation of these competences' (Rychen and Salganik, 2001).

The EQF definition reflects the consensus that there exist three distinct dimensions and that there is a certain progression between them: not only knowledge, but also skills needed for its application, and also other abilities (social and personal abilities, attitudes and values) indispensable for effective professional conduct that are described in the context of the EQF 'in terms of responsibility and autonomy'.

To differentiate abilities under dimension V (competence) from other abilities under the category 'skills', and considering their above description in the context of the EQF, detailed descriptors defining the eight EQF levels of competence have been used for guidance (Box 8) and applied to relevant O*NET characteristics.

Relevant O*NET characteristics relating to responsibility and autonomy (as defined by EQF descriptors) have been further structured into personal abilities, social abilities and methodological abilities (conforming to the EQF definition). Only one characteristic of competence, its importance, is indicated, again as a percentage value.

Figure 11 **Dimension IV, skills, and dimension V, competence (EU-27, 2010)**



Source: Author.

Box 8 **Examples of EQF descriptors defining eight levels of competence**

EQF descriptors of competence (Annex 2) focus on responsibility (e.g. taking responsibility for managing professional development; taking responsibility for evaluation and improvement; taking responsibility for completion of tasks; taking responsibility for decision-making in unpredictable conditions) and autonomy (e.g. working/studying with some autonomy; adapting own behaviour to circumstances in solving problems; exercising management and supervision in contexts where there is unpredictable change) but include also other aspects of authority, leadership and independence (e.g. reviewing and developing performance of self and others; exercising self-management within the guidelines; supervising work of others) as well as of innovation, creativity, and integrity (e.g. demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity).

Source: European Commission (2008a).

2.3. Supplementary characteristics

The last two dimensions of OSPs have a rather character in that they try to define certain general qualities of the job (occupation) which may (or may not) more or less correspond to those of the job holder. As both dimensions focus on the relationship between the job and the job holder, they can play a positive role in choosing the job and in the resulting match between them; they can fittingly supplement the previous, more specific, characteristics, and considerably extend the overall use of OSPs. The characteristics of both dimensions are expressed as an index with values ranging from 0 to 100, showing the strength of the given profile or orientation, and they can be aggregated at levels such as the group of occupations, the sector or the whole economy.

2.3.1. Dimension VI: occupational interests

This dimension is based on the theory of careers and vocational choice formulated by Holland (1997). This sees preferences for work environment as related to six distinct personality types which can be used to describe both persons and work environment: realistic, investigative, artistic, social, enterprising, and conventional (usually referred to by their first letters: R-I-A-S-E-C). Any person could be described as having interests associated with each of the six types in a descending order of preference; this assumption allows Holland codes to be used to describe 720 different personality patterns. As description of jobs and occupations is treated in the same way, i.e. how it corresponds with each of the six types, the Holland model has been adopted by the US Department of Labour for categorising jobs and occupations relative to interests, and has also become an important component in the comprehensive online job search system in O*NET.

Box 9 defines the six personality and work environment (occupation) types. As for each person, each occupation can contain characteristics of more than one type, although one type usually prevails or even dominates and defines the occupation from the perspective of occupational interests. According to the latest version of the O*NET, realistic type occupations display the highest values across all 750 occupations it defines; conventional type occupations follow at some distance. Conversely, artistic type occupations have the significantly lowest value.

Describing all occupations in terms of the six personality types permitted analysis of the relationship among individual types of both persons (job holders) and occupations (Table 11). Using O*NET data, it appears that the most opposed are the realistic and social types of occupations (Pearson’s correlation for 750 individual occupation is -0.63), followed by a pair of realistic and enterprising

types (-0.58) and then, with a little association, realistic and artistic types (-0.42) and conventional and artistic types (-0.40). The closest pairing is of social and artistic types (+0.32).

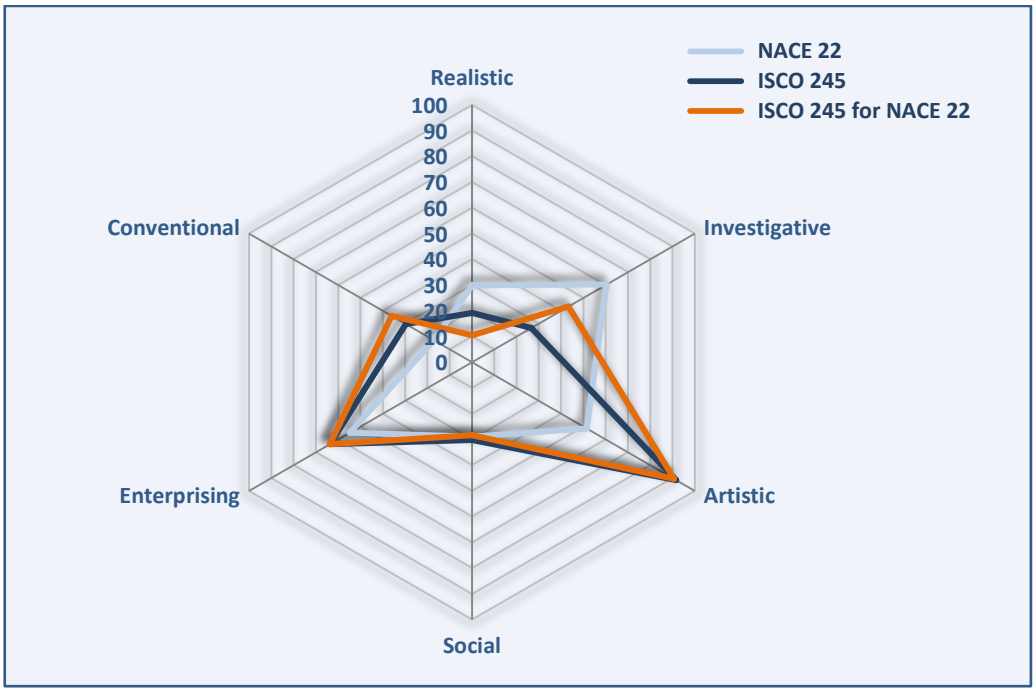
Figure 12 illustrates an example of determining and visualising this dimension.

Table 11 **Relationship between the six personality and work environment (occupation) types**

(Pearson correlation)	Realistic	Investigative	Artistic	Social	Enterprising	Conventional
Realistic	1	0	0	-1	-1	0
Investigative		1	0	0	0	0
Artistic			1	0	0	0
Social				1	0	0
Enterprising					1	0
Conventional						1

Source: Author.

Figure 12 **Dimension VI, occupational interests (EU-27, 2010)**



Source: Author.

2.3.2. Dimension VII: work values

Going beyond the domain of occupational interests, the dimension work values – based on the theory of work adjustment (Dawis and Lofquist, 1984) – characterises another aspect of the relationship between the job and the job holder that can also considerably affect the 'fit' of an individual to a particular occupation. It involves an individual's evaluation of the importance of work activities, of the nature of the work (e.g. authority, creativity), and of conditions of the work environment (e.g. compensation, advancement potential). To achieve a good 'fit' (that is both a satisfactory performance and job satisfaction), an individual's preferences and expectations, his/her needs, should match corresponding stimulus conditions associated with the maintenance of work behaviour, called reinforcers (Smith and Campbell, 2006).

A need profile for each O*NET occupational unit has been derived from job analyst ratings of the degree to which the occupational unit in question reinforces (i.e. provides employees with) each of the 21 defined needs. Six distinct meaningful values have been identified from need reinforcers through dimensional analyses, and the resulting occupational reinforcer patterns (McCloy et al., 1999) have been formed. Also two identical assessment instruments for job holders (work importance profiler for computerised administration and scoring, and work importance locator for card sort administration and scoring), directly linked to O*NET, have been developed by the US Department of Labour.

The six work values can be modelled as three dimensions, where each dimension includes polar opposite work values. The three pairs of polar opposites (Rounds, 1981) are relationships versus recognition, independence versus support, and achievement versus working conditions. It is thus possible to represent dimension VII, work values, in a similar way to dimension VI, occupational interests.

Box 10 summarises six work values and 21 need reinforcers, together with their defining statements. Figure 13 illustrates an example of determining this dimension.

Box 9 **Six personality and work environment (occupation) types**

Realistic (practical, physical, hands-on, tool-oriented) occupations frequently involve work activities that include practical, hands-on problems and solutions. They often deal with plants, animals, and real-world materials such as wood, tools, and machinery. Many of the occupations involve working outside, and do not include much paperwork or working closely with others. The holders of realistic occupations like to work with animals, tools, or machines; generally avoid social activities such as teaching, healing, and informing others; have good skills in working with tools, mechanical or electrical drawings, machines, or plants and animals; value practical things you can see, touch, and use such as plants and animals, tools, equipment, or machines; and see themselves as practical, mechanical, and realistic.

Investigative (analytical, intellectual, scientific, explorative) occupations frequently involve working with ideas, and require an extensive amount of thinking. These occupations can involve searching for facts and figuring out problems mentally. The holders of investigative occupation like to study and solve maths or science problems; generally avoid leading, selling, or persuading people; are good at understanding and solving science and maths problems; value science; and see themselves as precise, scientific, and intellectual.

Artistic (creative, original, independent, chaotic) occupations frequently involve working with forms, designs and patterns. They often require self-expression and the work can be done without following a clear set of rules. The holders of artistic occupation like creative activities such as art, drama, crafts, dance, music, or creative writing; generally avoid highly ordered or repetitive activities; have good artistic abilities in creative writing, drama, crafts, music, or art; value creative arts such as drama, music, art, or the works of creative writers; and see themselves as expressive, original, and independent.

Social (cooperative, supporting, helping, healing/nurturing) occupations frequently involve working with, communicating with, and teaching people. These occupations often involve helping or providing service to others. The holders of social occupations like to do things to help people like, teaching, nursing, or giving first aid, providing information; generally avoid using machines, tools, or animals to achieve a goal; are good at teaching, counselling, nursing, or giving information; value helping people and solving social problems; and see themselves as helpful, friendly, and trustworthy.

Enterprising (competitive environments, leadership, persuading) occupations frequently involve starting up and carrying out projects. These occupations can involve leading people and making many decisions. Sometimes they require risk-taking and often deal with business. The holders of enterprising occupations like to lead and persuade people, and to sell things and ideas; generally avoid activities that require careful observation and scientific, analytical thinking; are good at leading people and selling things or ideas; value success in politics, leadership, or business; and see themselves as energetic, ambitious, and sociable.

Conventional (detail-oriented, organising, clerical) occupations frequently involve following set procedures and routines. These occupations can include working with data and details more than with ideas. Usually there is a clear line of authority to follow. The holders of conventional occupations like to work with numbers, records, or machines in a set, orderly way and generally avoid ambiguous, unstructured activities; are good at working with written records and numbers in a systematic, orderly way; value success in business; and see themselves as orderly, and good at following a set plan.

Box 10 **Work value: need reinforcer and associated statements**

Achievement

Occupations that satisfy this work value are results-oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment:

- ability use – workers on this job make use of their individual abilities;
- achievement – workers on this job get a feeling of accomplishment.

Working conditions

Occupations that satisfy this work value offer job security and good working conditions:

- activity – workers on this job are busy all the time;
- independence – workers on this job do their work alone;
- variety – workers on this job have something different to do every day;
- compensation – workers on this job are paid well in comparison with other workers;
- security – workers on this job have steady employment;
- working conditions – workers on this job have good working conditions.

Recognition

Occupations that satisfy this work value offer advancement, potential for leadership, and are often considered prestigious:

- advancement – workers on this job have opportunities for advancement;
- recognition – workers on this job receive recognition for the work they do;
- authority – workers on this job give directions and instructions to others;
- social status – workers on this job are looked up to by others in their company and their community.

Relationships

Occupations that satisfy this work value allow employees to provide services to others and work with colleagues in a friendly non-competitive environment:

- colleagues – workers on this job have colleagues who are easy to get along with;
- social service – workers on this job have work where they do things for other people;
- moral values – workers on this job are never pressured to do things that go against their sense of right and wrong.

Support

Occupations that satisfy this work value offer supportive management that stands behind employees;

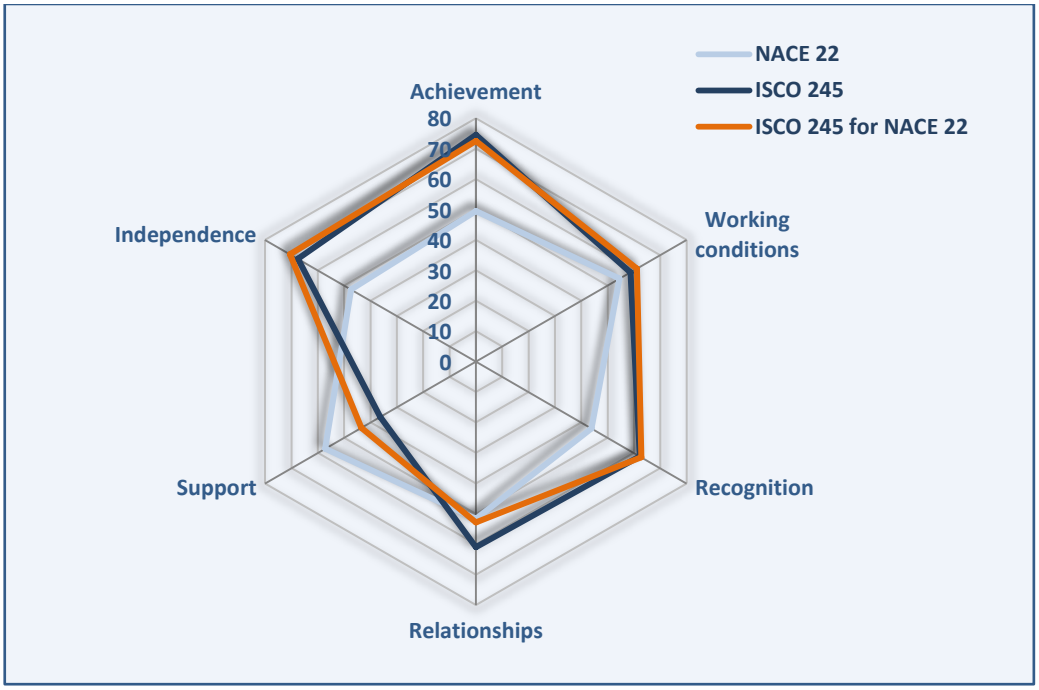
- company policies – workers on this job are treated fairly by the company;
- supervision human – workers on this job have supervisors who back up their workers with relations management;
- supervision technical – workers on this job have supervisors who train their workers well.

Independence

Occupations that satisfy this work value allow employees to work on their own and make decisions:

- creativity – workers on this job try out their own ideas;
- responsibility – workers on this job make decisions on their own;
- autonomy – workers on this job plan their work with little supervision.

Figure 13 **Dimension VII, work values (EU-27, 2010)**



Source: Author.

CHAPTER 3.

Data mapping and integration

This chapter describes the complex methodological process of data mapping and integration used to develop the OSP approach (see also the Annex). The best way to see how it works is using a specific example that illustrates and justifies both main assumptions: first, that it is necessary to determine OSPs at the lowest possible level, preferably at individual level as defined, for example, by the US SOC; second, that their aggregation at group level has to be sector-specific (using occupational weighting to maintain the specificity of individual occupations). It will also be shown how different results can be obtained when considering different dimensions of OSPs as defined in Chapter 2, especially concerning the level of qualification requirements (dimension I).

3.1. Benefits and pitfalls of the approach

The first challenge is to find a way to reconcile various systems of classification and various levels of classification, a necessary prerequisite for using data from different sources. The US BLS data and projections and O*NET characteristics of individual occupations based on the US classification of occupations have opened up particular problems of matching to the ISCO classification adopted by the European countries.

To this end, a correspondence table has been prepared for individual occupations as defined by the SOC and the ISCO. As Eurostat makes available data only at ISCO 3-digit level (out of 19 countries examined only six of them have data at ISCO 4-digit level), OSPs have been aggregated up to this level which currently contains about 110 occupational groups (Eurostat database). Also, to get sector-occupation employment matrices it is also necessary to map the US classification of industries (NAIRIC) to the European classification of sectors (NACE rev.1).

However, any aggregation to higher levels of classification and their application to sectors cannot be realised by simply adding together the values determined at a lower, more detailed level of individual occupations. Their specificity would be lost, as a range of different values would be substituted by their average. To base analyses and projections of qualification requirements only on aggregated groups of occupations, without having the possibility of their disaggregation and without respecting considerable differences in their

distribution across sectors, is questionable, as it impoverishes the information available.

A possible way to maintain the specific features of individual OSPs even after their aggregation to ISCO 3-digit and 2-digit, is by considering their sector-specific occupational structure (i.e. the different proportional representations of individual occupations in different sectors). For some occupational groups this implies preparing up to 38 different profiles ([10]). We can illustrate by example how effective the sector-specific approach is. The same example is also used to illustrate what difference the sector-specific approach makes for each of the seven dimensions as discussed in Chapter 2.

To sum up, aggregation of OSPs determined at a more detailed level of occupations (that is of about 800 individual occupations in the US SOC 2010) has to be sector-specific. The reason is obvious: at higher levels of aggregation, occupational groups contain several different occupations, so the mix of occupations (their proportion, prevalence or domination) is different in each sector (having for example a different degree of concentration ([11]) and exclusivity ([12])). Consequently there has to be a different, sector-specific OSP for each sector where the occupational group in question is represented (that is up to 38 sectors), the number of OSPs being equal to the number of respective sectors.

This implies that it is necessary to carry out the aggregation process for each sector separately rather than across all sectors. In this way the results of the aggregation will reflect the different job/employment shares of individual occupations in occupational groups classified at ISCO 3-digit level in different sectors. In other words, it uses different occupational weights derived from US data which reflect the situation in the US economy (and whose use has to be confined within the limits of the respective occupational group at ISCO-3-digit level and of the respective NACE sector).

([10]) The E3ME classification contains 41 sectors but three pairs of sectors have to be united into three new sectors due to data limitations (Chapter 1).

([11]) Occupational concentration of a sector indicates to what degree it is homogenous or heterogeneous from the point-of-view of occupations. It is high when one or only a few occupations dominate while other occupations are scarce.

([12]) On the other hand, occupational exclusivity of a sector indicates to what extent a given occupation is concentrated in a given sector. High exclusivity of a sector indicates that the occupation in question is concentrated there predominantly, and can be found only sporadically elsewhere. Examples of a high exclusivity are manufacture of other non-metallic mineral products (NACE 26), where almost all glass, ceramics and related plant operators (ISCO 813) are engaged, although they constitute only about 7% of employed in the sector.

The sector-specific approach yields good proxy results that are much better than using simple ways of aggregation (when only one qualification profile for any occupational group at ISCO 3-digit level is used for all sectors). In this way, both crucial criteria will be met: the sufficiently detailed level of classification and the availability of data.

In all 29 European countries, which are part of the analysis and the projection of skill needs, there exist roughly 230-240 million jobs that can be divided into several thousand of sector-specific groups of occupation at ISCO 3-digit level. For this reason it is proposed to use the 0.01% criterion (approximately 23 500 jobs), when selecting the smallest sector-specific group of occupation for which the OSP is calculated. On this basis, OSPs are calculated for roughly 900 sector-specific groups of occupation. Jobs belonging to the OSPs which are not calculated are assigned to similar sector-specific groups (either of the same occupational group in another sector or of a related occupational group in the same sector).

NACE 22, publishing, printing and reproduction of recorded media (Box 11), and the occupational group ISCO 245, writers and creative or performing artists (one of the most important groups of occupations within the sector), have been chosen to illustrate the process of transformation and construction of sector-specific OSPs (Koucký and Lepič, 2009).

First, we will assess overall educational requirements in the group of occupations ISCO 245 as determined by the European social survey 2004/05 and 2010/2011 (ESS 2 and ESS 5).

Two thirds of the job holders in this occupational group believe that newcomers applying for a job in their occupation will be required to have from three to seven (predominantly four to five) years of education beyond compulsory education. Two groups of job holders of almost the same size (about 17% each) believe that education required will be longer or shorter (Table 12). This confirms a great dispersion of requirements within occupational groups concerning individual occupations (units) or individual jobs forming the group.

Next, we assess five occupational groups at the fourth ISCO level by using the classification of education applied in the ESS and completed as described above (Chapter 1) to have eight internationally comparable levels of education. Table 13 allows us to draw some conclusions.

Box 11 **NACE 22 and ISCO 245**

NACE 22, publishing, printing and reproduction of recorded media, has been defined by NACE (rev 1.1) to include the following three clusters of activities: 22.1 publishing, 22.2 printing, 22.3 reproduction of recorded media. This sector includes units engaged in the publishing of newspapers, magazines, other periodicals, and books. In general, these units, which are known as publishers, issue copies of works for which they usually possess copyright. Works may be in one or more formats including traditional print form and electronic form. The printing activities print such products, and perform support activities, such as bookbinding, plate-making services, and data imaging. The support activities included here are an integral part of the printing industry, and a product that is an integral part of the printing industry is almost always provided by these operations. Though printing and publishing can be carried out by the same unit (a newspaper, for example), it is increasingly rare that these distinct activities are carried out in the same physical location.

ISCO 245, writers and creative or performing artists conceive and create or perform literary, dramatic, musical and other works of art. Tasks performed usually include: writing literary works; appraising merits of literary and other works of art; collecting information about current affairs and writing about them; sculpting, painting, engraving, or creating cartoons; restoring paintings; composing music; dancing or acting in dramatic productions or directing such productions. Supervision of other workers may be included. Occupations in this minor group are classified into the following five unit groups (ISCO 4-digit):

2451 authors, journalists and other writers,

2452 sculptors, painters and related artists,

2453 composers, musicians and singers,

2454 choreographers and dancers,

2455 film, stage and related actors and directors.

Table 12 **Years of education beyond compulsory needed**

ESS-2 (2004/05) and 5 (2010/11)	Highest level of education	ISCO 245, writers and creative or performing artists (%)
Years of education beyond compulsory needed by applicant for your job	No education needed	4.9
	Less than 1 year	1.4
	About 1 year	5.2
	About 2 years	5.7
	About 3 years	15.7
	About 4-5 years	30.0
	About 6-7 years	20.9
	About 8-9 years	8.6
	10 years or more	7.6
	Total	100.0

Source: Author.

At the fourth level of classification, the markedly largest proportion of jobs in Europe within the group of occupations ISCO 245 fall under ISCO 2451, and far less under ISCO 2452 and ISCO 2453. Hence the group of occupation 2451 is

decisive for determining the level of education in the whole ISCO 245 occupational group. Many job holders (over 60%) have a master or bachelor degree, although almost a third have attained only upper secondary (IIIa) and advanced vocational education (IV) levels.

Table 13 **Highest level of education**

(%)

ESS-2 (2004/05) and ESS-5 (2010/11)	ISCO						Total ISCO 245
Highest level of education	2451	2452	2453	2454	2455	2450	
ESS-ISCED I, less than lower secondary	0	1	0	0	0	0	1
ESS-ISCED II, lower secondary	1	1	1	0	1	0	3
ESS-ISCED IIIb, lower tier upper secondary	1	2	1	0	0	0	5
ESS-ISCED IIIa, upper tier upper secondary	7	4	2	1	2	1	18
ESS-ISCED IV, advanced vocational, subdegree	6	3	3	0	1	1	14
ESS-ISCED V1, lower tertiary education, BA level	12	5	3	0	3	1	24
ESS-ISCED V2, higher tertiary education, MA level	16	6	6	1	4	1	34
ESS-ISCED V3, highest tertiary education, PhD level	1	1	0	0	0	0	3
Total	44	22	17	2	11	4	100

NB: ISCO 2451 authors, journalists and other writers.
ISCO 2452 sculptors, painters and related artists.
ISCO 2453 composers, musicians and singers.
ISCO 2454 choreographers and dancers.
ISCO 2455 film, stage and related actors and directors.
ISCO 2450 245 not further classified.

Source: Author.

Even the fourth ISCO level containing about 450 groups of occupations is not enough to specify skill needs. In our example the composition of the unit group of occupations ISCO 2451, authors, journalists and other writers, is discussed. Although it is the lowest ISCO level possible, it still contains such different occupations as author, copywriter, advertising, critic, editor, journalist, writer and technical writer, whose OSPs can be quite different. If we go up to higher levels of classification, as for instance to the ISCO 3-digit level, far more different occupations are mixed together. The minor group of occupations ISCO 245 also includes ISCO 2451 also other unit groups of occupations such as ISCO 2452, ISCO 2453, ISCO 2454 and ISCO 2455; examples are sculptors, painters and related artists, composers, musicians and singers, choreographers and dancers, film, stage and related actors and directors. This conclusion is particularly true for still higher levels of aggregation, for the 2-digit level of the submajor group of occupations 24 and even more for the 1-digit level of the major group of occupations 2.

Perhaps an even more complicated situation can be demonstrated when using US data, taken over from the US BLS and O*NET (more in detail in Chapter 1), and defined by the US SOC that contains almost 1 000 individual occupations. After linking the ISCO and the US SOC together it has become evident that, under occupational group ISCO 245, it is possible to classify 16 individual occupations as defined by the US SOC (indicated in Tables 14 and 15) ([13]). In the same way it is possible to aggregate four relevant individual industries as defined at the fourth NAIRIC level into the sector NACE 22, publishing, printing and reproduction of recorded media.

Tables 14 and 15 contain data about individual occupations as defined in the US SOC falling under the ISCO 245 group of occupations: numbers of jobs in them in the US economy in 2010; educational attainment of job holders 25 years old and older; typical education needed for entry into the occupation; work experience in a related occupation; and typical on-the-job training needed to attain competence in the occupation.

As all the three problems – of aggregation, mapping and disaggregation – are intertwined, it is necessary to explain in detail how to:

(a) link together the international and US classifications of sectors/industries (NACE, used by the Eurostat for European countries, and NAIRIC, used in the US);
(b) similarly link classifications for occupations (ISCO and SOC);
(c) use their linkage for comparing European and US projections of employment in individual sectors, occupational groups and jobs.

([13]) If, for instance, instead of O*NET/SOC the Italian classification – developed as a part of the project Indagine sulle professioni – should be used, 19 occupations would be classified from more than 800 occupations; should the far more detailed Czech classification KZAM – established in 1991 by adopting all four levels of the ISCO-88 and extending it by the fifth national level – be used, 62 occupations of about 3 500 occupational units would be classified. Therefore, the size of about 1 000 occupational units suffices for disaggregating occupational groups defined at a higher level.

Table 14 **BLS employment matrix by occupation and education and training**

US 2010			Educational attainment for workers 25 years and older (%)							Education and training assignments by detailed occupation		
SOC code (for ISCO 245)	SOC occupation name	Employment 2010 (thousands)	Less than high school diploma	High school diploma or equivalent	Some college, no degree	Associate degree	Bachelor degree	Master degree	Doctoral or professional degree	Typical education needed for entry	Work experience in a related occupation	Typical on-the-job training needed to attain competence in the occupation
27-1011	Art directors	84.2	3.0	11.4	19.6	9.6	42.4	12.5	1.6	Bachelor degree	1-5 years	None
27-1012	Craft artists	13.6	3.0	11.4	19.6	9.6	42.4	12.5	1.6	High school diploma or equivalent	None	Long-term on-the-job training
27-1013	Fine artists, including painters, sculptors and illustrators	23.6	3.0	11.4	19.6	9.6	42.4	12.5	1.6	High school diploma or equivalent	None	Long-term on-the-job training
27-1019	Artists and related workers, all other	21.5	3.0	11.4	19.6	9.6	42.4	12.5	1.6	High school diploma or equivalent	None	Long-term on-the-job training
27-2011	Actors	56.5	3.1	9.7	20.8	6.7	45.8	12.5	1.3	Some college, no degree	None	Long-term on-the-job training
27-2012	Producers and directors	98.6	1.0	6.4	14.8	6.0	56.4	12.9	2.5	Bachelor degree	1-5 years	None
27-2031	Dancers	13.0	14.3	25.9	27.4	7.3	21.5	3.2	0.3	High school diploma or equivalent	None	Long-term on-the-job training
27-2032	Choreographers	16.2	14.3	25.9	27.4	7.3	21.5	3.2	0.3	High school diploma or equivalent	More than 5 years	Long-term on-the-job training
27-2041	Music directors and composers	53.6	4.6	15.1	22.1	5.2	30.7	18.4	3.9	Bachelor degree	1-5 years	None
27-2042	Musicians and singers	186.4	4.6	15.1	22.1	5.2	30.7	18.4	3.9	High school diploma or equivalent	None	Long-term on-the-job training
27-3021	Broadcast news analysts	7.7	0.3	3.0	10.5	3.9	61.2	18.3	2.8	Bachelor degree	None	None
27-3022	Reporters and correspondents	61.6	0.3	3.0	10.5	3.9	61.2	18.3	2.8	Bachelor degree	None	None
27-3041	Editors	129.6	0.6	3.7	10.6	4.0	56.6	19.7	4.8	Bachelor degree	1-5 years	None
27-3042	Technical writers	48.9	0.5	5.2	13.7	7.3	47.4	19.9	5.9	Bachelor degree	1-5 years	Short-term on-the-job training
27-3043	Writers and authors	151.7	0.5	2.9	9.2	3.0	49.8	26.2	8.4	Bachelor degree	None	Long-term on-the-job training
27-3099	Media and communication workers, all other	34.3	3.3	11.7	22.8	14.1	30.1	13.5	4.5	High school diploma or equivalent	None	Short-term on-the-job training
	Total (ISCO 245)	1 001.0	2.5	9.0	16.5	5.9	44.6	17.5	4.0			

Source: Author calculation based on BLS.

Table 15 **O*NET requirements by occupation**

US 2010		Required level of education (%)											
SOC code (for ISCO 245)	SOC occupation name	Less than a high school diploma	High school diploma	Post-secondary certificate	Some college courses	Associate degree	Bachelor degree	Post-bacca-laureate certificate	Master degree	Post-master certificate	First professional degree	Doctoral degree	Post-doctoral training
27-1011	Art directors	0	0	0	11	66	24	0	0	0	0	0	0
27-1012	Craft artists	15	36	9	9	12	18	0	0	0	0	0	0
27-1013	Fine artists, including painters, sculptors and illustrators	16	22	5	15	9	22	3	3	0	5	0	0
27-2011	Actors	52	8	0	28	0	9	1	0	0	2	0	0
27-2012	Producers and directors	2	9	6	21	7	45	5	1	0	4	0	0
27-2031	Dancers	47	35	0	0	3	14	1	1	0	0	0	0
27-2032	Choreographers	8	32	4	12	4	28	0	8	0	4	0	0
27-2041	Music directors and composers	8	4	1	15	12	39	4	6	6	0	6	0
27-2042	Musicians and singers	22	31	0	17	0	11	0	19	0	0	0	0
27-3021	Broadcast news analysts	0	7	0	1	14	75	1	2	0	0	0	0
27-3022	Reporters and correspondents	1	1	0	9	2	64	7	16	0	0	0	0
27-3041	Editors	0	2	0	7	7	73	1	3	0	6	0	0
27-3042	Technical writers	0	2	0	1	4	92	1	0	0	0	0	0
27-3043	Writers and authors	8	16	0	13	5	52	2	3	0	0	0	2

Source: Author calculation based on O*NET.

3.2. Mapping US data to European classifications

Table 16 illustrates the first stage of the process. US data have been transposed by using two correspondence tables, NACE to NAIRIC, and ISCO to SOC. The twin table shows, first, employment in the US economy in 2006 for all SOC occupations which map into ISCO 245, and, at the same time, are under those NAIRIC individual industries which are aggregated to NACE 22. Reading the table horizontally, total employment (taken from the US data) is indicated for each occupation, followed by the number of jobs in the respective NAIRIC individual industry, while the last column to the right (that is the sum of the previous four columns) indicates the result transposed to the international classification, the sector NACE 22. The same process is applied vertically. The first row indicates total employment, a further 16 rows indicate the position of respective occupations; the last row, the sum of all jobs in respective SOC occupations and NAIRIC individual industries, is already transposed to the occupational group ISCO 245, while the final total sum (the last column to the right) is transposed both to ISCO 245 and to NACE 22. The second part of the twin table repeats the exercise for the projection for 2020.

Table 16 illustrates very uneven distribution of individual occupations in different sectors. Those employed in occupations more or less akin to art and literature represent more than 70% of all jobs in the occupational group ISCO 245 across sectors, in the whole economy, whereas reporters and correspondents and editors represent less than 18% of jobs in this occupational group. The latter, on the contrary, in the sector publishing, printing and reproduction of recorded media (NACE 22) represent more than 80% of jobs in the whole occupational group ISCO 245, whereas the former represent less than 15% (mostly writers and authors).

Uneven distribution of occupations persists in the 10-year projection. In this, total employment in the US economy will increase by more than 14% in the period 2010-20 but the employment in the sector NACE 22 will decrease by almost 9%. Most occupations in the occupational group ISCO 245 will grow when considered across sectors, in the whole economy, but fall in the sector NACE 22. The number of jobs in occupations such as writers, technical writers, authors, music directors and composers is expected to increase rapidly, while the number of jobs in occupations reporters and correspondents and editors will stagnate.

Table 16 **Mapping data to European classifications**

Jobs/employment in US economy by industry and by occupation for sector NACE 22 and group of occupations ISCO 245 (employment projection 2010-20, US BLS 2012)		**Total employment, all workers**	**Printing and related support activities**	**Manufacturing and reproducing magnetic and optical media**	**Newspaper, periodical, book, and directory publishers**	**Motion picture, video, and sound recording industries**	**Publishing, printing and reproduction of recorded media**
SOC code:			**NAIRIC code:**				**NACE 22**
			3231	**3346**	**5111**	**5120**	
2010							
00-0000	**Total, all occupations, US 2010**	**143 068 200**	**486 900**	**24 900**	**501 300**	**372 000**	**1 385 100**
27-1011	Art directors	66 500	700		1 300	100	2 100
27-1012	Craft artists	3 500					<50
27-1013	Fine artists, including painters, sculptors and illustrators	6 900			200		200
27-1014	Multimedia artists and animators	17 300	100	100	400		600
27-1019	Artists and related workers, all other	6 300					<50
27-2011	Actors	31 500					<50
27-2012	Producers and directors	87 200			200	600	800
27-2031	Dancers	5 500					<50
27-2032	Choreographers	12 400					<50
27-2041	Music directors and composers	49 900				200	200
27-2042	Musicians and singers	88 000					<50
27-3021	Broadcast news analysts	6 300			100		100
27-3022	Reporters and correspondents	40 700			26 900		26 900
27-3041	Editors	55 500	300	100	23 500	100	24 000
27-3042	Technical writers	36 300		100	200		300
27-3043	Writers and authors	30 800			3 100	100	3 200
27-3099	Media and communication workers, all other	16 000			300	100	400
ISCO 245	Writers and creative or performing artists	560 600	1 100	300	56 200	1 200	58 800

Jobs/employment in US economy by industry and by occupation for sector NACE 22 and group of occupations ISCO 245 (employment projection 2010-20, US BLS 2012)		Total employment, all workers	Printing and related support activities	Manufacturing and reproducing magnetic and optical media	Newspaper, periodical, book, and directory publishers	Motion picture, video, and sound recording industries	Publishing, printing and reproduction of recorded media
SOC code:			NAIRIC code:				NACE 22
			3231	3346	5111	5120	
2020							
00-0000	Total, all occupations, US 2020	163 537 100	454 700	21 900	439 700	347 000	1 263 300
27-1011	Art directors	72 200	700		1 000		1 700
27-1012	Craft artists	4 100					<50
27-1013	Fine artists, including painters, sculptors, and illustrators	8 300			200		200
27-1014	Multimedia artists and animators	21 900	100	100	300		500
27-1019	Artists and related workers, all other	5 900					<50
27-2011	Actors	34 700					<50
27-2012	Producers and directors	98 900			100	200	300
27-2031	Dancers	5 900					<50
27-2032	Choreographers	15 300					<50
27-2041	Music directors and composers	52 200				100	100
27-2042	Musicians and singers	92 100					<50
27-3021	Broadcast news analysts	6 900			100		100
27-3022	Reporters and correspondents	36 700			21 100		21 100
27-3041	Editors	53 600	300	100	16 600		17 000
27-3042	Technical writers	43 200		100	100		200
27-3043	Writers and authors	34 700			2 400		2 400
27-3099	Media and communication workers, all other	18 400			200		200
ISCO 245	Writers and creative or performing artists	605 000	1 100	300	42 100	300	43 800

NB: For statistical reasons (by US rules) the table does not contain data for cells containing fewer than 50 cases which are considered unreliable.
Five occupations have no or very low employment (less than 50) in the sector NACE 22 (although they are quite numerous in other sectors) and are not included in the employment of the sector NACE 22. Respective cells are coloured in grey.

Source: Author calculation based on BLS.

The table is only part of a large matrix based on US data and containing 352 industries defined at the fourth NAIRIC level by 826 individual occupations defined by SOC (many of more than 290 000 cells of the matrix will be empty). The large matrix is then transposed into international classifications (used by Eurostat) and, at the same time, aggregated into a smaller matrix containing 38 NACE sectors currently used in European projections and 110 occupational groups at ISCO 3-digit level, which can always find its counterpart in several SOC individual occupations.

To sum up the approach, a qualification profile for any ISCO 3-digit occupational group represented in a given NACE sector is prepared by using knowledge about how individual occupations (classified by the SOC and described by the O*NET) are represented in those NAIRIC individual industries which correspond to a given NACE sector.

To appreciate the added value of the approach developed in this study, it must be considered that without the estimates obtained from the correspondence matrices provided between the US and Europe data sources, Table 16 would be restricted to four overall values indicated in the four corners of the table. However, this approach is restricted to a specific objective, to determine sector-specific OSPs, and it is not possible to transfer the inner – US based – contents of the table to various countries or over time.

3.3. Constructing a sector-specific profile

Table 17 shows the second stage of the process: how a sector-specific OSP has been arrived at. A relatively narrow occupational group ISCO 245 (writers and creative or performing artists) and the sector NACE 22 (publishing, printing and reproduction of recorded media) serve as an example. The table also illustrates how different results have been obtained for the seven dimensions of OSPs.

To begin with, let us compare the OSP of the occupational group ISCO 24 (other professional) with those of ISCO 245, (part of ISCO 24), and of concrete SOC occupations included in ISCO 245 (the table offers four examples). Their respective OSPs differ a lot as occupations in ISCO 245 represent only about 15% of all ISCO 24 jobs. Due to other large groups, such as ISCO 241 (business professionals); 242 (legal professionals) or 244 (social science and related professionals), the whole ISCO 24 requires a higher level of formal qualification, with a strong role for economics and law, which is quite different from ISCO 245.

Similar marked differences also exist between the ISCO 245 group and individual occupations contained in it. Some occupations are demanding in terms of qualification requirements (reporters and correspondents), some only

moderately (actors). Some occupations require education in art (actors), some in humanities or social sciences (producers and directors). At higher levels of aggregation, however, the values are closer to the average or tilted towards predominant occupational groups. Any marked individual differences at the detailed occupational level get suppressed.

The representation of individual occupations across sectors differs greatly as well. For instance, reporters and correspondents (and the corresponding ISCO occupation, journalists) represent only about 6% of ISCO 245 jobs taken across all sectors, but one third of all jobs of the sector NACE 22 (publishing, printing and reproduction of recorded media) as two third of journalists work within this sector. In contrast, actors representing almost 8% of ISCO 245 jobs (taken across all sectors) are almost non-existent in the NACE 22. Whereas the impact of reporters and correspondents on the ISCO 245 profile is significant, that of actors is nil.

The occupation ‘reporters and correspondents’ has a rather different OSP compared to other occupations of ISCO 245 in NACE 22. For qualification requirements, the seventh level (master degree) prevails, while the sixth level (bachelor degree) dominates the occupational group. Similar differences can be observed in education/training. Whereas in the occupation ‘reporters and correspondents’, mostly graduates in social, media and cultural studies are sought-after in ISCO 245, it is graduates in art studies that are required. Similarly, it is possible to find great differences when comparing other dimensions of OSPs.

For the first proposition, Table 17 shows that the results on dimensions of an OSPs depend largely on the level of detail at which they have been determined. Three levels have been considered: besides the ISCO 2-digit and the ISCO 3-digit levels (with 27 and 110 occupations respectively) there are also the more detailed level of individual occupations. In the left part of the table, very different outcomes are indicated for ISCO 24, for ISCO 245, and for four individual occupations which all would come under ISCO 245: actors; art directors; producers and directors; reporters and correspondents (selected out of the 16 SOC occupations which come under ISCO 245 according to the correspondence table).

Table 17 **An example of a sector-specific profile**

Occupational skills profile (OSP)			Group of occupation		Individual occupation (SOC and ISCO 245)				NACE 22 specific	
OSP dimensions		**OSP characteristics**	**ISCO 24**	**ISCO 245**	**Actors**	**Art directors**	**Producers and directors**	**Reporters and corresp.**	**ISCO 245**	**ISCO 24**
Level of qualification requirements		Low	0	1	4	0	0	0	0	0
		Medium	21	19	55	54	24	3	9	9
		High	79	80	41	46	76	97	91	90
		Average years of education	15.1	15.2	13.5	13.8	15.0	15.9	15.6	15.6
Field of education/ training		General, no specific field	3	8	5	6	10	11	9	9
		Art, fine/applied	7	36	78	48	23	4	16	13
		Humanities	9	14	5	2	10	21	24	20
		Technical and engineering	6	9	1	28	13	4	7	8
		Agriculture/forestry	1	1	0	0	0	5	1	2
		Teacher training/education	3	4	1	3	3	4	5	4
		Science/mathematics/computing, etc.	2	1	0	0	1	2	2	2
		Medical/health services/nursing, etc.	2	2	0	0	0	2	2	2
		Economics/business/administration	29	5	0	6	14	6	5	14
		Social studies/media/culture	22	17	10	6	22	36	24	22
		Law and legal services	15	1	0	0	1	2	2	2
		Personal care services	1	1	0	2	2	1	1	1
		Public order and safety	0	0	0	0	0	1	1	1
		Transport and telecommunications	0	1	0	0	1	1	1	1
Knowledge	Level	Education and training	19	51	37	61	44	44	46	46
		Arts and humanities	19	53	55	53	45	49	52	48
		Social sciences, economy and law	21	35	35	22	34	35	33	34
		Sciences, mathematics and computers	21	25	12	20	24	27	27	28
		Engineering, technology, production and processing	35	28	13	42	33	23	26	27
		Health services	32	15	16	9	8	12	12	12
		Services	46	34	17	33	42	36	34	34
		Business and management	47	44	24	44	49	39	41	43
	Importance	Education and training	44	46	34	43	37	36	42	41
		Arts and humanities	48	59	60	56	51	57	59	55
		Social sciences, economy and law	31	34	42	21	34	32	30	32
		Sciences, mathematics and computers	30	21	9	16	22	22	22	23
		Engineering, technology, production and processing	45	29	15	42	35	22	27	28
		Health services	42	13	10	7	6	11	11	11
		Services	17	37	22	36	47	38	36	36
		Business and management	19	43	24	50	53	37	38	41

Occupational skills profile (OSP)			Group of occupation		Individual occupation (SOC and ISCO 245)				NACE 22 specific	
OSP dimensions		OSP characteristics	ISCO 24	ISCO 245	Actors	Art directors	Producers and directors	Reporters and corresp.	ISCO 245	ISCO 24
Skills	Level	Cognitive skills	19	60	45	54	57	54	56	56
		Communication in the mother language	36	40	23	38	46	35	35	35
		Communication in foreign languages	34	70	52	49	54	59	55	54
		Numeracy and basic SMT concepts	12	16	9	8	15	11	18	17
		ICT/digital	11	32	6	39	37	27	32	34
		Learning to learn	49	9	1	3	20	10	7	9
		Practical skills	45	64	63	61	59	52	54	53
	Importance	Cognitive skills	68	68	53	65	69	64	64	65
		Communication in the mother language	58	47	29	46	54	44	44	44
		Communication in foreign languages	28	82	73	76	81	86	80	79
		Numeracy and basic SMT concepts	24	17	8	10	17	11	17	17
		ICT/digital	75	30	5	41	37	25	30	33
		Learning to learn	60	11	1	4	19	10	10	11
		Practical skills	18	63	70	61	56	46	49	49
Competence		Personal abilities	75	77	80	77	80	76	76	75
		Social abilities	54	59	64	65	65	57	56	56
		Methodological abilities	58	56	49	61	71	53	56	56
Occupational interests		Realistic	40	17	28	33	18	11	10	11
		Investigative	57	23	6	6	9	50	29	30
		Artistic	69	89	95	100	70	89	90	76
		Social	42	25	33	22	31	28	21	22
		Enterprising	13	69	61	89	98	56	73	73
		Conventional	44	32	11	33	48	33	42	49
Work values		Achievement	72	74	78	83	76	78	74	73
		Working conditions	70	59	53	81	69	58	58	59
		Recognition	64	63	61	67	77	72	67	66
		Relationships	67	57	83	45	69	39	48	52
		Support	53	37	17	39	42	39	45	47
		Independence	66	70	61	89	81	67	77	75

NB: The characteristics of the first two dimensions – level of qualification requirements and field of education/training – indicate a relative, percentage distribution of jobs (the sum of the respective column – for all eight EQF levels or for all 14 fields of education – makes 100%). The characteristics of the remaining five dimensions – knowledge, skills, competence, occupational interests, and work values – indicate the required level of the characteristics in question. Although in the O*NET data set the characteristics were expressed by different scales (e.g. 0-6, 0-5, 1-7, etc.), they have all been converted to percentage values 0%-100% for presentation, to make them more understandable and, in particular, comparable.
The columns 'group of occupation' and 'individual occupation (SOC and ISCO 245) covers all sectors. As for the column 'individual occupation (SOC and ISCO 245), O*NET defines characteristics for individual occupations regardless of the sector.

Source: Author.

For the second proposition, the sector-specific way of aggregation is illustrated using the example of NACE 22 (the first analysed). The difference in results is shown by comparing the columns headed ISCO 24 and ISCO 245: those on the left are based on results for all sectors added together, whereas those on the right are sector-specific, based on the observed job weights for NACE 22, reflecting actual jobs shares as classified by the US SOC and transposed to the ISCO 3-digit by using the correspondence table.

3.4. Justifying using US data to calculate OSPs in Europe

Users of OSPs may ask whether it is appropriate to use US data, such as the O*NET and the occupational projection and training data, to calculate OSPs for European countries. Are not the occupational structures within sectors in the US and European countries too different? Are O*NET questions perceived in the same way in Europe as in the US? Are data obtained for the O*NET database in the US similar to those that would be obtained in similar surveys in Europe?

These and similar questions have been answered for dimensions III through VII, because the first two dimensions have been based either solely (as dimension II, fields of education) or predominantly (as dimension I, qualification requirements) on European data. On the other hand, only O*NET data have been used to calculate dimensions III through VII.

In recent years two surveys based on O*NET questionnaires have been concluded in EU Member States, Indagine sulle professioni in Italy and Kvalifikace 2008 in the Czech Republic.

The results of both surveys can be compared with O*NET data at the ISCO 2-digit and 3-digit levels. Correlation analysis was used to test the degree of similarity between both European surveys and the O*NET.

Correlations are quite or very high, mostly around 0.8, with three exceptions: level and importance of communication in foreign languages; level of personal abilities; and partly for level and importance for numeracy and SMT concepts.

Table 18 **Correlation with the O*NET data**

			ISCO 3D		ISCO 2D	
			IT	CZ	IT	CZ
Knowledge	01 Education and training	Importance	0.812	0.771	0.848	0.919
		Level	0.814	0.743	0.823	0.817
	02 Arts and humanities	Importance	0.845	0.870	0.921	0.995
		Level	0.870	0.893	0.925	0.845
	03 Social sciences, economy and law	Importance	0.855	0.771	0.930	0.923
		Level	0.872	0.925	0.938	0.993
	04 Sciences, mathematics and computers	Importance	0.817	0.804	0.811	0.836
		Level	0.821	0.820	0.818	0.870
	05 Engineering, technology, production and processing	Importance	0.752	0.693	0.742	0.759
		Level	0.732	0.792	0.703	0.734
	06 Health services	Importance	0.884	0.855	0.927	0.906
		Level	0.882	0.914	0.890	0.853
	07 Services	Importance	0.731	0.774	0.618	0.665
		Level	0.773	0.697	0.691	0.611
	08 Business and management	Importance	0.683	0.687	0.878	0.853
		Level	0.757	0.797	0.899	0.876
Skills	01 Cognitive skills	Importance	0.743	0.715	0.892	0.962
		Level	0.774	0.683	0.900	0.915
	02 Practical skills	Importance	0.766	0.670	0.814	0.859
		Level	0.763	0.711	0.795	0.735
	03 Communication in the mother language	Importance	0.886	0.836	0.950	0.953
		Level	0.834	0.841	0.926	0.978
	04 Communication in foreign languages	Importance	0.338	0.291	0.428	0.491
		Level	0.489	0.536	0.596	0.602
	05 Numeracy + basic SMT concepts	Importance	0.474	0.507	0.512	0.484
		Level	0.528	0.461	0.640	0.697
	06 ICT/digital	Importance	0.835	0.895	0.818	0.756
		Level	0.856	0.929	0.825	0.875
	07 Learning to learn	Importance	0.787	0.703	0.851	0.815
		Level	0.797	0.714	0.917	0.958
Competence	01 Personal abilities	Importance	0.714	0.782	0.897	0.924
		Level	0.220	0.281	0.448	0.360
	02 Social abilities	Importance	0.830	0.861	0.923	0.912
		Level	0.848	0.763	0.922	0.964
	03 Methodical abilities	Importance	0.662	0.750	0.871	0.855
		Level	0.758	0.673	0.904	0.999
		min	0.220	0.281	0.428	0.360
		max	0.886	0.929	0.950	0.999
		avg	0.745	0.734	0.811	0.821

Source: Author.

The difference in the required level and importance of communication in foreign languages is to be expected, not only because the US economy represents a huge and relatively self-sufficient market, but also because Americans can more frequently use their own language overseas than Italians or Czechs. Similarly, the low linear correlation for personal abilities between European and US data across occupations is not surprising when considering that this dimension covers various kinds of competence such as thinking creatively, leadership, originality, initiative, cooperation and so on. In contrast, differences highlighted in levels of numeracy and SMT concepts raise some perplexities, especially when considering that the statistics available show similar ranking in mathematics performance for the three countries under analysis (OECD, 2011).

Although these exemptions may potentially restrict the validity of the analyses, correlations are generally so high that it appears methodologically valid to use US data to construct OSPs for European countries.

CHAPTER 4.

Examples of results obtained

Illustrating the use of occupational skills profiles (OSPs) has been aided by the project Forecasting of skill supply and demand in Europe to 2020.

OSPs have been calculated for each of 33 European countries (EU-27 Member States, Croatia, FYROM, Iceland, Norway, Switzerland and Turkey) as well as for the EU-27 as a whole, for each of 38 sectors and 37 occupations, and for the three years 2000, 2010 and 2020.

The magnitude of the exercise can be illustrated. For each country the results were presented in two tables, for sectors and for occupations. Both tables have 66 columns (corresponding to the detailed structuring of dimensions as described in Chapter 2): the sector table has 114 rows (37 occupations plus the economy as a whole for three years, that is 38 x 3) and the occupation table has 117 rows (38 sectors plus economy as a whole for three years, that is 39 x 3). This makes a total of more than 15 000 cells for each country.

Three examples, each covering a different area and comparing different type of data at different levels indicate the range and contribution of results obtained. The first example summarises the development of all seven dimensions in 2000-20 for the whole EU-27 (Section 4.1.). The second example looks into the different development of the level of qualification requirements (dimension I) by sector and by occupation (Section 4.2.). The third example analyses and examines why qualification requirements and occupational structures of three selected sectors (agriculture, motor vehicles, health and social work) differ so much across the EU-27 Member States (Section 4.3.).

4.1. Change of OSP dimensions over time at EU level

This example illustrates the change in all seven dimensions of an OSP aggregated at the highest possible level, that of the whole economy of the EU-27, in the period 2000, 2010 and 2020.

The detailed results for each dimension are condensed in Tables 19 to 25. They have an identical structure, indicating for all categories of the respective dimension (listed vertically as rows) their relative proportion (for dimensions I and II also absolute numbers) and the change between years 2000, 2010 and 2020 (horizontally as columns).

The main expected changes in each dimension between 2010 and 2020 can be summarised as follows:

(a) level of qualification requirements: a limited increase (0.12 years) is estimated in the average years of education required for jobs in 2010-20, while the share of highly qualified jobs is expected to increase by 2.14 percentage points;
(b) fields of study: the highest growth is expected for jobs where the required field of study is economics, commerce, business and administration. Jobs related to agriculture/forestry will tend to decline the most;
(c) knowledge: the highest increase in the dimension of knowledge is expected in engineering, technology, production and processing and health services;
(d) skills: the importance and level of numeracy and basic SMT concepts and ICT/digital will increase the most together with communication skills;
(e) competences: the importance and level of methodological abilities (as defined in EQF where competences are structured into the three areas of personal, social, and methodological abilities) will increase the most;
(f) occupational interests: among occupational interests the enterprising dimension shows a clear increasing trend;
(g) working values: the importance of recognition and achievement will be the fastest growing dimensions.

4.1.1. Dimensions I and II: coordinating characteristics

Table 19 **Level of qualification requirements**

EU-27 Required education level	Number of jobs (in thousands)			% of total			Change 2000-20		Change 2000-10		Change 2010-20	
	2000	2010	2020	2000	2010	2020	Number	Share of total	Number	Share of total	Number	Share of total
Low	54 535	52 353	52 135	25.71	23.45	22.58	-2 400	-3	-2 182	-2	-219	-1
Medium	103 864	106 307	107 013	48.96	47.62	46.36	3 149	-3	2 442	-1	706	-1
High	53 721	64 558	71 698	25.33	28.92	31.06	17 976	6	10 836	4	7 140	2
Total	212 121	223 218	230 845	11.98 (*)	12.22 (*)	12.34 (*)	18 724	0	11 097	0	7 627	0

(*) Average years of education.
Source: Author.

Table 20 **Field of study**

EU-27 Field of education	Number of jobs (in thousands)			% of total			Change 2000-20		Change 2000-10		Change 2010-20	
	2000	2010	2020	2000	2010	2020	Number	Share of total	Number	Share of total	Number	Share of total
General, no specific field	33 583	34 818	35 727	15.83	15.60	15.48	2 144	-0.36	1 235	-0.23	909	-0.12
Art, fine/applied	3 135	3 551	3 768	1.48	1.59	1.63	633	0.15	416	0.11	217	0.04
Humanities	3 290	3 700	3 864	1.55	1.66	1.67	574	0.12	410	0.11	164	0.02
Technical and engineering	63 107	62 795	63 327	29.75	28.13	27.43	220	-2.32	-312	-1.62	531	-0.70
Agriculture/forestry	10 017	8 881	8 730	4.72	3.98	3.78	-1 287	-0.94	-1 136	-0.74	-151	-0.20
Teacher training/education	10 031	10 998	11 070	4.73	4.93	4.80	1 039	0.07	967	0.20	72	-0.13
Science/mathematics/computing, etc.	5 290	6 006	6 479	2.49	2.69	2.81	1 190	0.31	716	0.20	474	0.12
Medical/health services/nursing, etc.	13 398	16 115	16 896	6.32	7.22	7.32	3 497	1.00	2 716	0.90	781	0.10
Economics/commerce/business admin.	39 041	41 745	44 029	18.40	18.70	19.07	4 988	0.67	2 704	0.30	2 284	0.37
Social studies/admin./media/culture	7 688	8 870	9 822	3.62	3.97	4.25	2 134	0.63	1 181	0.35	952	0.28
Law and legal services	2 123	2 635	2 878	1.00	1.18	1.25	755	0.25	512	0.18	243	0.07
Personal care services	12 544	13 986	14 617	5.91	6.27	6.33	2 073	0.42	1 441	0.35	631	0.07
Public order and safety	3 585	4 353	4 678	1.69	1.95	2.03	1 093	0.34	768	0.26	325	0.08
Transport and telecommunications	4 482	4 766	4 960	2.11	2.14	2.15	478	0.04	284	0.02	194	0.01
Total	212 121	223 218	230 845	99.62	100.00	100.00	18 724		11 097		7 627	

Source: Author. Lowest value percentile Highest value

4.1.2. Dimensions III to V: main characteristics

Table 21 **Knowledge (average score up to a max of 100%)**

EU-27Knowledge	2000 (%)	2010 (%)	2020 (%)	2000-20 (p. p.)	2000-10 (p. p.)	2010-20 (p. p.)
Importance						
01 Education and training	46.38	42.56	42.62	-3.76	-3.83	0.06
02 Arts and humanities	47.91	43.42	43.62	-4.29	-4.49	0.20
03 Social sciences, economy and law	25.13	23.93	24.02	-1.11	-1.20	0.10
04 Sciences, mathematics and computers	23.70	22.07	22.17	-1.53	-1.63	0.10
05 Engineering, technology, production and processing	31.36	28.57	28.86	-2.49	-2.78	0.29
06 Health services	29.61	26.46	26.74	-2.87	-3.15	0.28
07 Services	27.97	23.06	23.07	-4.90	-4.91	0.01
08 Business and management	28.04	22.82	22.88	-5.17	-5.22	0.05
Level						
01 Education and training	26.48	26.64	26.56	0.08	0.16	-0.09
02 Arts and humanities	26.01	25.16	25.08	-0.93	-0.86	-0.08
03 Social sciences, economy and law	24.90	17.76	17.92	-6.98	-7.14	0.16
04 Sciences, mathematics and computers	22.84	16.39	16.54	-6.31	-6.45	0.14
05 Engineering, technology, production and processing	38.77	38.48	38.61	-0.16	-0.28	0.12
06 Health services	33.79	32.56	32.70	-1.10	-1.23	0.14
07 Services	38.49	38.54	38.74	0.25	0.05	0.20
08 Business and management	37.47	35.53	35.80	-1.67	-1.94	0.27

Source: Author.

Table 22 **Skills (average score up to a max of 100%)**

EU-27Skills	2000 (%)	2010 (%)	2020 (%)	2000-20 (p. p.)	2000-10 (p. p.)	2010-20 (p. p.)
Importance						
01 Cognitive skills	59.75	56.42	56.60	-3.16	-3.33	0.17
02 Practical skills	50.56	46.73	46.92	-3.64	-3.83	0.19
03 Communication in the mother language	35.16	34.02	33.81	-1.35	-1.14	-0.21
04 Communication in foreign languages	29.49	27.84	27.72	-1.77	-1.64	-0.13
05 Numeracy + basic SMT concepts	63.82	60.46	60.69	-3.13	-3.37	0.24
06 ICT/digital	51.32	47.51	47.74	-3.58	-3.81	0.22
07 Learning to learn	16.08	15.14	15.26	-0.82	-0.94	0.12
Level						
01 Cognitive skills	14.62	13.33	13.46	-1.16	-1.28	0.12
02 Practical skills	35.83	31.09	31.22	-4.60	-4.74	0.14
03 Communication in the mother language	31.93	27.71	27.87	-4.06	-4.22	0.16
04 Communication in foreign languages	12.19	9.72	9.88	-2.31	-2.47	0.16
05 Numeracy + basic SMT concepts	11.05	8.20	8.38	-2.67	-2.85	0.18
06 ICT/digital	42.11	39.13	39.21	-2.90	-2.98	0.08
07 Learning to learn	40.03	36.54	36.68	-3.35	-3.49	0.14

Source: Author.

Table 23 **Competences (average score up to a max of 100%)**

EU-27 Competence	2000 (%)	2010 (%)	2020 (%)	2000-20 (p. p.)	2000-10 (p. p.)	2010-20 (p. p.)
Importance						
01 Personal abilities	68.41	66.79	66.92	-1.49	-1.62	0.14
02 Social abilities	46.89	43.27	43.44	-3.45	-3.62	0.17
03 Methodical abilities	53.06	51.29	51.54	-1.52	-1.77	0.25
Level						
01 Personal abilities	45.07	42.55	42.79	-2.28	-2.52	0.23
02 Social abilities	51.29	48.73	48.88	-2.41	-2.56	0.14
03 Methodical abilities	40.10	36.85	37.09	-3.01	-3.25	0.24

Source: Author.

4.1.3. Dimensions VI and VII: supplementary characteristics

Table 24 **Occupational interests (average score up to a max of 100%)**

EU-27 Occupational interest	2000 (%)	2010 (%)	2020 (%)	2000-20 (p. p.)	2000-10 (p. p.)	2010-20 (p. p.)
Artistic	18.46	15.42	15.41	-3.05	-3.04	-0.01
Conventional	54.37	58.87	58.87	4.49	4.49	0.00
Enterprising	43.93	47.19	47.88	3.95	3.25	0.69
Investigative	38.66	27.48	27.78	-10.89	-11.19	0.30
Realistic	59.38	59.51	58.66	-0.73	0.13	-0.85
Social	36.75	31.86	32.16	-4.59	-4.88	0.30

Source: Author.

Table 25 **Working values (average score up to a max of 100%)**

EU-27 Work values	2000 (%)	2010 (%)	2020 (%)	2000-20 (p. p.)	2000-10 (p. p.)	2010-20 (p. p.)
Achievement	51.58	43.67	44.17	-7.41	-7.91	0.50
Independence	56.20	48.59	48.89	-7.31	-7.61	0.30
Recognition	43.61	36.20	36.75	-6.86	-7.40	0.55
Relationships	60.41	59.95	60.17	-0.24	-0.47	0.23
Support	54.98	55.84	55.66	0.68	0.86	-0.18
Working conditions	49.89	43.92	44.19	-5.71	-5.98	0.27

Source: Author.

4.2. Differences in qualification requirements by sector and by occupation

To show better the full potential of the OSP approach, in this example differences across individual sectors, occupations and countries in the level of qualification requirements (dimension I) are analysed and illustrated. In Section 4.2.1., differences in dimension I by sector will be examined.

Dimension I distinguishes eight levels of qualification requirements based on the EQF. The characteristics of the level of qualification requirements indicate a percentage distribution of jobs for all the eight levels (their sum making 100%). For better measurability of differences across countries (or sectors or occupations), one aggregated index is constructed: the total qualification requirements (TQR). It is calculated as a scalar product of percentage distribution of jobs for all the eight levels of work complexity, corresponding to eight qualification levels assigned integer scores (1-8).

The example below shows in detail how the TQR is calculated for two sectors (01 agriculture and 02 coal) for overall EU-27 data in the year 2010. TQR values for groups of occupations or for individual European countries are calculated in the same way.

Table 26 **Total qualification requirements**

EU-27 2010	Level of qualification requirements (EQF) (%)								Total
	1	2	3	4	5	6	7	8	
01 Agriculture	16.1	24.3	23.8	15.9	11.1	4.4	3.6	0.8	3.13
02 Coal	8.1	20.4	24.8	18.2	14.1	6.1	6.7	1.6	3.63
TQR for agriculture sector is equal to:									
1*0.161+ 2*0.243+3*0.238+4*0.159+5*0.111+6*0.044+7*0.036+8*0.008 = 3.13									
TQR for coal sector is equal to:									
1*0.081+ 2*0.204+3*0.248+4*0.182+5*0.141+6*0.061+7*0.067+8*0.016 = 3.63									

Source: Author.

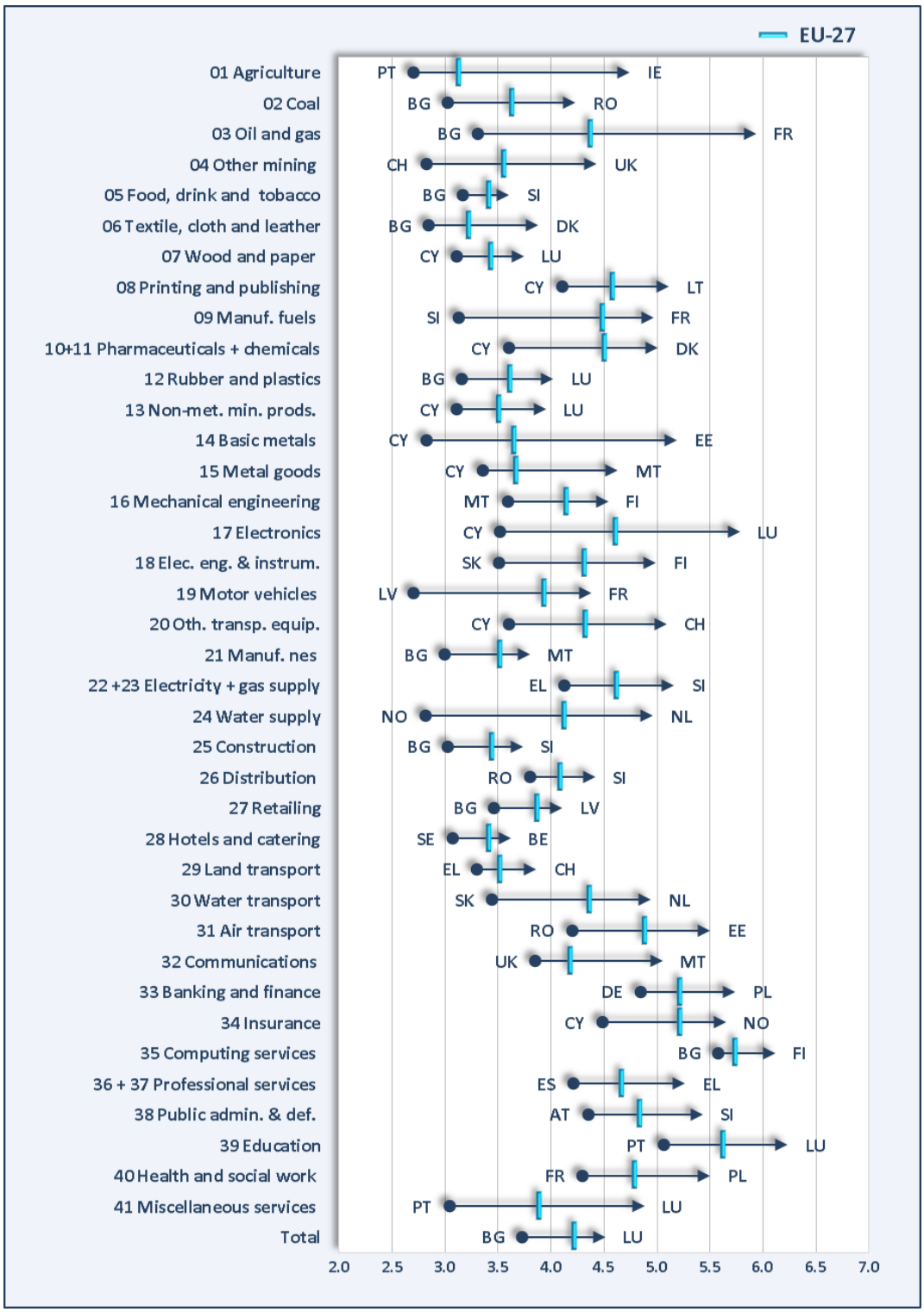
4.2.1. Analyses by sector

The TQR of jobs is calculated for each of the EU-27 Member States plus Switzerland and Norway (EU-27+) and for the EU-27 as a whole. Differences among countries relating to individual sectors are notable, as illustrated by Figure 14 indicating three values for each sector: the countries with maximum and the minimum levels of TQR and the EU-27.

There are high inter-country differences in each sector. Table 27 shows five sectors with the highest and five sectors with the lowest inter-country differences. They are measured as a difference between the highest and the lowest TQR of jobs (of countries) in a given sector.

However, comparing sectors and countries by just considering the difference between maximum and minimum values of TQR may be misleading because little is known about the distribution of qualification requirement within countries. Therefore, it is also necessary to compare the standard deviation of the level of qualification requirements among all countries in a given sector (Table 28).

Figure 14 **Total level of qualification requirements of jobs by sector 2010; E3ME sectors; EU-27+**



Source: Author.

Table 27 **Maximal differences in total level of qualification requirements of jobs**

	Sector	Difference
Sectors with the biggest inter-country differences	03 Oil and gas	2.62
	14 Basic metals	2.37
	17 Electronics	2.26
	24 Water supply	2.15
	01 Agriculture	2.04
Sectors with the lowest inter-country differences	26 Distribution	0.62
	29 Land transport	0.56
	28 Hotels and catering	0.55
	35 Computing services	0.54
	05 Food, drink and tobacco.	0.44
	Average difference in all sectors	1.24

Source: Author.

Table 28 **Standard deviation of total level of qualification requirements of jobs**

Sector	SD
03 Oil and gas	0.690
17 Electronics	0.525
09 Manufacturing fuels	0.486
41 Miscellaneous services	0.465
24 Water supply	0.438
19 Motor vehicles	0.409
14 Basic metals	0.378
01 Agriculture	0.378
04 Other mining	0.377
18 Electrical engineering and instrument	0.376
20 Other transport equipment	0.356
30 Water transport	0.339
10+11 Pharmaceuticals + Chemicals	0.336
02 Coal	0.329
38 Public administration and def.	0.318
31 Air transport	0.280
40 Health and social work	0.269
39 Education	0.268
08 Printing and publishing	0.267
06 Textiles, clothing and leather	0.259

Sector	SD
34 Insurance	0.256
32 Communications	0.250
22+23 Electricity + gas supply	0.238
15 Metal goods	0.231
16 Mechanical engineering	0.230
33 Banking and finance	0.228
36+37 Professional services	0.221
Total	0.210
12 Rubber and plastics	0.197
21 Manufacturing n.e.s.	0.184
13 Non-metallic mineral products	0.184
26 Distribution	0.171
25 Construction	0.166
07 Wood and paper	0.159
27 Retailing	0.143
29 Land transport	0.132
35 Computing services	0.129
28 Hotels and catering	0.116
05 Food, drink and tobacco	0.111

Source: Author.

While sectors listed in Table 27 with the lowest inter-country differences are also sectors with the lowest standard deviation, sectors with the biggest inter-country differences do not necessarily show the highest standard deviation. For example, the basic metals sector (14) which has the third highest inter-country difference is placed only seventh in Table 28. Similar differences are observed for agriculture (01). This implies that in these sectors there are only a limited number of countries where qualification requirements differ significantly from other countries.

For instance, in agriculture only two countries (Ireland and the Netherlands) show high TQR (Section 4.4.1.). The third highest level of TQR is in the Czech Republic (0.7 point lower than in the Netherlands and 1.3 points lower than in Ireland). For comparison, the difference of TQR in agriculture between the Czech Republic and Portugal (the country with the lowest TQR in this sector) is less than 0.8. It means that in agriculture there are two outlier countries, but all other countries are quite similar in this respect.

Table 29 shows sectors with the highest and lowest TQR for each country. Countries are sorted in ascending order by difference across sectors, with the highest and lowest TQR in a given country.

In most (18) countries the highest total level of qualification requirements for jobs is in computing services, while in 10 countries the sector with the highest level of TQR is education. Agriculture is most often the sector with the lowest TQR (11 countries), followed by textiles, wearing apparel and leather (six countries), and hotels and catering (four countries).

Table 30 shows the TQR in EU-27 in 2010, while Table 31 shows TQR for whole economy for each country (data sorted in descending order).

It is clear that in countries where the TQR is lower; there is probably also a lower level of qualification requirement in most sectors compared with countries with higher TQR. That is why it is necessary to compare not only the absolute value of level of TQR size (Figure 14), but also the relative level of qualification requirement for a given sector in a given country compared with the overall TQR in that country. In Figure 15 the sectoral values of TQR are standardised so that all countries have the same overall average TQR.

Comparing values in Figure 14 and Figure 15 leads to an interesting finding. In the sector distribution (26) the TQR of jobs in Bulgaria is 3.90, the fourth lowest absolute value of all countries in this sector. However, the relative level of TQR is in this sector in Bulgaria is 104% (Figure 15) of TQR in Bulgaria, highest value of all countries in this sector. Thus, while in Figure 14 Bulgaria is among the lowest value the distribution sector, in Figure 15, in the same sector, Bulgaria generated

the maximum value relative to the overall TQR in the country. It is necessary to be careful and always clarify the correct interpretation of the results.

Table 29 **Differences in total level of qualification requirements of jobs**

	Total qualification requirements of jobs							
	Max		Whole economy	Min		Difference		
	TQR	Sector		TQR	Sector	Max-Tot	Tot-Min	Max-Min
IE	5.70	Education	4.35	3.26	Construction	1.35	1.09	2.44
DE	5.79	Computing services	4.31	3.32	Food, drink and tobacco	1.48	0.99	2.47
CZ	5.69	Education	4.24	3.21	Textile, cloth and leather	1.45	1.03	2.48
AT	5.75	Education	4.15	3.22	Agriculture	1.59	0.94	2.53
EU-27	5.73	Computing services	4.21	3.13	Agriculture	1.52	1.08	2.60
UK	5.86	Computing services	4.38	3.25	Agriculture	1.48	1.12	2.61
RO	5.65	Insurance	3.75	3.01	Textile, cloth and leather	1.89	0.74	2.64
IT	5.60	Computing services	4.12	2.96	Agriculture	1.48	1.16	2.64
PL	5.82	Computing services	4.13	3.18	Textile, cloth and leather	1.69	0.95	2.64
DK	5.85	Computing services	4.41	3.16	Hotels and catering	1.44	1.25	2.69
BG	5.59	Computing services	3.74	2.85	Textile, cloth and leather	1.85	0.88	2.73
BE	5.99	Education	4.50	3.25	Agriculture	1.49	1.25	2.74
FR	5.94	Oil and gas	4.30	3.19	Agriculture	1.64	1.12	2.76
HU	5.76	Computing services	4.15	3.00	Other mining	1.61	1.15	2.76
NL	6.05	Education	4.51	3.27	Hotels and catering	1.54	1.24	2.78
LT	5.83	Computing services	4.27	3.03	Agriculture	1.56	1.24	2.80
EE	5.97	Computing services	4.26	3.15	Textile, cloth and leather	1.71	1.11	2.82
SK	5.85	Computing services	4.13	3.00	Textile, cloth and leather	1.72	1.13	2.85
FI	6.13	Computing services	4.41	3.26	Hotels and catering	1.71	1.16	2.87
SE	5.95	Computing services	4.43	3.08	Hotels and catering	1.52	1.35	2.87
CH	5.81	Computing services	4.39	2.83	Other mining	1.42	1.56	2.98
SI	5.91	Education	4.31	2.92	Agriculture	1.59	1.39	2.98
NO	5.83	Computing services	4.40	2.82	Water supply	1.43	1.58	3.01
CY	5.89	Education	3.94	2.83	Basic metals	1.95	1.11	3.06
MT	5.99	Computing services	4.21	2.90	Motor vehicles	1.78	1.31	3.09
ES	5.94	Education	3.95	2.81	Agriculture	1.99	1.14	3.13
EL	6.13	Education	4.08	2.99	Agriculture	2.05	1.09	3.14
LV	5.86	Computing services	4.16	2.72	Motor vehicles	1.70	1.44	3.14
PT	5.87	Computing services	3.81	2.71	Agriculture	2.06	1.10	3.16
LU	6.24	Education	4.52	2.86	Other mining	1.72	1.66	3.38

Source: Author.

Table 30 **Total level of qualification requirements of jobs by sector**

Sector	TQR	Sector	TQR
35 Computing services	5.73	24 Water supply	4.12
39 Education	5.62	26 Distribution	4.09
33 Banking and finance	5.22	19 Motor vehicles	3.93
34 Insurance	5.21	41 Miscellaneous services	3.89
31 Air transport	4.88	27 Retailing	3.87
38 Public administration and def.	4.83	15 Metal goods	3.66
40 Health and social work	4.79	14 Basic metals	3.65
36+37 Professional services	4.66	02 Coal	3.63
22+23 Electricity + gas supply	4.62	12 Rubber and plastics	3.61
17 Electronics	4.61	04 Other mining	3.56
08 Printing and publishing	4.58	29 Land transport	3.52
10+11 Pharmaceuticals + chemicals	4.50	21 Manufacturing n.e.s.*	3.52
09 Manufacturing fuels	4.48	13 Non-metallic mineral products	3.50
03 Oil and gas	4.36	25 Construction	3.44
30 Water transport	4.36	07 Wood and paper	3.43
20 Other transport equipment	4.32	28 Hotels and catering	3.41
18 Electrical engineering and instruments	4.31	05 Food, drink and tobacco	3.41
32 Communications	4.18	06 Textile, clothing and leather	3.22
16 Mechanical engineering	4.14	01 Agriculture	3.13

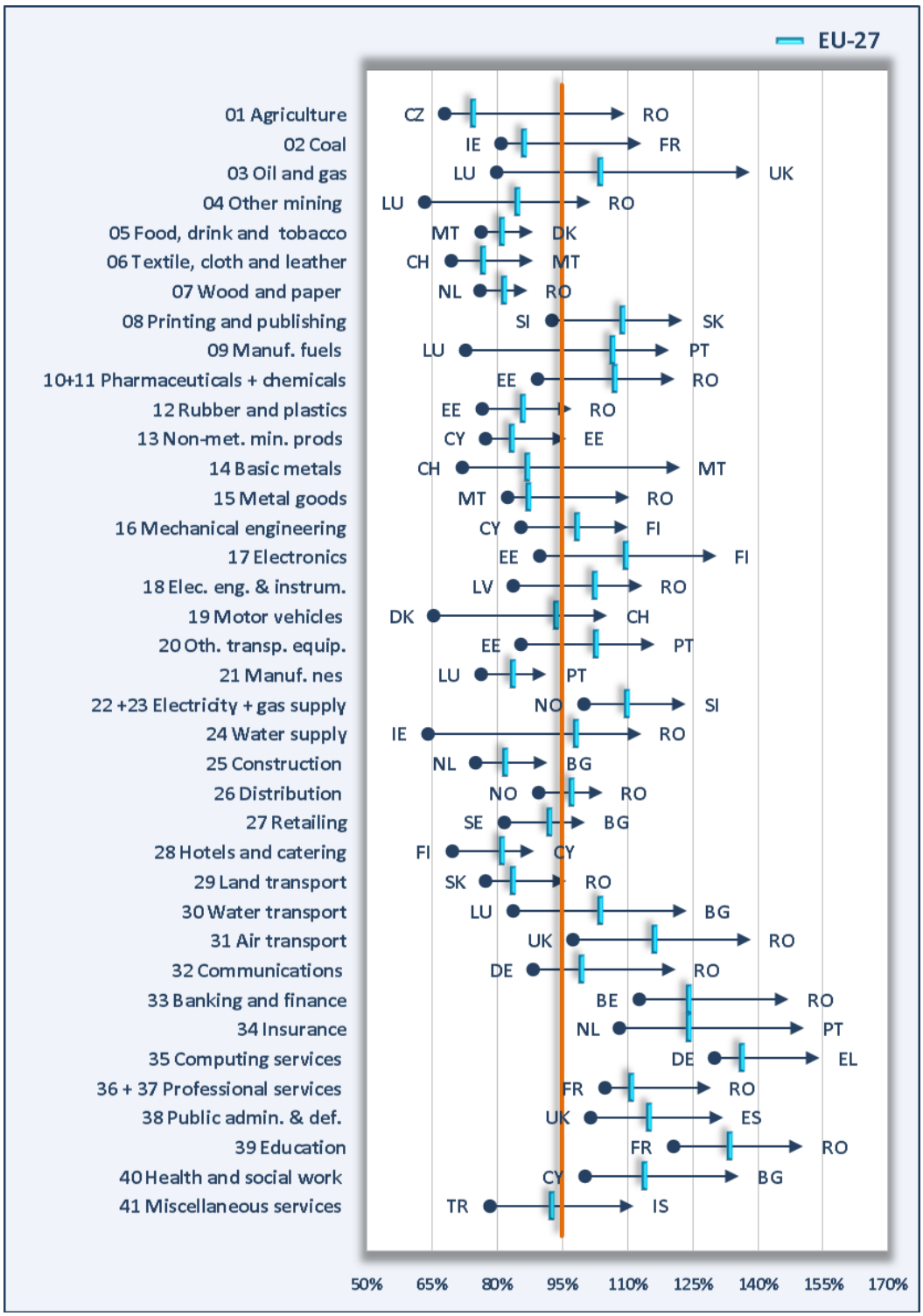
* Not elsewhere specified.
Source: Author.

Table 31 **Total level of qualification requirements of jobs by country**

Country	TQR	Country	TQR	Country	TQR
LU	4.52	SI	4.31	HU	4.15
NL	4.51	DE	4.31	PL	4.13
BE	4.50	FR	4.30	SK	4.13
SE	4.43	LT	4.27	IT	4.12
FI	4.41	EE	4.26	EL	4.08
DK	4.41	CZ	4.24	ES	3.95
NO	4.40	EU-27	4.21	CY	3.94
CH	4.39	MT	4.21	PT	3.81
UK	4.38	LV	4.16	RO	3.75
IE	4.35	AT	4.15	BG	3.74

Source: Author.

Figure 15 **Relative total level of qualification requirements of jobs by sector; 2010; E3ME sectors; EU-27+; ratio to country total**



Source: Author.

4.2.2. Analyses by occupation

This section examines differences in dimension I by occupation. As in the previous analysis of sectors, TQR are calculated for the occupations for each EU-27 Member States plus Switzerland and Norway (EU-27+) and the EU-27 as a whole. Figure 16 shows maximum (of countries) TQR, minimum (of countries) TQR and TQR for EU-27 as a whole in a given occupational group and total economy (the same as for total economy in Figure 14).

Occupations with the biggest and the lowest inter-country differences are in Table 32.

Differences between countries are smaller for individual occupations than for sectors. The average difference is now 0.27 compared to 1.33 for sectors. In this context, standard deviations are much lower for occupations than for sectors.

Table 34 shows occupations with the highest and lowest TQR for each country. In almost all countries the highest TQR is for occupational group ISCO 22, life science and health professionals. Only in Belgium is the highest level of TQR in another occupational group, teaching professionals. Occupational group ISCO 92 (agricultural; fishery and related labourers) has the lowest level of TQR in 28 countries out of 30.

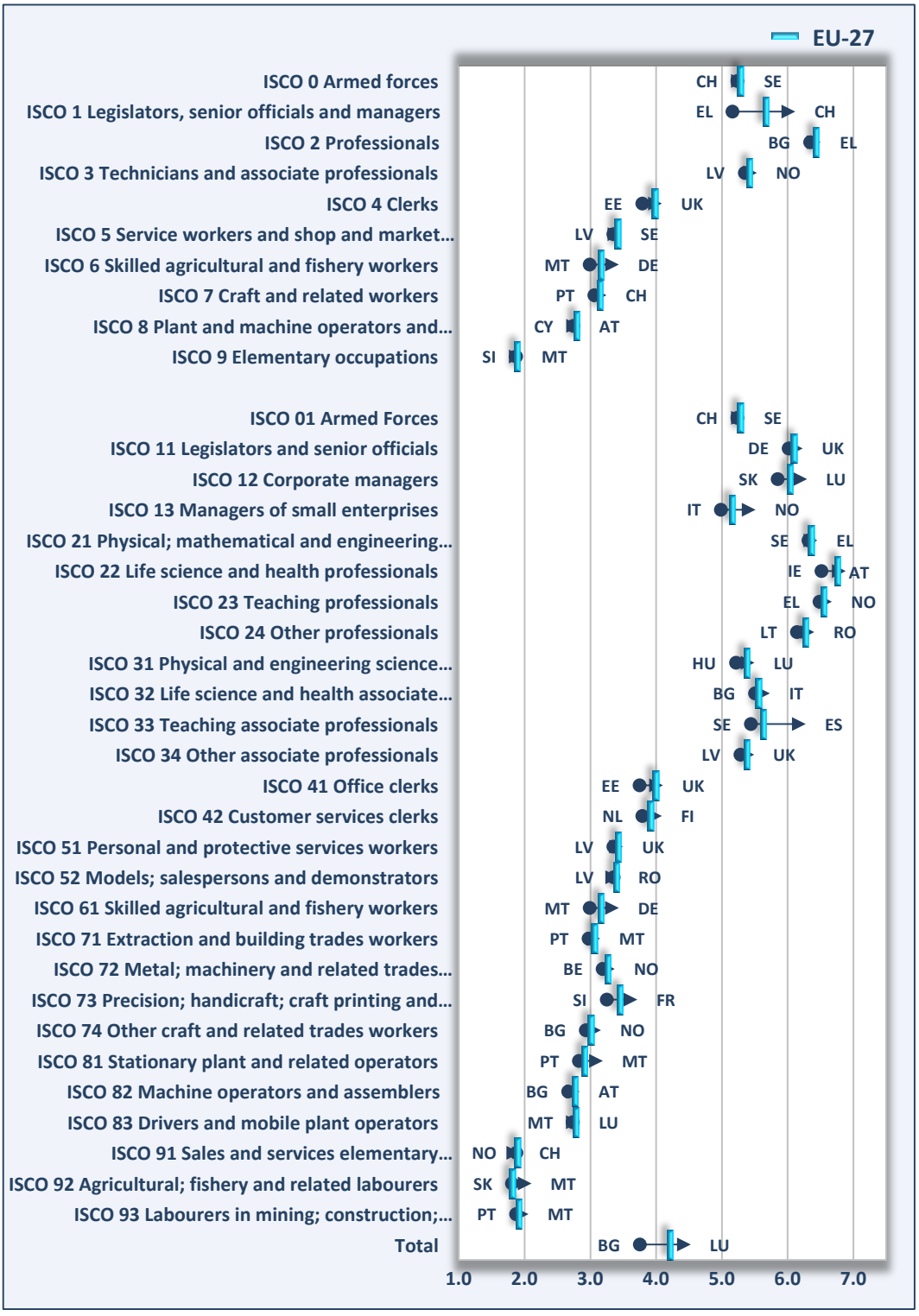
Countries are sorted in descending order by difference between occupation with the highest and lowest TQR in a given country.

Table 32 **Occupational inter-country differences**

	Occupational group	Difference
Occupations with the biggest inter-country differences	ISCO 33 Teaching associate professionals	0.83
	ISCO 13 Managers of small enterprises	0.53
	ISCO 73 Precision; handicraft; craft printing and related trades workers	0.47
	ISCO 12 Corporate managers	0.45
	ISCO 61 Skilled agricultural and fishery workers	0.44
Occupations with the lowest inter-country differences	ISCO 21 Physical; mathematical and engineering science professionals	0.14
	ISCO 01 Armed forces	0.12
	ISCO 83 Drivers and mobile plant operators	0.11
	ISCO 52 Models; salespersons and demonstrators	0.09
	ISCO 91 Sales and services elementary occupations	0.06
	Average difference in all occupations	0.27

Source: Author.

Figure 16 **Total level of qualification requirements of jobs by occupation; 2010; EU-27+**



Source: Author.

Table 33 **Standard deviation of total level of job qualification requirements**

Occupation	SD
ISCO 33 Teaching associate professionals	0.162
ISCO 73 Precision; handicraft; craft printing and related trades workers	0.116
ISCO 13 Managers of small enterprises	0.116
ISCO 61 Skilled agricultural and fishery workers	0.112
ISCO 22 Life science and health professionals	0.102
ISCO 12 Corporate managers	0.089
ISCO 42 Customer services clerks	0.081
ISCO 41 Office clerks	0.080
ISCO 81 Stationary plant and related operators	0.079
ISCO 31 Physical and engineering science associate professionals	0.075
ISCO 32 Life science and health associate professionals	0.071
ISCO 24 Other professionals	0.063
ISCO 74 Other craft and related trades workers	0.058
ISCO 11 Legislators and senior officials	0.054

Occupation	SD
ISCO 92 Agricultural; fishery and related labourers	0.053
ISCO 23 Teaching professionals	0.047
ISCO 71 Extraction and building trades workers	0.045
ISCO 34 Other associate professionals	0.043
ISCO 82 Machine operators and assemblers	0.040
ISCO 72 Metal; machinery and related trades workers	0.040
ISCO 51 Personal and protective services workers	0.039
ISCO 93 Labourers in mining; construction; manufacturing and transport	0.034
ISCO 21 Physical; mathematical and engineering science professionals	0.028
ISCO 83 Drivers and mobile plant operators	0.022
ISCO 01 Armed Forces	0.021
ISCO 91 Sales and services elementary occupations	0.016
ISCO 52 Models; salespersons and demonstrators	0.016

Source: Author.

Table 34 **Occupation with maximum and minimum total level of job qualification requirements**

Country	Max		Whole economy	Min		Difference		
	TQR	Occupation (ISCO)		TQR	Occupation (ISCO)	Max-Tot	Tot-Min	Max-Min
IT	6.87	22 Life science and health professionals	4.12	1.82	92 Agricultural; fishery and related labourers	2.74	2.30	5.05
AT	6.88		4.15	1.84		2.73	2.32	5.05
UK	6.86		4.38	1.83		2.49	2.55	5.03
CH	6.87		4.39	1.85		2.48	2.55	5.03
EL	6.83		4.08	1.81		2.75	2.27	5.02
SK	6.83		4.13	1.81		2.70	2.32	5.02
DE	6.86		4.31	1.85		2.55	2.46	5.01
RO	6.82		3.75	1.82		3.07	1.94	5.00
EE	6.82		4.26	1.82		2.55	2.45	5.00
CZ	6.81		4.24	1.81		2.57	2.43	5.00
LV	6.81		4.17	1.82		2.64	2.35	4.99
FR	6.87		4.30	1.89	91 Sales and services elementary occupations	2.57	2.42	4.99
LT	6.80		4.28	1.81	92 Agricultural; fishery and related labourers	2.52	2.46	4.98
SI	6.77		4.31	1.81		2.45	2.50	4.95
DK	6.81		4.41	1.86		2.40	2.55	4.95
LU	6.79		4.52	1.84		2.27	2.68	4.95
EU-27	6.77		4.22	1.82		2.55	2.39	4.94
BG	6.74		3.75	1.81		2.99	1.94	4.93
HU	6.76		4.15	1.85		2.61	2.30	4.91
FI	6.74		4.41	1.83		2.32	2.58	4.90
NO	6.70		4.40	1.83		2.30	2.58	4.87
SE	6.68		4.43	1.83		2.25	2.60	4.85
NL	6.67		4.51	1.83		2.16	2.68	4.84
ES	6.65		3.95	1.81		2.70	2.14	4.84
CY	6.65		3.94	1.82		2.70	2.12	4.83
PT	6.60		3.85	1.81		2.76	2.03	4.79
PL	6.60		4.13	1.81		2.47	2.32	4.79
MT	6.68		4.21	1.92	91 Sales and services elementary occupations	2.47	2.30	4.77
BE	6.56	23 Teaching professionals	4.50	1.82	92 Agricultural; fishery and related labourers	2.06	2.68	4.74
IE	6.51	22 Life science and health professionals	4.35	1.83		2.16	2.52	4.68

Source: Author.

Table 35 shows the TQR of jobs in the EU-27 in 2010. Occupations follow in the descending order.

The table which shows the TQR of jobs for whole economy for each country is not reproduced here, because it is the same regardless of whether it is based on sectors or occupations (Table 31).

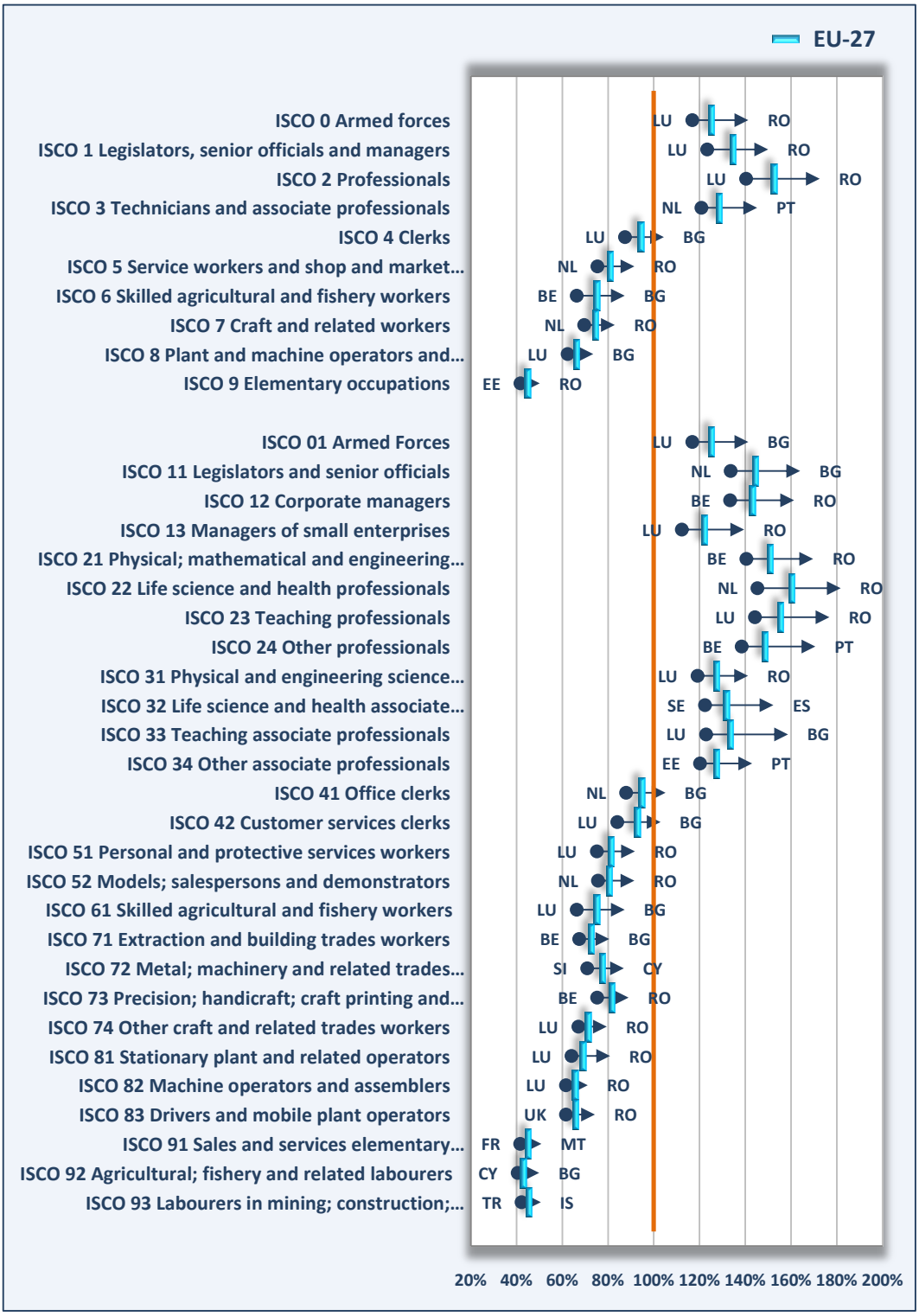
Table 35 **Total level of qualification requirements of jobs in EU-27**

Occupation (ISCO)	TQR	Occupation (ISCO)	TQR
22 Life science and health professionals	6.77	73 Precision; handicraft; craft printing and related trades workers	3.46
23 Teaching professionals	6.56	51 Personal and protective services workers	3.43
21 Physical; mathematical and engineering science professionals	6.37	52 Models; salespersons and demonstrators	3.40
24 Other professionals	6.28	72 Metal; machinery and related trades workers	3.27
11 Legislators and senior officials	6.10	61 Skilled agricultural and fishery workers	3.17
12 Corporate managers	6.04	71 Extraction and building trades workers	3.07
33 Teaching associate professionals	5.63	74 Other craft and related trades workers	3.02
32 Life science and health associate professionals	5.56	81 Stationary plant and related operators	2.92
31 Physical and engineering science associate professionals	5.38	83 Drivers and mobile plant operators	2.79
34 Other associate professionals	5.38	82 Machine operators and assemblers	2.78
01 Armed forces	5.29	93 Labourers in mining; construction; manufacturing and transport	1.92
13 Managers of small enterprises	5.16	91 Sales and services elementary occupations	1.90
41 Office clerks	4.00	92 Agricultural; fishery and related labourers	1.82
42 Customer services clerks	3.92		

Source: Author.

Figure 17 shows the TQR for a given occupational group in a given country compared with the TQR for that country.

Figure 17 **Relative total level of qualification requirements of jobs by occupation; 2010; EU-27+; ratio to country total**



Source: Author.

The previous analysis shows a large difference between sectoral and occupational data. However, while occupational groups show quite small inter-country differences and quite high inter-occupation differences in a given occupation, for sectors it is the opposite. While in the EU-27 the difference between the highest and lowest TQR in sectors is only 2.60 points (5.73 points in computing services, -3.13 points in agriculture), for occupational groups this difference is 4.94 points (6.77 points for life science and health professionals.1.82 points for agricultural, fishery and related labourers).

In a given sector, differences in the level of TQR across countries are mainly caused by different occupational structures within the sector. Some examples will be provided in the next section.

4.3. Why occupational structures differ across countries

Three examples are used to explain why qualification requirements and occupational structures in a given sector can differ so much in different European countries. Two criteria have been used: each of the sectors selected represents a quite different area of the economy, and the cause of the difference across countries is different in each case. The first example (agriculture) illustrates the role that methodological and statistical factors can play in this. The second (motor vehicles) and the third (health and social work) examples illustrate that it may be caused by objective factors, such as the overall orientation and technological level of the sector. Both characteristics affect the resulting skills profiles of the sector in question, as illustrated by the example of dimension I (TQR).

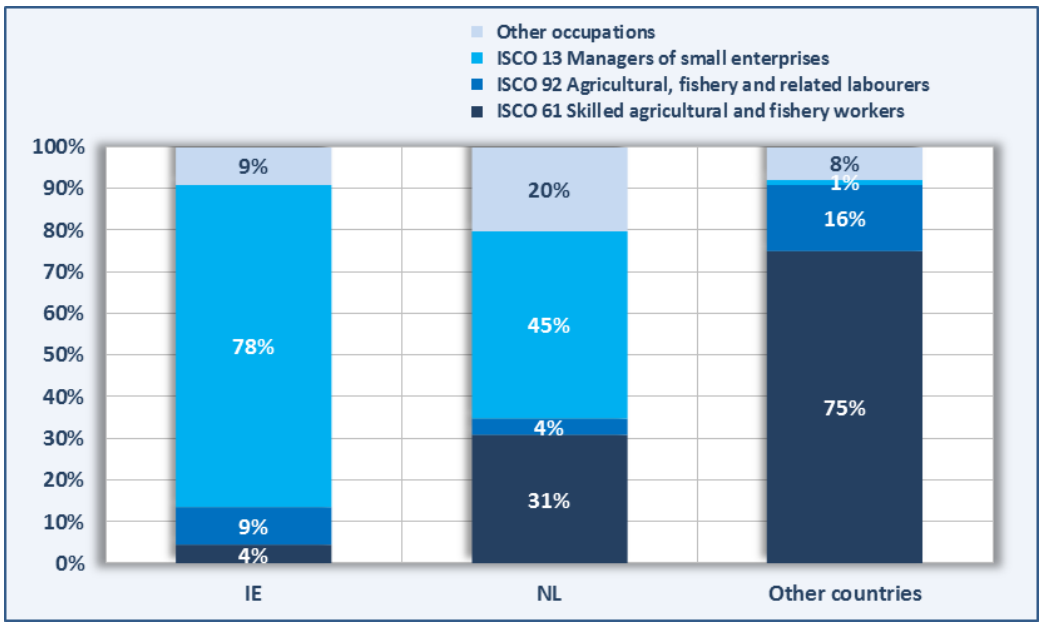
4.3.1. Agriculture

This is an example of a sector with non-uniform perceptions of job classification in their inclusion to statistical groups in various European countries. This lack of homogeneity causes different occupational structure and subsequently different TQR for jobs in different countries.

Figure 18 shows the occupational structure in Ireland, the Netherlands and other countries.

Ireland and the Netherlands are two countries with a high TQR in agriculture. Figure 18 shows that the dominant reason is the different classification of occupations between the two countries. Most of the employment classified in other countries as agricultural and fishery related occupations, is classified, in Ireland and the Netherlands, as managers of small enterprises (farms).

Figure 18 **Occupational structure of agriculture sector 2010; Ireland, the Netherlands and sum of other countries (EU-27+)**



Source: Author.

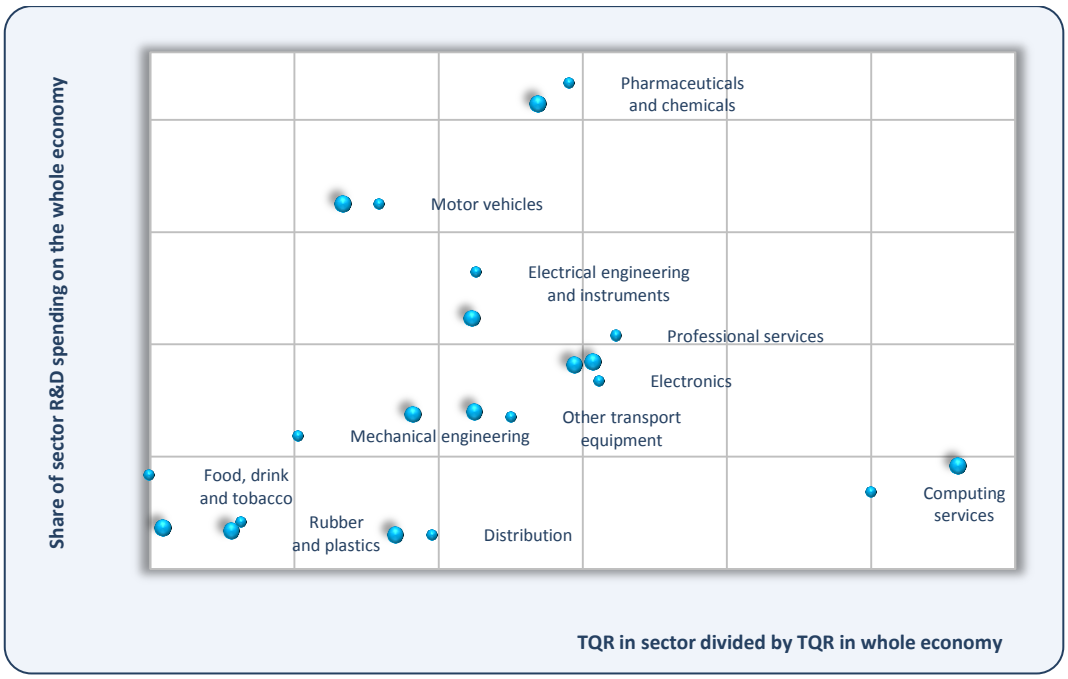
4.3.2. Motor vehicles

This is an example of a sector with different country orientation: to research, development and innovation, on the one side, or to assembling and plain manufacturing on the other. This causes different occupational structures and subsequently a different TQR in different countries.

The motor vehicles sector is an R&D-intensive sector absorbing more than 16% of total private R&D spending in the EU-27 (Figure 19). Average R&D intensity (R&D spending per employment) in the motor vehicles sector in the EU-27 in 2010 is about EUR 12 500 (in constant prices 2000).

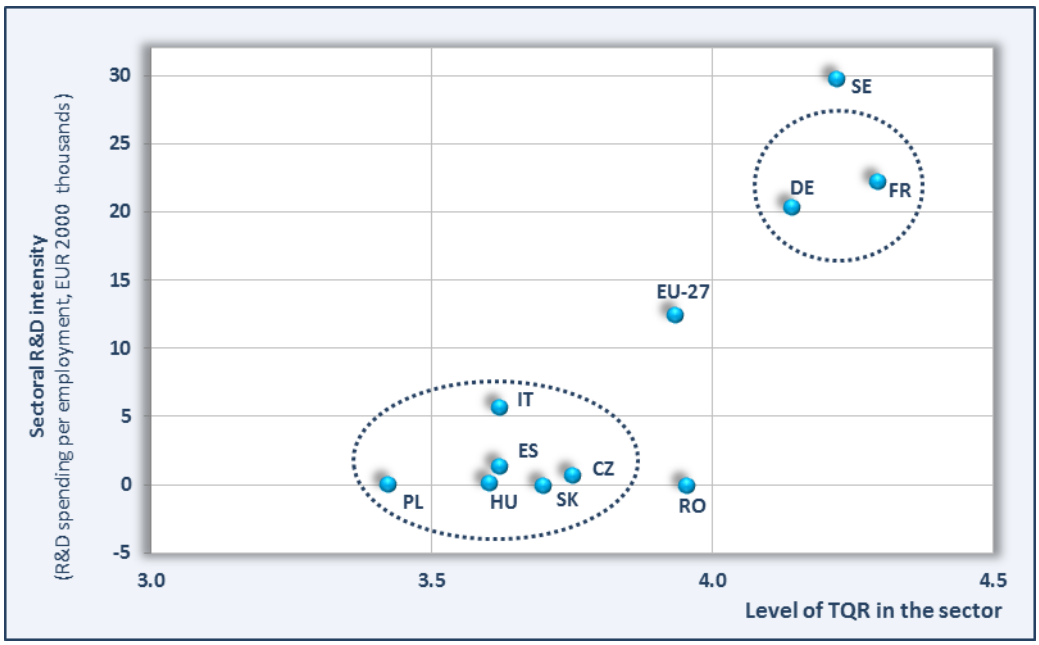
Three criteria have been used to select countries for specific analysis of the impact of R&D intensity in the motor vehicle sector on the average TQR in various European countries: the rate of sectoral output in the whole national economy, the rate of sectoral employment in the whole national economy, and the ratio of the country sectoral employment to the overall EU-27 employment in the sector. The 10 countries selected are above the average of the EU-27 Member States concerning all the three criteria together (in the descending order): Germany (DE), the Czech Republic (CZ), Poland (PL), Spain (ES), France (FR), Hungary (HU), Slovakia (SK), Italy (IT), Sweden (SE), and Romania (RO). Figure 20 summarises the results of the analysis.

Figure 19 **Total level qualification requirements of jobs and R&D spending by sector, 2010, EU-27; only sectors with share to total R&D spending > 1%**



Source: Author.

Figure 20 **Total level of qualification requirements of jobs and R&D intensity by country (motor vehicles sector)**

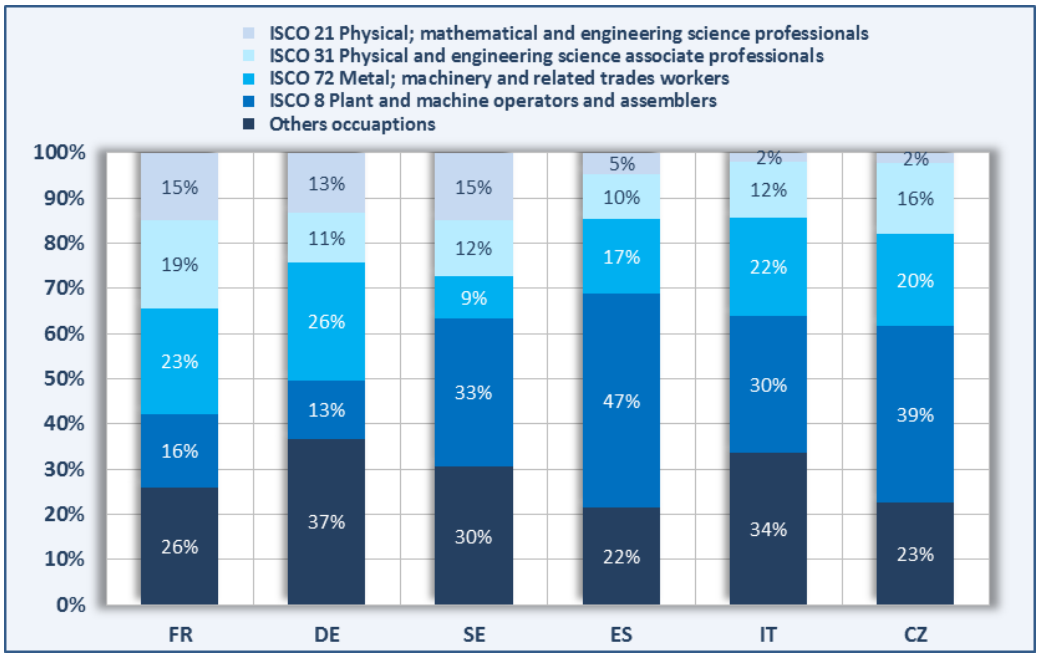


Source: Author.

The results confirm that the relationship between the R&D intensity and the level of TQR is positive and really strong (with the exception of Romania whose data seem to be suspect). Further, European countries with an important motor vehicles sector can be divided into two groups. The first one is Germany, France and Sweden, whose motor vehicles sector has a high level of the R&D intensity (a little under EUR 30 000 per employment) and a corresponding high level of TQR (within the interval 4.1 – 4.3). The second group comprises six countries: the Czech Republic, Spain, Italy, Hungary, Poland and Slovakia. All have a markedly lower R&D intensity (the highest one in Italy is still more than several times lower than others in the first group of countries), in relation to their TQR (between 3.4 and 3.7).

In this example a different orientation of the sector – research versus assembling – determines a different occupational structure that in turn explains the variation of TQR across countries for the sector. In some countries the occupational group ISCO 21, physical mathematical and engineering science professionals, has a relatively high number of jobs. This indicates countries oriented to research and development. In other countries there are a lot of jobs for the group ISCO 8, plant and machine operators and assemblers, which indicates countries oriented to assembling.

Figure 21 **Occupational structure of the motor vehicles sector**



Source: Author.

Figure 21 shows the occupational structure of the sector in six European countries. Germany, France and Sweden belong to the first group (focused on research and development), while the Czech Republic, Spain and Italy are examples of those focused on assembling.

4.3.3. Health and social work

The third example is a sector with different multiple subsectors whose proportions differ in individual countries. This causes that the whole sector to have quite different occupational structures and subsequently different TQR in different countries.

The health and social work sector has three subsectors: human health activities ([14]), veterinary activities ([15]), and social work activities ([16]).

The veterinary activities subsector is the smallest, its share in the number of employed in the sector being less than 2.5% in almost all EU-27 Member States except for Bulgaria and Cyprus (about 3%) and Romania (about 4%). Hence the main differences in the TQR are caused by a different proportion of the two other subsectors.

Figure 22 shows a strong relationship between the level of economic development (measured as GDP per capita) and the proportion of social work activities in health and social work sectors in a given country.

There is a clear relationship between the two variables: the more developed the economy was in 2010, the higher the share of social work activities (and the lower the share of human health activities). A higher share of social work activities means a higher orientation towards the care of older or otherwise socially disadvantaged people.

A different structure of work characteristics in subsectors leads to a different occupational structure. Figure 23 shows how different main occupational groups are represented in each subsector.

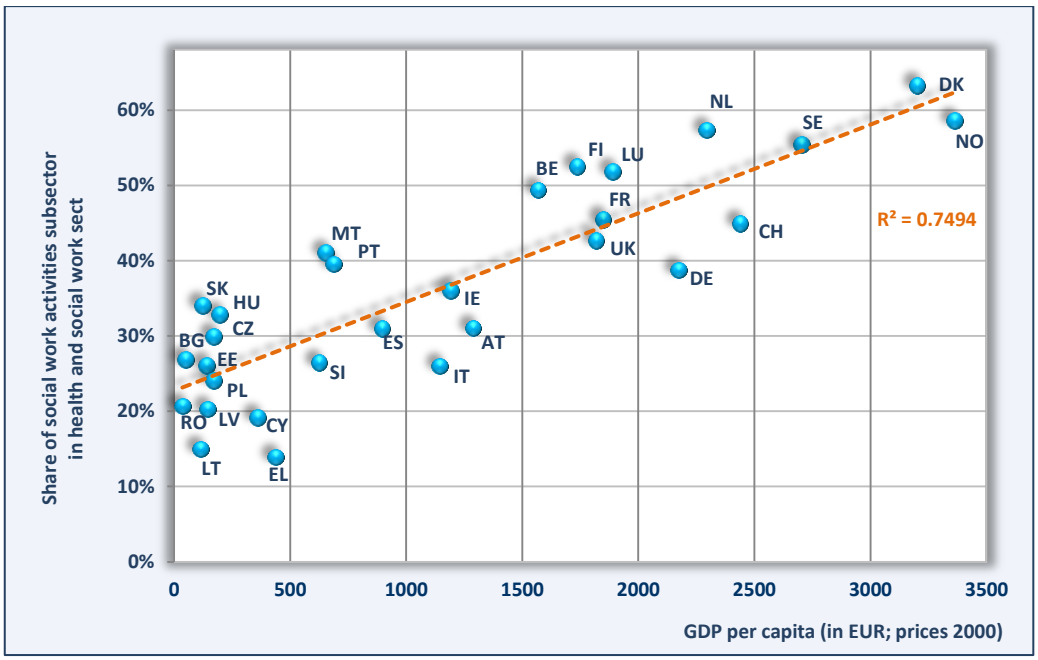
Four occupational groups dominate human health activities: health professionals, except nursing (ISCO 222); modern health associate professionals, except nursing (ISCO 322); nursing and midwifery associate professionals (ISCO 323); personal care and related workers (ISCO 513). Health professionals dominate In veterinary activities, except nursing (ISCO 222) and in social work activities personal care and related workers (ISCO 513).

([14]) Defined as group 851 in NACE Rev.1 and as group 86 in NACE Rev. 2.

([15]) Defined as group 852 in NACE Rev.1 and as group 75 in NACE Rev. 2.

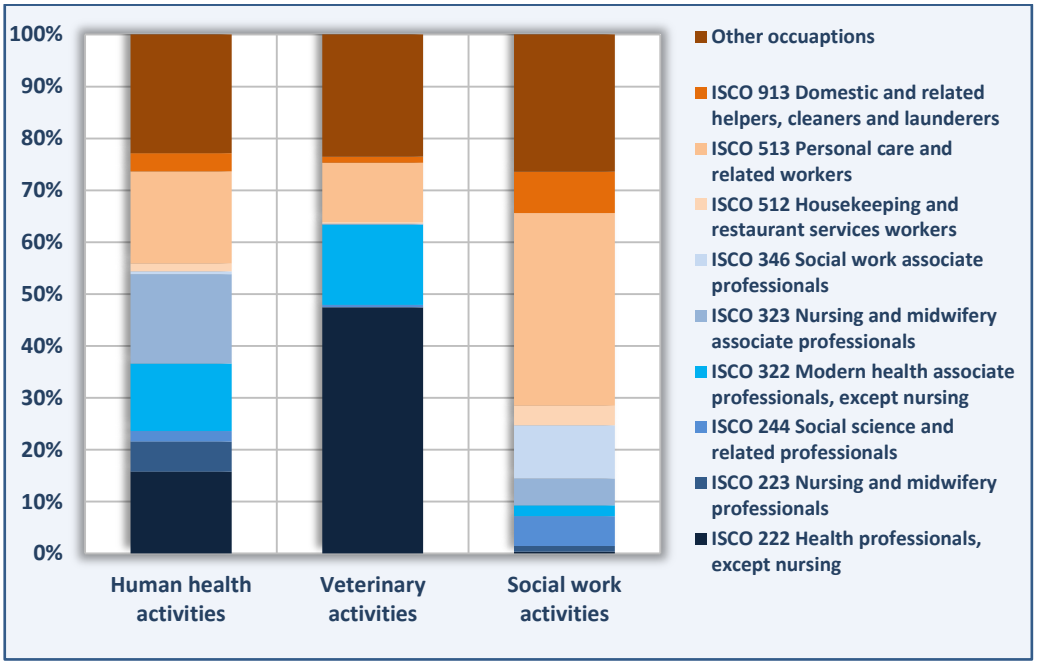
([16]) Defined as group 853 in NACE Rev.1 and as groups 87 and 88 in NACE Rev. 2.

Figure 22 **GDP per capita and share of social work activities in the health and social work sector by country**



Source: Author.

Figure 23 **Occupational structure of subsectors in health and social work sector**



Source: Author.

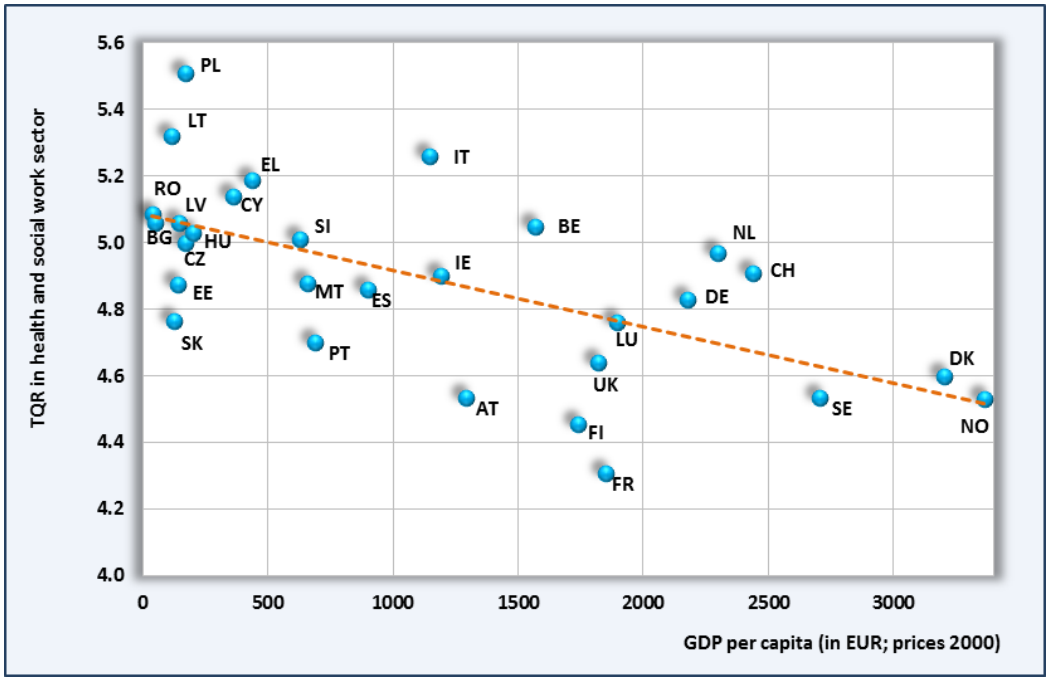
Different occupational structures of subsectors and different proportions of subsectors in a given country (and thus different occupational structures of the

whole economy) result in different values of TQR in a given country in the whole sector. Jobs with a high proportion employed from occupational groups ISCO 2 (professionals) and ISCO 3 (technicians and associate professionals) have a higher value of TQR than jobs where employment comes from occupational groups ISCO 5 (personal care, personal services and related workers).

It is not surprising that the lowest TQR in the sector in the EU-27 is found in social work activities (4.19 in 2010). Human health activities had TQR equal to 5.08 in 2010, and Veterinary activities equal to 6.00. The TQR for the health and social work sector in the EU-27 were equal to 4.79 points in 2010.

Figure 24, showing the TQR in the health and social work sector in individual countries, suggests an unexpected, yet very reasonable, conclusion that the more developed countries (measured by GDP per capita) have a lower TQR for the whole sector health and social work, which is related to a higher share of social work activities (Figure 22).

Figure 24 **Total level of qualification requirements of jobs in health and social work sector and GDP per capita by country**



Source: Author.

The sector illustrates how a different proportion of subsectors in individual countries (related to their macroeconomic situation and standard of living), and the corresponding different occupational structure, can explain differences in the TQR in a given sector and country.

CHAPTER 5.

Conclusion

This study presented a new approach for measuring occupational skills profiles (OSPs) aimed at overcoming limitations and lack of comparable statistical data on occupational skill needs. Integrating different statistical sources, OSPs have the potential to summarise most characteristics required for a given occupation in terms of qualifications (level and field), knowledge, skills, personal abilities, attitudes and values. OSPs have the potential to provide essential information to complement labour market analysis and forecasting. However, the approach developed in this study also presents some critical points and applicative limits.

5.1. Advantages of the approach

The basic advantage of the OSP approach is twofold: job requirements are defined coherently and comprehensively across all occupations, with a focus on relevant generic skill needs; and job requirements are not only qualitatively described but also quantified, making use of data sources that are regularly provided. OSPs are therefore comparable at individual job level across sectors, countries and over time.

The approach developed allow us to aggregate OSPs at higher levels – that is at the level of occupational group, sector or even the whole economy – without losing their information content. By making use of the sector-specific approach, not only the range of OSP mutual comparability but also their applicability has been substantially widened.

OSPs are thus suitable for analysing and forecasting skill needs and identifying potential skills mismatches, comparing them across various occupations, sectors, and countries, and providing information on their development over time. As they are based on job requirements, they represent the demand side of the labour market, and can be compared with labour market projections traditionally based on surveys of job holders carried out on the supply side.

5.2. Critical points and limits of applicability

To ensure valid results, a series of stringent assumptions and requirements has to be met. The most important is the need to define OSPs at a level of

occupational classification where the job structure and characteristics are sufficiently detailed and supported by empirical data.

These constraints limit the choice of data among existing data sources that are able to fulfil the four criteria identified: availability, usability, accessibility, and suitability. For this reason, European data and statistical sources had to be supplemented by data from US surveys. Once analyses conducted on both European and US data sources have confirmed that this is possible, a series of suitable conversion tables between the two sources have been developed.

It must also be considered that, by definition, OSPs describe the characteristics of the job, and not of the job holder. This pinpoints the crucial problem of the distinction between job qualification requirements and the job holder qualification as indicated by formal education attained. We separate the two notions, working only with job characteristics as described by the seven dimensions of OSPs. We do not make any forecasts, but use forecasts of jobs defined by sector (38 industries) and occupation (ISCO 2-digit) elaborated by Cedefop, assigning the jobs characteristics to their respective OSPs.

Finally, the scope and origin of data used for calculating OSPs affect their final form. We used all available sources that are suitable, relevant and which meet the stringent conditions for including them into a common database. Alongside US data (not only O*NET but also BLS) and ESS, data from the Czech Republic, Germany and Italy are used. However, other relevant sources have not been considered (e.g. the British skill survey data).

5.3. Possible future application and development

Although still at the experimental stage, the OSPs approach has the potential to bring about significant improvements in efforts to analyse, project and forecast labour market and skill needs in Europe. However, the approach developed so far has two main limitations.

First, the existing approach does not allow for country-level differences across the EU, while analyses have shown that skill requirements may differ significantly not only over time, but also between individual countries analysed.

Although the use of US data for constructing OSPs for European countries has been justified by a correlation analysis, a second limitation is the lack of suitable methods for a better integration of US and EU statistical sources.

Expanding the OSP approach to overcome these limitations and to enable a more precise and usable international comparison of changes in skills structures is a clear direction for future research.

The first avenue identified is to use data collected for the OECD project programme for the international assessment of adult competences to validate and improve the methods for generating OSPs, including the generation of country-specific coefficients in the models.

By adopting a job requirement approach, PIAAC attempts to assess the level and distribution of adult skills in a coherent and consistent way across 23 countries. It focuses on the key cognitive and workplace skills that are needed for successful participation in the economy and society and required in a specific job identified by sector and occupation. The size of the PIAAC database, with more than 100 000 respondents in employment, ensures a rich source of information about country differences (around 5 000 cases in each country). Results from the study will be available in autumn 2013.

The PIAAC data could considerably contribute to the further development of OSPs, especially for their quantification and validity at individual country level (all sectors and occupations for a given country). It may also bring a deeper understanding of mismatches between labour market requirements and actual employment qualification. Equally important is that PIAAC will be conducted in the US as well. Its data will also serve to verify further the suitability of US data sources (particularly the O*NET) for determining qualification requirements in European countries, thus making OSPs even more robust. Further, one can include country-level variables from other sources such as R&D expenditure and innovation policies to improve the reliability of OSPs for small countries, for example, using methods such as those from small-area statistics. Other national studies can also be used to improve and evaluate the model.

Improving the integration of US and EU statistical sources is a second possible future development of the OSPs approach. Although including information from the European social survey and some national surveys, the OSP approach is already largely based on the US O*NET system on occupational profiles. However, the ‘mechanical’ approach used to get the European occupational structure from O*NET data do not allow us adequately to take into account both differences in OSP between the US and European economies, and dynamic changes in occupational profiles in terms of skill needs. It will be necessary to develop further approaches aimed at analysing structure and changes in skill demands at European level on the basis of information drawn from the US O*NET.

Finally, the continuing work on a European standard classification for skills and competences (ESCO) will provide a valuable tool linking skills and competences to occupations and bridging the information gap between the worlds of work and learning.

List of abbreviations

BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin [Federal Institute for Occupational Safety and Health] (DE)
BIBB	Bundesinstitut für Berufsbildung [Federal Institute for Vocational Education and Training] (DE)
BLS	Bureau of Labour Statistics
EQF	European qualifications framework
ESCO	European skills, competences and occupations taxonomy
ESS	European social survey
EU-27+	27 Member States of the European Union plus Switzerland and Norway
EU-LFS	European labour force survey
EURES	European job mobility portal
IALS	international adult literacy survey
ISCED	international standard classification of education
ISCED-97	international standard classification of education, approved in 1997
ISCO	international standard classification of occupations
ISCO-08	international standard classification of occupations, approved in 2008
ISCO-88	international standard classification of occupations, approved in 1988
ISFOL	Istituto per lo sviluppo della formazione professionale dei lavoratori [Institute for the development of vocational training of workers] (IT)
ISIC	international standard industry classification
ISTAT	Istituto nazionale di statistica [Italian National Institute of Statistics] (IT)
KZiS	Klasyfikacja zawodów i specjalności na potrzeby rynku pracy [classification of occupations and specialisations for labour market needs] (PL)
LFS	labour force survey
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne [Statistical classification of economic activities in the European Community] (FR)
NAICS	North American industry classification system
O*NET	occupational information network
OECD	Organisation for Economic Cooperation and Development
OES	occupational employment statistics
OSP	occupational skills profile
PIAAC	programme for the international assessment of adult competences
SIALS	second international adult literacy survey
SMT	science, mathematics and technology
SOC	standard occupation classification system
TQR	total qualification requirement

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Annexes Approach and methodology

Annex 1
How occupational skills profiles have been generated

Occupational skills profiles (OSPs) are structured into seven dimensions. The first two – grouped together as coordinating characteristics – relate to the level of education and training required (and hence to the complexity of the occupation), and to the field of education and training required. Three further dimensions – together referred to as main characteristics – contain what is required to do the job in terms of theoretical and factual knowledge, cross-functional skills, and personal, social and methodological abilities. The last two dimensions – under the heading of supplementary characteristics – add information relating to the profile and orientation of work, such as occupational interests (preferences for work environment) and work values (important to job satisfaction).

The data sources for the seven OSP dimensions are described in detail in Chapters 1 and 2. The way they have been used to generate them differs according to their origin – European or US – and to the dimension in question. Generating dimensions III to VII is similar and as it is more complicated, it will be discussed first.

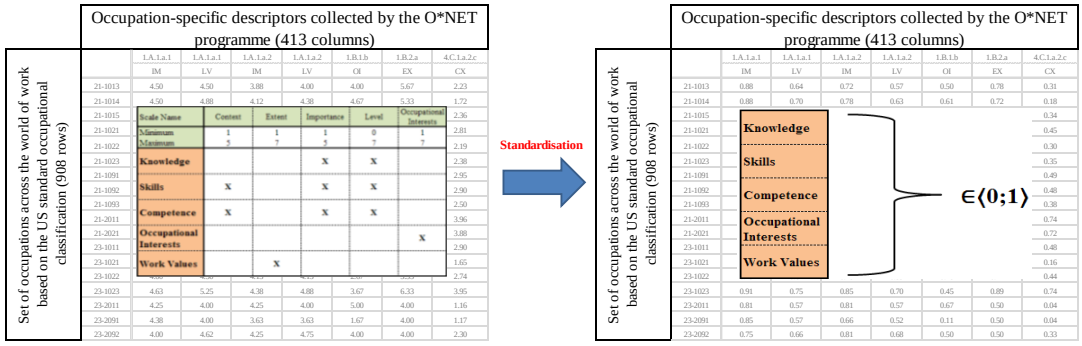
Computing dimensions III to VII

*Step 1: Standardise O*NET descriptors*

The matrix of O*NET descriptors is first converted (standardised) to the range 0 to 1.

Input matrix: the original O*NET database – US occupational groups (SOC) x occupation-specific descriptors collected by the O*NET programme (908 x 413 = 375 004 cells). These can take various values depending on the particular descriptor chosen.

Output matrix: the standardised O*NET database – US occupational groups (SOC) x standardised occupation-specific descriptors collected by the O*NET programme (908 x 413 = 375 004 cells). Values of each descriptor are now standardised.



$$\forall_{i=1,\dots,908;\ d=1,\dots,413}\quad a_{id} = \frac{x_{id} - min_s}{max_s - min_s}$$, where

x_{id} … elements of the input matrix
a_{id} … elements of the output matrix
i … occupational group
d … occupation-specific descriptors collected by the O*NET programme
s … scale; s ∈{context; extent; importance; level; occupational interests}

*Step 2: transform O*NET descriptors*

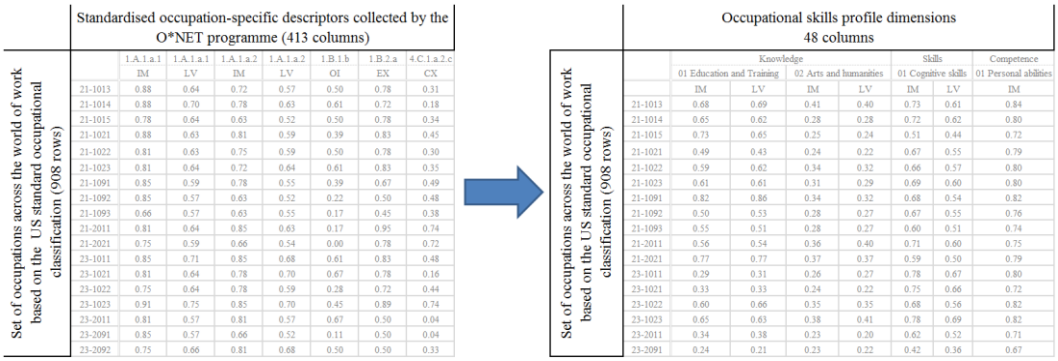
The matrix of standardised occupation-specific descriptors collected by the O*NET programme is matched to the OSP dimensions. The 413 O*NET descriptors are aggregated to 48 OSP dimensions (it is only 48 dimensions, not 66 as set out above, because this part is only for dimension III-VII and there are only 48 dimensions: the other 18 dimensions covered to dimension I and II). For detailed of assignation see Annex 2.

Input matrix: the standardised O*NET database – US occupational groups (SOC) x standardised occupation-specific descriptors collected by the O*NET programme (908 x 413 = 375 004 cells).

Output matrix: the matrix of OSP for US occupational groups (SOC) – US occupational groups (SOC) x OSP dimensions (908 x 48 = 43 584 cells).

Step 3: Generating a mapping from the North American industry classification system (NAICS) to NACE categories

The industry categories used in the latest US National Employment Matrix (for last version it is Matrix with 2008 data) are converted to the NACE classification used in the main Cedefop projections.



Standardised occupation-specific descriptors collected by the O*NET programme (413 columns)

Set of occupations across the world of work based on the US standard occupational classification (908 rows)

	1.A.1.a.1 IM	1.A.1.a.1 LV	1.A.1.a.2 IM	1.A.1.a.2 LV	1.B.1.b OI	1.B.2.a EX	4.C.1.a.2.c CX
21-1013	0.88	0.64	0.72	0.57	0.50	0.78	0.31
21-1014	0.88	0.70	0.78	0.63	0.61	0.72	0.18
21-1015	0.78	0.64	0.63	0.52	0.50	0.78	0.34
21-1021	0.88	0.63	0.81	0.59	0.39	0.83	0.45
21-1022	0.81	0.63	0.75	0.59	0.50	0.78	0.30
21-1023	0.81	0.64	0.72	0.64	0.61	0.83	0.35
21-1091	0.85	0.59	0.78	0.55	0.39	0.67	0.49
21-1092	0.85	0.57	0.63	0.52	0.22	0.50	0.48
21-1093	0.66	0.57	0.63	0.55	0.17	0.45	0.38
21-2011	0.81	0.64	0.85	0.63	0.17	0.95	0.74
21-2021	0.75	0.59	0.66	0.54	0.00	0.78	0.72
23-1011	0.85	0.71	0.85	0.68	0.61	0.83	0.48
23-1021	0.81	0.64	0.78	0.70	0.67	0.78	0.16
23-1022	0.75	0.64	0.78	0.59	0.28	0.72	0.44
23-1023	0.91	0.75	0.85	0.70	0.45	0.89	0.74
23-2011	0.81	0.57	0.81	0.57	0.67	0.50	0.04
23-2091	0.85	0.57	0.66	0.52	0.11	0.50	0.04
23-2092	0.75	0.66	0.81	0.68	0.50	0.50	0.33

Occupational skills profile dimensions 48 columns

Set of occupations across the world of work based on the US standard occupational classification (908 rows)

	Knowledge 01 Education and Training IM	Knowledge 01 Education and Training LV	Knowledge 02 Arts and humanities IM	Knowledge 02 Arts and humanities LV	Skills 01 Cognitive skills IM	Skills 01 Cognitive skills LV	Competence 01 Personal abilities IM
21-1013	0.68	0.69	0.41	0.40	0.73	0.61	0.84
21-1014	0.65	0.62	0.28	0.28	0.72	0.62	0.80
21-1015	0.73	0.65	0.25	0.24	0.51	0.44	0.72
21-1021	0.49	0.43	0.24	0.22	0.67	0.55	0.79
21-1022	0.59	0.62	0.34	0.32	0.66	0.57	0.80
21-1023	0.61	0.61	0.31	0.29	0.69	0.60	0.80
21-1091	0.82	0.86	0.34	0.32	0.68	0.54	0.82
21-1092	0.50	0.53	0.28	0.27	0.67	0.55	0.76
21-1093	0.55	0.51	0.28	0.27	0.60	0.51	0.74
21-2011	0.56	0.54	0.36	0.40	0.71	0.60	0.75
21-2021	0.77	0.77	0.37	0.37	0.59	0.50	0.79
23-1011	0.29	0.31	0.26	0.27	0.78	0.67	0.80
23-1021	0.33	0.33	0.24	0.22	0.75	0.66	0.72
23-1022	0.60	0.66	0.35	0.35	0.68	0.56	0.82
23-1023	0.65	0.63	0.38	0.41	0.78	0.69	0.82
23-2011	0.34	0.38	0.23	0.20	0.62	0.52	0.71
23-2091	0.24	0.21	0.23	0.22	0.42	0.36	0.67

$$\forall_{i=1,\ldots,908;d=1,\ldots,48} \quad a_{id} = \frac{\sum_{j=1}^{N_d} x_{ij}}{N_d}$$, where

x_{ij} … elements of input matrix

a_{id} … elements of output matrix

i … occupational group

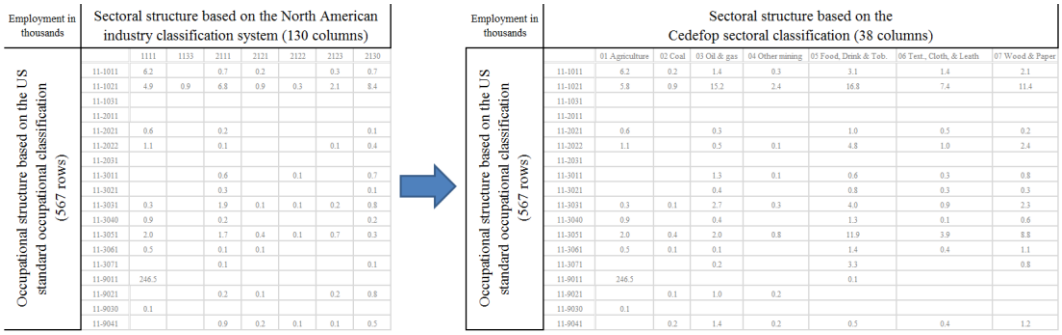
d … OSP dimension

N_d … number of occupation-specific descriptors collected by the O*NET programme covered by the OSP dimension d

Input matrix: the latest US National Employment Matrix, industry employment by occupation – US occupation groups (SOC) x US industrial groups (NAICS) (567 x 130 = 73 710 cells).

Output matrix: the modified US national employment matrix (it is employment in the US in combination of US SOC and European NACE categories); industry employment by occupation – US occupation groups (SOC) x Cedefop sectoral groups ([17]) (567 x 38 = 21 546 cells).

([17]) In the main Cedefop project Cambridge Econometrics use the E3ME model, in which the structure of sectors is based on the NACE Rev.1.1 classification. The number of sectors has been reduced in E3ME by aggregation to 41. EPC use basically the same classification here. However the number of sectors has been further reduced to just 38, as three pairs of sectors had to be combined due to data limitations. The first combined sector unites pharmaceuticals (10) and chemicals (11), the second one electricity (22) and gas supply (23), and the third one professional services (36) and other business services (37).



$$\forall_{i=1,\ldots,567;\ d=1,\ldots,38} \quad a_{id} = \sum_{j=1}^{N_d} x_{ij}$$, where

x_{ij} … number employed in occupation *i* in the sectoral group *j* (elements of the input matrix)

a_{id} … number employed in occupation *i* in the sectoral group *d* (elements of the output matrix)

i … occupational group (SOC classification)

j … sectoral group (NAICS classification)

d … sectoral group (Cedefop classification)

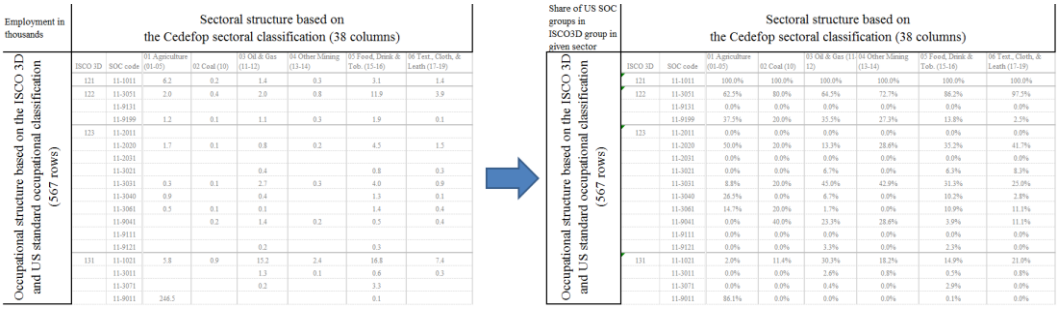
N_d … number of sectoral groups defined by the NAICS covered by the Cedefop sectoral group *d*

Step 4: Development of sector-specific weights

In this step, sector specific weights are developed (for the aggregated Cedefop 38 sectors, Ind 38) for computing OSPs for occupational groups based on ISCO 3-digit categories (ISCO 3D).

Input matrix: the modified employment matrix from step 3, which is industry employment by occupation – US occupational groups (SOC) and ISCO 3D groups (103) x Cedefop sectoral groups (567 x 38 = 21 546 cells).

Output matrix: the matrix of weights for the occupational group *i* (SOC classification) in the occupational group *j* (ISCO 3D classification) in the sectoral group *d* (Cedefop sectoral classification).



$$\forall_{j=1,\ldots,103;\ d=1,\ldots,38} \quad w_{ijd} = \frac{a_{id}}{\sum_{i=1}^{567} k_{ij}.a_{id}}$$, where

w_{ijd}… weight (or share) of the occupational group *i* in occupational group *j* in sectoral group *d* (elements of the output matrix)

a_{id} … number employed in the US SOC occupational group *i* in sectoral group *d* (elements of the input matrix)

i … occupational group (SOC classification)

j … occupational group (ISCO 3D classification)

d … sectoral group (Cedefop classification)

$$k_{ij} = \begin{cases} 0 \ldots \text{occupation group } i \text{ (SOC classification) is not a part of occupational group } j \text{ (ISCO 3D classification)} \\ 1 \ldots \text{occupation group } i \text{ (SOC classification) is a part of occupational group } j \text{ (ISCO 3D classification)} \end{cases}$$

Mapping the US SOC occupational group to ISCO 3D groups is based on correspondence table.

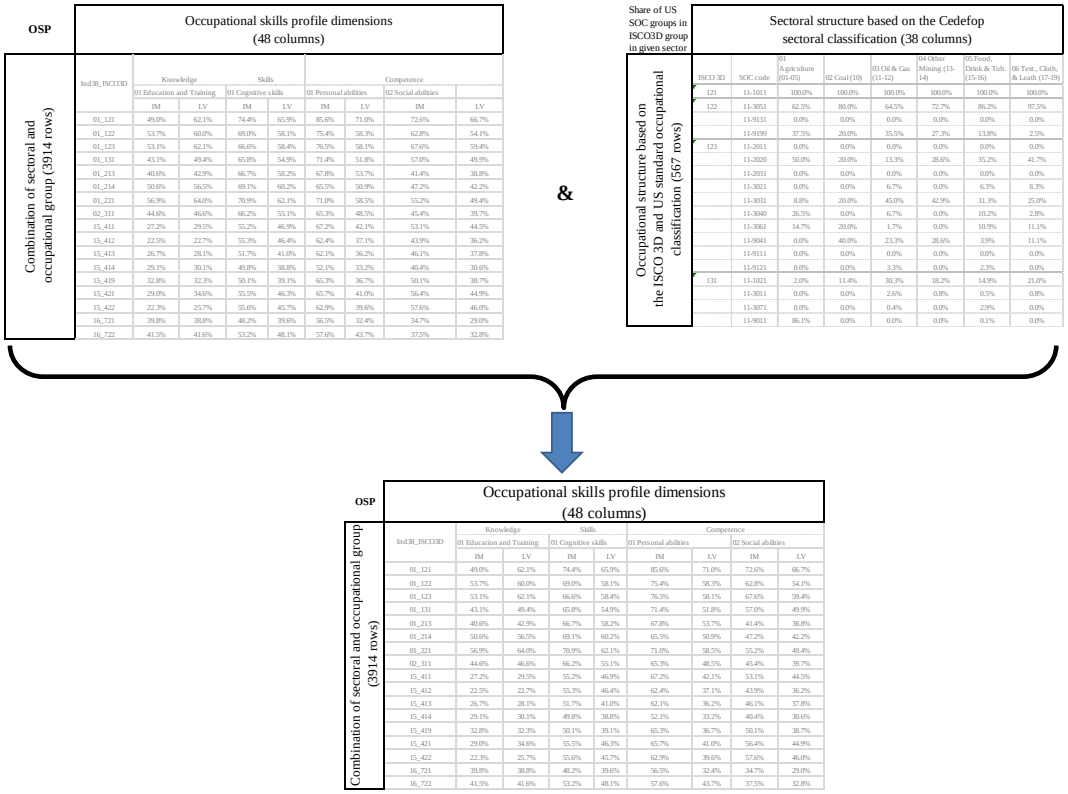
Step 5: Development of sector-specific OSPs

In this step, sector specific OSPs are computed for each combination of occupations (ISCO 3D) and sectors (38 sectoral groups).

Input matrixes:

– the matrix of OSP for US occupational groups (SOC) – US occupational groups (SOC) x OSP dimensions (908 x 48 = 43 584 cells), from step 2, and
– the matrix of weights for the occupational group *i* (SOC classification) in the occupational group *j* (ISCO 3D classification) in the sectoral group *d* (Cedefop sectoral classification) (567 x 38 = 21 546 cells), from step 4.

Output matrix: the matrix of OSP for each combination occupation (ISCO 3D or ISCO 2D) x sector (Ind 38).

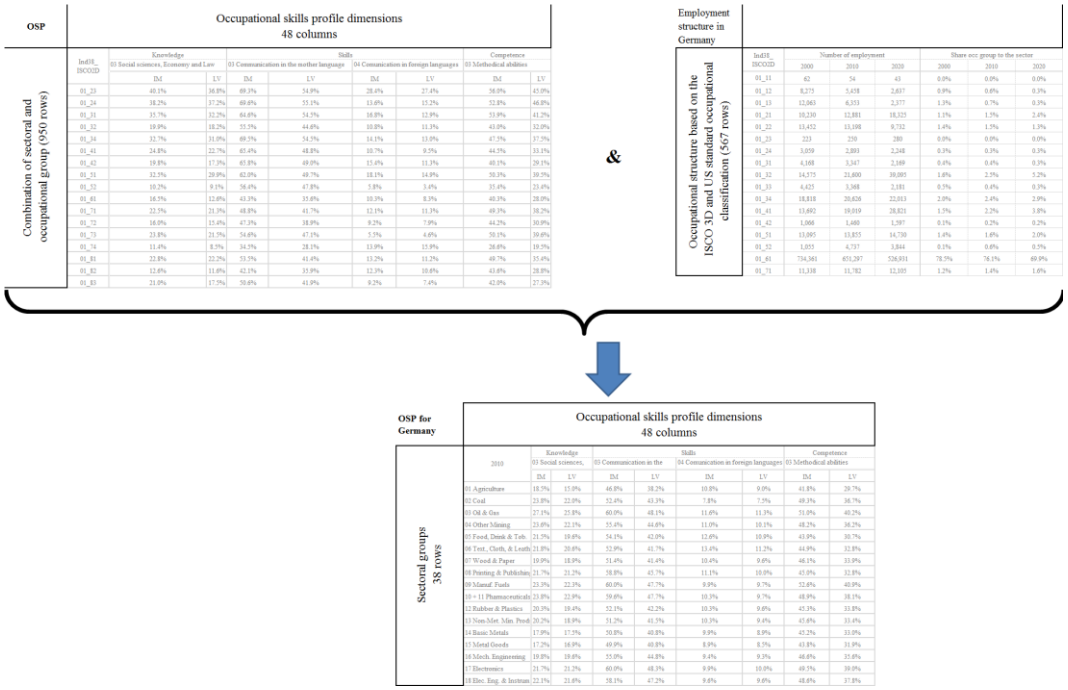


As in the core project the ISCO 2D classification is used, the OSP matrix computed in this step (ISCO 3D x Ind 38) is transformed to the matrix ISCO2D x Ind 38. As a weight, the employment structure of the EU-19 ([18]) is used.

Step 6: Generate OSPs for all industries

In the last step, OSPs are computed for each country. They are based on its particular employment structure (occupation x sectors).

([18]) The EU-19 covers EU-15 Member States + Czech Republic, Hungary, Poland and Slovakia. Only EU-19 is used because authors have no data for ISCO 3D for all Member States.



Computing dimensions I and II

The approach is not so complicated here. European sources (such as ESS or BIBB) use the ISCO x NACE classifications. It is straightforward to find the value of dimension I and II in OSPs for each necessary combination of the ISCO 2-digit (ISCO 2D) and NACE industry category (in particular the 38 categories used here (Ind 38).

For the US data the procedure required is the same as described in steps 4 to 6 in the previous section.

Annex 2
Assigning variables from O*NET

Dimension III: knowledge

Detail dimension	O*NET code	O*NET name
01 Education and training	2.C.6	Education and training
02 Arts and humanities	2.C.3.c	Design
	2.C.7.a	English language
	2.C.7.c	Fine arts
	2.C.7.d	History and archaeology
	2.C.7.e	Philosophy and theology
	2.C.9.b	Communications and media
03 Social sciences, economy and law	2.C.1.c	Economics and accounting
	2.C.4.e	Psychology
	2.C.4.f	Sociology and anthropology
	2.C.8.b	Law and government
04 Sciences, mathematics and computers	2.C.4.a	Mathematics
	2.C.4.b	Physics
	2.C.4.c	Chemistry
	2.C.4.d	Biology
	2.C.4.g	Geography
05 Engineering, technology, production and processing	2.C.2.a	Production and processing
	2.C.2.b	Food Production
	2.C.3.a	Computers and electronics
	2.C.3.b	Engineering and technology
	2.C.3.d	Building and construction
	2.C.3.e	Mechanical
06 Health services	2.C.5.a	Medicine and dentistry
	2.C.5.b	Therapy and counselling
07 Services	2.C.1.e	Customer and personal service
	2.C.10	Transportation
	2.C.8.a	Public safety and security
	2.C.9.a	Telecommunications
08 Business and management	2.C.1.a	Administration and management
	2.C.1.b	Clerical
	2.C.1.d	Sales and marketing
	2.C.1.f	Personnel and human resources

Dimension IV: skills

Detail dimension	O*NET code	O*NET name
01 Cognitive skills	1.A.1.b.4	Deductive reasoning
	1.A.1.b.5	Inductive reasoning
	1.A.1.b.6	Information ordering
	1.A.1.b.7	Category flexibility
	1.C.7.b	Analytical thinking
	2.A.2.a	Critical thinking
	2.A.2.b	Active learning
	2.B.2.i	Complex problem Solving
	4.A.2.a.1	Judging the qualities of things, services, or people
	4.A.2.a.2	Processing information
	4.A.2.a.3	Evaluating information to determine compliance with Standards
	4.A.2.a.4	Analysing data or information
	4.A.2.b.1	Making decisions and solving problems
	4.A.2.b.3	Updating and using relevant knowledge

Detail dimension	O*NET code	O*NET name
02 Practical skills	2.B.3.a	Operations analysis
	2.B.3.b	Technology design
	2.B.3.c	Equipment selection
	2.B.3.d	Installation
	2.B.3.g	Operation monitoring
	2.B.3.h	Operation and control
	2.B.3.j	Equipment maintenance
	2.B.3.k	Troubleshooting
	2.B.3.l	Repairing
	2.B.3.m	Quality control analysis
	4.A.1.a.1	Getting information
	4.A.1.a.2	Monitor processes, materials, or surroundings
	4.A.1.b.1	Identifying objects, actions, and events
	4.A.1.b.2	Inspecting equipment, structures, or material
	4.A.1.b.3	Estimating the quantifiable characteristics of products, events, or information
	4.A.3.b.1	Interacting with computers
	4.A.3.b.2	Drafting, laying out, and specifying technical devices, parts, and equipment
	4.A.3.b.4	Repairing and maintaining mechanical equipment
	4.A.3.b.5	Repairing and maintaining electronic equipment
	4.A.3.b.6	Documenting/recording information
03 Communication in the mother language	1.A.1.a.1	Oral comprehension
	1.A.1.a.2	Written comprehension
	1.A.1.a.3	Oral expression
	1.A.1.a.4	Written expression
	2.A.1.a	Reading comprehension
	2.A.1.b	Active listening
	2.A.1.c	Writing
	2.A.1.d	Speaking
	4.A.4.a.1	Interpreting the meaning of information for others
	4.A.4.a.2	Communicating with supervisors, peers, or subordinates
	4.A.4.a.3	Communicating with persons outside organisation
	4.A.4.a.8	Performing for or working directly with the public
	4.C.1.a.2.c	Public speaking
	4.C.1.a.2.f	Telephone
	4.C.1.a.2.h	Electronic mail
	4.C.1.a.2.j	Letters and memos
	4.C.1.a.2.l	Face-to-face discussions
	4.C.1.a.4	Contact with others
04 Communication in foreign languages	2.C.7.b	Foreign language
05 Numeracy + basic SMT concepts	1.A.1.c.1	Mathematical reasoning
	1.A.1.c.2	Number facility
	2.A.1.e	Mathematics
	2.A.1.f	Science
06 ICT/digital	2.B.3.e	Programming
07 Learning to learn	2.A.2.c	Learning strategies

Dimension V: competence

Detail dimension	O*NET code	O*NET name
01 Personal abilities	1.A.1.b.1	Fluency of ideas
	1.A.1.b.2	Originality
	1.A.1.b.3	Problem sensitivity
	1.C.1.a	Achievement/effort
	1.C.1.b	Persistence
	1.C.1.c	Initiative
	1.C.2.b	Leadership
	1.C.3.a	Cooperation
	1.C.3.b	Concern for others
	1.C.4.a	Self-control
	1.C.4.b	Stress tolerance
	1.C.4.c	Adaptability/flexibility
	1.C.5.a	Dependability
	1.C.5.c	Integrity
	1.C.6	Independence
	1.C.7.a	Innovation
	2.A.2.d	Monitoring
	4.A.2.b.2	Thinking creatively
02 Social abilities	2.B.1.a	Social perceptiveness
	2.B.1.b	Coordination
	2.B.1.c	Persuasion
	2.B.1.d	Negotiation
	2.B.1.e	Instructing
	2.B.1.f	Service orientation
	4.A.4.a.4	Establishing and maintaining interpersonal relationships
	4.A.4.a.5	Assisting and caring for others
	4.A.4.a.6	Selling or influencing others
	4.A.4.a.7	Resolving conflicts and negotiating with others
	4.C.1.b.1.e	Work with work group or team
03 Methodical abilities	2.B.4.e	Judgment and decision-making
	2.B.4.g	Systems analysis
	2.B.4.h	Systems evaluation
	2.B.5.a	Time management
	2.B.5.b	Management of financial resources
	2.B.5.c	Management of material resources
	2.B.5.d	Management of personnel resources
	4.A.2.b.4	Developing objectives and strategies
	4.A.2.b.5	Scheduling work and activities
	4.A.2.b.6	Organising, planning, and prioritising work
	4.A.4.b.1	Coordinating the work and activities of others
	4.A.4.b.2	Developing and building teams
	4.A.4.b.3	Training and teaching others
	4.A.4.b.4	Guiding, directing and motivating subordinates
	4.A.4.b.5	Coaching and developing others
	4.A.4.b.6	Provide consultation and advice to others
	4.A.4.c.2	Staffing organisational units
	4.A.4.c.3	Monitoring and controlling resources
	4.C.1.b.1.g	Coordinate or lead others
	4.C.1.c.2	Responsibility for outcomes and results
	4.C.3.a.1	Consequence of error
	4.C.3.a.2.a	Impact of decisions on co-workers or company results
	4.C.3.a.2.b	Frequency of decision making
	4.C.3.a.4	Freedom to make decisions
	4.C.3.b.8	Structured versus unstructured work
	4.C.3.d.1	Time pressure

Dimension VI: occupational interests

Detail dimension	O*NET code	O*NET name
Artistic	1.B.1.c	Artistic
Conventional	1.B.1.f	Conventional
Enterprising	1.B.1.e	Enterprising
Investigative	1.B.1.b	Investigative
Realistic	1.B.1.a	Realistic
Social	1.B.1.d	Social

Dimension VII: work values

Detail dimension	O*NET code	O*NET name
Achievement	1.B.2.a	Achievement
Independence	1.B.2.f	Independence
Recognition	1.B.2.c	Recognition
Relationships	1.B.2.d	Relationships
Support	1.B.2.e	Support
Working conditions	1.B.2.b	Working conditions

Annex 3
Level scale anchors

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
1.A.1.a.1	Oral comprehension	Skills / 03 Communication in the mother language	LV	2	29	Understand a television commercial
				4	57	Understand a coach's oral instructions for a sport
				6	86	Understand a lecture on advanced physics
1.A.1.a.2	Written comprehension	Skills / 03 Communication in the mother language	LV	2	29	Understand signs on the highway
				4	57	Understand an apartment lease
				6	86	Understand an instruction book on repairing missile guidance systems
1.A.1.a.3	Oral expression	Skills / 03 Communication in the mother language	LV	2	29	Cancel newspaper delivery by phone
				4	57	Give instructions to a lost motorist
				6	86	Explain advanced principles of genetics to college freshmen
1.A.1.a.4	Written expression	Skills / 03 Communication in the mother language	LV	1	14	Write a note to remind someone to take food out of the freezer
				4	57	Write a job recommendation for a subordinate
				6	86	Write an advanced economics textbook
1.A.1.b.1	Fluency of ideas	Competence / 01 Personal abilities	LV	2	29	Name four different uses for a screwdriver
				4	57	Think of as many ideas as possible for the name of a new company
				6	86	Name all the possible strategies for a military battle
1.A.1.b.2	Originality	Competence / 01 Personal abilities	LV	2	29	Use a credit card to open a locked door
				4	57	Redesign job tasks to be interesting for employees
				6	86	Invent a new type of man-made fibre
1.A.1.b.3	Problem sensitivity	Competence / 01 Personal abilities	LV	2	29	Recognise that an unplugged lamp will not work
				4	57	Recognise from the mood of prisoners that a prison riot is likely to occur
				6	86	Recognise an illness at an early stage of a disease when there are only a few symptoms
1.A.1.b.4	Deductive reasoning	Skills / 01 Cognitive skills	LV	2	29	Know that a stalled car can coast downhill
				5	71	Decide what factors to consider in selecting stocks
				6	86	Design an aircraft wing using principles of aerodynamics

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
1.A.1.b.5	Inductive reasoning	Skills / 01 Cognitive skills	LV	2	29	Decide what to wear based on the weather report
				4	57	Determine the prime suspect based on crime scene evidence
				6	86	Diagnose a disease using results of many different lab tests
1.A.1.b.6	Information ordering	Skills / 01 Cognitive skills	LV	1	14	Put things in numerical order
				2	29	Follow the correct steps to make change
				6	86	Assemble a nuclear warhead
1.A.1.b.7	Category flexibility	Skills / 01 Cognitive skills	LV	2	29	Sort nails in a toolbox on the basis of length
				3	43	Classify flowers according to size, colour, and smell
				6	86	Classify man-made fibres in terms of their strength, cost, flexibility, melting points, etc.
1.A.1.c.1	Mathematical reasoning	Skills / 05 Numeracy + basic SMT concepts	LV	1	14	Determine how much 10 oranges will cost when they are priced at two for 20 cents
				4	57	Decide how to calculate profits to determine the amounts of yearly bonuses
				6	86	Determine the mathematics required to simulate a spacecraft landing on the moon
1.A.1.c.2	Number facility	Skills / 05 Numeracy + basic SMT concepts	LV	1	14	Add 2 and 7
				3	43	Balance a cheque book
				5	71	Compute the interest payment that should be generated from an investment
2.A.1.a	Reading comprehension	Skills / 03 Communication in the mother language	LV	2	29	Read step-by-step instructions for completing a form
				4	57	Read a memo from management describing new personnel policies
				6	86	Read a scientific journal article describing surgical procedures
2.A.1.b	Active listening	Skills / 03 Communication in the mother language	LV	2	29	Take a customer's order
				4	57	Answer inquiries regarding credit references
				6	86	Preside as judge in a complex legal disagreement
2.A.1.c	Writing	Skills / 03 Communication in the mother language	LV	2	29	Take a telephone message
				4	57	Write a memo to staff outlining new directives
				6	86	Write a novel for publication
2.A.1.d	Speaking	Skills / 03 Communication in the mother language	LV	2	29	Greet tourists and explain tourist attractions
				4	57	Interview applicants to obtain personal and work history
				6	86	Argue a legal case before the Supreme Court
2.A.1.e	Mathematics	Skills / 05 Numeracy + basic SMT concepts	LV	2	29	Count the amount of change to be given to a customer
				4	57	Calculate the square footage of a new home under construction
				6	86	Develop a mathematical model to simulate and resolve an engineering problem

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.A.1.f	Science	Skills / 05 Numeracy + basic SMT concepts	LV	2	29	Conduct standard tests to determine soil quality
				4	57	Conduct product tests to ensure safety standards are met, following written instructions
				6	86	Conduct analyses of aerodynamic systems to determine the practicality of an aircraft design
2.A.2.a	Critical thinking	Skills / 01 Cognitive skills	LV	2	29	Determine whether a subordinate has a good excuse for being late
				4	57	Evaluate customer complaints and determine appropriate responses
				6	86	Write legal brief challenging a federal law
2.A.2.b	Active learning	Skills / 01 Cognitive skills	LV	2	29	Think about the implications of a newspaper article for job opportunities
				4	57	Determine the impact of new menu changes on a restaurant's purchasing requirements
				6	86	Identify the implications of a new scientific theory for product design
2.A.2.c	Learning strategies	Skills / 07 Learning to learn	LV	2	29	Learn a different method of completing a task from a co-worker
				4	57	Identify an alternative approach that might help trainees who are having difficulties
				6	86	Apply principles of educational psychology to develop new teaching methods
2.A.2.d	Monitoring	Competence / 01 Personal abilities	LV	2	29	Proofread and correct a letter
				4	57	Monitor a meeting's progress and revise the agenda to ensure that important topics are discussed
				6	86	Review corporate productivity and develop a plan to increase productivity
2.B.1.a	Social perceptiveness	Competence / 02 Social abilities	LV	2	29	Notice that customers are angry because they have been waiting too long
				4	57	Be aware of how a co-worker's promotion will affect a work group
				6	86	Counsel depressive patients during a crisis period
2.B.1.b	Coordination	Competence / 02 Social abilities	LV	2	29	Schedule appointments for a medical clinic
				4	57	Work with others to put a new roof on a house
				6	86	Work as director of a consulting project calling for interaction with multiple subcontractors
2.B.1.c	Persuasion	Competence / 02 Social abilities	LV	2	29	Solicit donations for a charity
				4	57	Convince a supervisor to purchase a new copy machine
				6	86	Change the opinion of the jury in a complex legal case
2.B.1.d	Negotiation	Competence / 02 Social abilities	LV	2	29	Present justification to a manager for altering work schedule
				4	57	Contract with a wholesaler to sell items at a given cost
				6	86	Work as an ambassador in negotiating a new treaty

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.B.1.e	Instructing	Competence / 02 Social abilities	LV	2	29	Instruct a new employee in the use of a time clock
				4	57	Instruct a co-worker in how to operate a software program
				6	86	Demonstrate surgical procedure to interns in a teaching hospital
2.B.1.f	Service orientation	Competence / 02 Social abilities	LV	2	29	Ask customers if they would like cups of coffee
				4	57	Make flight reservations for customers, using airline reservation system
				6	86	Direct relief agency operations in a disaster area
2.B.2.i	Complex problem solving	Skills / 01 Cognitive skills	LV	2	29	Lay out tools to complete a job
				4	57	Redesign a floor layout to take advantage of new manufacturing techniques
				6	86	Develop and implement a plan to provide emergency relief for a major metropolitan area
2.B.3.a	Operations analysis	Skills / 02 Practical skills	LV	2	29	Select a photocopy machine for an office
				4	57	Suggest changes in software to make a system more user friendly
				6	86	Identify the control system needed for a new process production plant
2.B.3.b	Technology design	Skills / 02 Practical skills	LV	2	29	Adjust exercise equipment for use by a customer
				4	57	Redesign the handle on a hand tool for easier gripping
				6	86	Create new technology for producing industrial diamonds
2.B.3.c	Equipment selection	Skills / 02 Practical skills	LV	2	29	Select a screwdriver to use in adjusting a vehicle's carburettor
				4	57	Choose a software application to use to complete a work assignment
				6	86	Identify the equipment needed to produce a new product line
2.B.3.d	Installation	Skills / 02 Practical skills	LV	2	29	Install a new air filter in an air conditioner
				4	57	Install new switches for a telephone exchange
				6	86	Install a ‘one of a kind’ process production moulding machine
2.B.3.e	Programming	Skills / 06 ICT/digital	LV	2	29	Write a program in BASIC to sort objects in a database
				4	57	Write a statistical analysis program to analyse demographic data
				6	86	Write expert system programs to analyse ground radar geological data for probable existence of mineral deposits
2.B.3.g	Operation monitoring	Skills / 02 Practical skills	LV	2	29	Monitor completion times while running a computer program
				4	57	Monitor machine functions on an automated production line
				6	86	Monitor and integrate control feedback in a petrochemical processing facility to maintain production flow

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.B.3.h	Operation and control	Skills / 02 Practical skills	LV	2	29	Adjust the settings on a copy machine to make reduced size photocopies
				4	57	Adjust the speed of assembly line equipment based on the type of product being assembled
				6	86	Control aircraft approach and landing at a large airport during a busy period
2.B.3.j	Equipment maintenance	Skills / 02 Practical skills	LV	2	29	Add oil to an engine as indicated by a gauge or warning light
				4	57	Clean moving parts in production machinery
				6	86	Conduct maintenance checks on an experimental aircraft
2.B.3.k	Troubleshooting	Skills / 02 Practical skills	LV	2	29	Identify the source of a leak by looking under a machine
				4	57	Identify the circuit causing an electrical system to fail
				6	86	Direct the debugging of control code for a new operating system
2.B.3.l	Repairing	Skills / 02 Practical skills	LV	2	29	Tighten a screw to get a door to close properly
				4	57	Replace a faulty hydraulic valve
				6	86	Repair structural damage after an earthquake
2.B.3.m	Quality control analysis	Skills / 02 Practical skills	LV	2	29	Inspect a draft memorandum for clerical errors
				4	57	Measure new part requisitions for tolerance to specifications
				6	86	Develop procedures to test a prototype of a new computer system
2.B.4.e	Judgment and decision- making	Competence / 03 Methodical abilities	LV	2	29	Decide how scheduling a break will affect work flow
				4	57	Evaluate a loan application for degree of risk
				6	86	Decide whether a manufacturing company should invest in new robotics technology
2.B.4.g	Systems analysis	Competence / 03 Methodical abilities	LV	2	29	Determine how loss of a team member will affect the completion of a job
				4	57	Determine how the introduction of a new piece of equipment will affect production rates
				6	86	Identify how changes in tax laws are likely to affect preferred sites for manufacturing operations in different industries
2.B.4.h	Systems evaluation	Competence / 03 Methodical abilities	LV	2	29	Determine why a co-worker has been overly optimistic about how long it would take to complete a task
				4	57	Identify the major reasons why a client might be unhappy with a product
				6	86	Evaluate the long-term performance problem of a new computer system
2.B.5.a	Time management	Competence / 03 Methodical abilities	LV	2	29	Keep a monthly calendar of appointments
				4	57	Allocate the time of subordinates to projects for the coming week
				6	86	Allocate the time of scientists to multiple research projects

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.B.5.b	Management of financial resources	Competence	LV	2	29	Take money from petty cash to buy office supplies and record the amount of the expenditure
		03 Methodical abilities		4	57	Prepare and manage a budget for a short-term project
				6	86	Develop and approve yearly budgets for a large corporation and obtain financing as necessary
2.B.5.c	Management of material resources	Competence	LV	2	29	Rent a meeting room for a management meeting
		03 Methodical abilities		4	57	Evaluate an annual uniform service contract for delivery drivers
				6	86	Determine the computer system needs of a large corporation and monitor use of the equipment
2.B.5.d	Management of personnel resources	Competence	LV	2	29	Encourage a co-worker who is having difficulty finishing a piece of work
		03 Methodical abilities		4	57	Direct the activities of a road repair crew with minimal disruption of traffic flow
				6	86	Plan, implement, and manage recruitment, training, and incentive programmes for a high-performance company
2.C.1.a	Administration and management	Knowledge	LV	2	29	Sign a pay voucher
		08 Business and management		4	57	Monitor progress of a project to ensure timely completion
				6	86	Manage a US10-million company
2.C.1.b	Clerical	Knowledge	LV	2	29	File letters alphabetically
		08 Business and management		3	43	Type 30 words per minute
				5	71	Organise a storage system for company forms
2.C.1.c	Economics and accounting	Knowledge	LV	2	29	Answer billing questions from credit card customers
		03 Social sciences, economy and law		4	57	Develop financial investment programs for individual clients
				6	86	Keep a major corporation's financial records
2.C.1.d	Sales and marketing	Knowledge	LV	2	29	Sell cakes at a bake sale
		08 Business and management		4	57	Call a list of clients to introduce them to a new product line
				6	86	Develop a marketing plan for a nationwide telephone system
2.C.1.e	Customer and personal service	Knowledge	LV	2	29	Process customer dry-cleaning drop off
		07 Services		4	57	Work as a day care aide supervising 10 children
				6	86	Respond to a citizen's request for assistance after a major disaster
2.C.1.f	Personnel and human resources	Knowledge	LV	2	29	Fill out a medical claim form
		08 Business and management		3	43	Interview applicants for a secretarial position
				6	86	Design a new personnel selection and promotion system for the Army

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.C.10	Transportation	Knowledge 07 Services	LV	2	29	Ride a train to work
				5	71	Steer a large freighter through a busy harbour
				6	86	Control air traffic at a busy airport
2.C.2.a	Production and processing	Knowledge 05 Engineering, technology, production and processing	LV	2	29	Put a computer back into its packing materials
				4	57	Supervise an appliance assembly line
				6	86	Manage an international shipping company distribution centre
2.C.2.b	Food production	Knowledge 05 Engineering, technology, production and processing	LV	2	29	Keep an herb box in the kitchen
				5	71	Operate a commercial fishing boat
				6	86	Run a 100 000 acre farm
2.C.3.a	Computers and electronics	Knowledge 05 Engineering, technology, production and processing	LV	1	14	Operate a VCR to watch a recorded training tape
				3	43	Use a word processor
				6	86	Create a program to scan computer disks for viruses
2.C.3.b	Engineering and technology	Knowledge 05 Engineering, technology, production and processing	LV	2	29	Install a door lock
				4	57	Design a more stable grocery cart
				6	86	Plan for the impact of weather in designing a bridge
2.C.3.c	Design	Knowledge 02 Arts and humanities	LV	2	29	Draw a straight line 4 3/16 inches long
				4	57	Draw plans for remodelling a kitchen
				6	86	Develop detailed plans for a high-rise office building
2.C.3.d	Building and construction	Knowledge 05 Engineering, technology, production and processing	LV	2	29	Choose the proper type of wood for adding a deck onto a house
				4	57	Fix a plumbing leak in the ceiling
				6	86	Build a high-rise office tower

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.C.3.e	Mechanical	Knowledge 05 Engineering, technology, production and processing	LV	2	29	Replace the filters in a furnace
				4	57	Replace a valve on a steam pipe
				7	100	Overhaul an airplane jet engine
2.C.4.a	Mathematics	Knowledge 04 Sciences, mathematics and computers	LV	1	14	Add two numbers
				4	57	Analyse data to determine areas with the highest sales
				6	86	Derive a complex mathematical equation
2.C.4.b	Physics	Knowledge 04 sciences, mathematics and computers	LV	1	14	Use a crowbar to pry open a box
				4	57	Calculate water pressure through a pipe
				6	86	Design a cleaner burning gasoline engine
2.C.4.c	Chemistry	Knowledge 04 Sciences, mathematics and computers	LV	2	29	Use a common household bug spray
				4	57	Use the proper concentration of chlorine to purify a water source
				6	86	Develop a safe commercial cleaner
2.C.4.d	Biology	Knowledge 04 Sciences, mathematics and computers	LV	1	14	Feed domestic animals
				5	71	Investigate the effects of pollution on marine plants and animals
				7	100	Isolate and identify a new virus
2.C.4.e	Psychology	Knowledge 03 Social sciences, economy and law	LV	2	29	Monitor several children in a playground
				4	57	Understand the impact of alcohol on human responses
				6	86	Treat a person with severe mental illness
2.C.4.f	Sociology and anthropology	Knowledge 03 Social sciences, economy and law	LV	2	29	Identify two cultures in a story as being different
				5	71	Write a pamphlet about cultural differences
				7	100	Create a new theory about the development of civilizations
2.C.4.g	Geography	Knowledge 04 Sciences, mathematics and computers	LV	2	29	Know the capital of the United States
				4	57	Identify Turkey on a world map
				6	86	Develop a map of the world showing mountains, deserts, and rivers

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2.C.5.a	Medicine and dentistry	Knowledge 06 Health services	LV	1	14	Use a band-aid
				5	71	Fill a tooth cavity
				7	100	Perform open heart surgery
2.C.5.b	Therapy and counselling	Knowledge 06 Health services	LV	2	29	Put ice on a sprained ankle
				4	57	Provide job counselling to the unemployed
				6	86	Counsel an abused child
2.C.6	Education and training	Knowledge 01 Education and training	LV	2	29	Show someone how to bowl
				4	57	Lead a quality improvement seminar
				6	86	Design a training programme for new employees
2.C.7.a	English language	Knowledge 02 Arts and humanities	LV	2	29	Write a thank you note
				4	57	Edit a feature article in a local newspaper
				6	86	Teach a college English class
2.C.7.b	Foreign language	Skills 04 Communication in foreign languages	LV	1	14	Say ‘please’ and ‘thank you’ in a foreign language
				3	43	Ask directions in a foreign city
				5	71	Write an English language review of a book written in a foreign language
2.C.7.c	Fine arts	Knowledge 02 Arts and humanities	LV	1	14	Attend a popular music concert
				3	43	Play a minor part in a local theatre play
				5	71	Design an artistic display for a major trade show
2.C.7.d	History and archaeology	Knowledge 02 Arts and humanities	LV	3	43	Take a class in US history
				4	57	Teach local history to school children
				6	86	Determine the age of bones for placing them in fossil history
2.C.7.e	Philosophy and theology	Knowledge 02 Arts and humanities	LV	2	29	Watch a Television programme on family values
				4	57	Understand another culture's religious practices
				6	86	Compare the teachings of major philosophers
2.C.8.a	Public safety and security	Knowledge 07 Services	LV	1	14	Use a seatbelt
				4	57	Inspect a building site for safety violations
				6	86	Command a military operation
2.C.8.b	Law and government	Knowledge 03 Social sciences, economy and law	LV	2	29	Register to vote in a national election
				4	57	Prepare documents and title papers for the purchase of a new house
				6	86	Serve as a judge in a federal court

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
2.C.9.a	Telecommunications	Knowledge / 07 Services	LV	1	14	Dial a phone
				2	29	Install a satellite television dish
				7	100	Develop a new, world-wide telecommunications network
2.C.9.b	Communications and media	Knowledge / 02 Arts and humanities	LV	2	29	Write a thank you note
				4	57	Be a radio disc jockey
				5	71	Write a novel
4.A.1.a.1	Getting information	Skills / 02 Practical skills	LV	2	29	Follow a standard blueprint
				4	57	Review a budget
				6	86	Study international tax laws
4.A.1.a.2	Monitor processes, materials, or surroundings	Skills / 02 Practical skills	LV	2	29	Check to see if baking bread is done
				4	57	Test electrical circuits
				6	86	Check the status of a patient in critical medical care
4.A.1.b.1	Identifying objects, actions, and events	Skills / 02 Practical skills	LV	2	29	Test an automobile transmission
				4	57	Judge the acceptability of food products
				6	86	Determine the reaction of a virus to a new drug
4.A.1.b.2	Inspecting equipment, structures, or material	Skills / 02 Practical skills	LV	1	14	Check that doors to a building are locked
				4	57	Inspect equipment in a chemical processing plant
				6	86	Inspect a nuclear reactor
4.A.1.b.3	Estimating the quantifiable characteristics of products, events, or information	Skills / 02 Practical skills	LV	2	29	Estimate the size of household furnishings to be crated
				4	57	Estimate the time required to evacuate a city in the event of a major disaster
				6	86	Estimate the amount of natural resources that lie beneath the world's oceans
4.A.2.a.1	Judging the qualities of things, services, or people	Skills / 01 Cognitive skills	LV	2	29	Determine whether to remove a tree that has been damaged
				4	57	Determine the value of property lost in a fire
				6	86	Establish the value of a recently discovered ancient art work
4.A.2.a.2	Processing information	Skills / 01 Cognitive skills	LV	2	29	Tabulate the costs of parcel deliveries
				4	57	Calculate the adjustments for insurance claims
				6	86	Compile data for a complex scientific report

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4.A.2.a.3	Evaluating information to determine compliance with standards	Skills / 01 Cognitive skills	LV	1	14	Review forms for completeness
				4	57	Evaluate a complicated insurance claim for compliance with policy terms
				6	86	Make a ruling in court on a complicated motion
4.A.2.a.4	Analysing data or information	Skills / 01 Cognitive skills	LV	1	14	Determine the location of a lost order
				4	57	Determine the interest cost to finance a new building
				6	86	Analyse the cost of medical care services for all hospitals in the country
4.A.2.b.1	Making decisions and solving problems	Skills / 01 Cognitive skills	LV	2	29	Determine the meal selection for a cafeteria
				4	57	Select the location for a major department store
				6	86	Make the final decision about a company's five-year plan
4.A.2.b.2	Thinking creatively	Competence / 01 Personal abilities	LV	1	14	Change the spacing on a printed report
				4	57	Adapt popular music for a high school marching band
				6	86	Create new computer software
4.A.2.b.3	Updating and using relevant knowledge	Skills / 01 Cognitive skills	LV	2	29	Keep up with price changes in a small retail store
				4	57	Keep current on changes in maintenance procedures for repairing sports cars
				6	86	Learn information related to a complex and rapidly changing technology
4.A.2.b.4	Developing objectives and strategies	Competence / 03 Methodical abilities	LV	2	29	Plan the holiday schedule for an airline workforce
				4	57	Develop the plan to complete the merger of two organisations over a three-year period
				6	86	Develop a 10-year business plan for an organisation
4.A.2.b.5	Scheduling work and activities	Competence / 03 Methodical abilities	LV	2	29	Make appointments for patients using a predetermined schedule
				4	57	Prepare the work schedule for salesclerks in a large retail store
				6	86	Schedule a complex conference programme with multiple, parallel sessions
4.A.2.b.6	Organising, planning, and prioritising work	Competence / 03 Methodical abilities	LV	2	29	Organise a work schedule that is repetitive and easy to plan
				4	57	Plan and organise your own activities that often change
				6	86	Prioritise and plan multiple tasks several months ahead
4.A.3.b.1	Interacting with computers	Skills / 02 Practical skills	LV	2	29	Enter employee information into a computer database
				4	57	Write software for keeping track of parts in inventory
				6	86	Set up a new computer system for a large multinational company

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
4.A.3.b.2	Drafting, laying out, and specifying technical devices, parts, and equipment	Skills / 02 Practical skills	LV	2	29	Specify the lighting for a work area
				4	57	Specify the furnishings for a new school
				6	86	Draw the electronic circuitry for a high-speed scientific computer
4.A.3.b.4	Repairing and maintaining mechanical equipment	Skills / 02 Practical skills	LV	2	29	Make simple, external adjustments to a door hinge with ordinary hand tools
				4	57	Adjust a grandfather clock
				6	86	Overhaul a power plant turbine
4.A.3.b.5	Repairing and maintaining electronic equipment	Skills / 02 Practical skills	LV	1	14	Use knobs to adjust a television picture
				4	57	Make repairs by removing and replacing circuit boards
				6	86	Use complex test equipment to calibrate electronic equipment
4.A.3.b.6	Documenting/recording information	Skills / 02 Practical skills	LV	2	29	Record the weights of trucks that use the highways
				4	57	Document the results of a crime scene investigation
				6	86	Maintain information about the use of orbiting satellites for private industry communications
4.A.4.a.1	Interpreting the meaning of information for others	Skills / 03 Communication in the mother language	LV	1	14	Interpret a blood pressure reading
				4	57	Interpret how foreign tax laws apply to US exports
				6	86	Interpret a complex experiment in physics for general audiences
4.A.4.a.2	Communicating with supervisors, peers, or subordinates	Skills / 03 Communication in the mother language	LV	1	14	Write brief notes to others
				4	57	Report the results of a sales meeting to a supervisor
				6	86	Create a videotaped presentation of a company's internal policies
4.A.4.a.3	Communicating with persons outside organisation	Skills / 03 Communication in the mother language	LV	1	14	Have little contact with people outside the organisation
				4	57	Make standard presentations about available services
				6	86	Prepare or deliver press releases
4.A.4.a.4	Establishing and maintaining interpersonal relationships	Competence / 02 Social abilities	LV	1	14	Exchange greetings with a co-worker
				4	57	Maintain good working relationships with almost all co-workers and clients
				7	100	Gain cooperation from a culturally diverse group of executives hostile to your company

Element ID	Element name	OSP group / OSP subgroup	Scale ID	Anchor value	Anchor (%)	Anchor description
4.A.4.a.5	Assisting and caring for others	Competence / 02 Social abilities	LV	2	29	Help a co-worker complete an assignment
				4	57	Assist a stranded traveller in finding lodging
				6	86	Care for seriously injured persons in an emergency room
4.A.4.a.6	Selling or influencing others	Competence / 02 Social abilities	LV	1	14	Convince a co-worker to assist with an assignment
				4	57	Deliver standard arguments or sales pitches to convince others to buy popular products
				6	86	Deliver a major sales campaign in a new market
4.A.4.a.7	Resolving conflicts and negotiating with others	Competence / 02 Social abilities	LV	2	29	Apologise to a customer who complains about waiting too long
				4	57	Get two subordinates to agree about vacation schedules
				7	100	Negotiate a major labour-management contract
4.A.4.a.8	Performing for or working directly with the public	Skills / 03 Communication in the mother language	LV	1	14	Tend a highway toll booth
				4	57	Sell shoes in a popular shoe store
				6	86	Perform a monologue on national television
4.A.4.b.1	Coordinating the work and activities of others	Competence / 03 Methodical abilities	LV	2	29	Exchange information during a shift change
				4	57	Organise the clean-up crew after a major sporting event
				7	100	Act as general contractor for building a large industrial complex
4.A.4.b.2	Developing and building teams	Competence / 03 Methodical abilities	LV	1	14	Encourage two co-workers to stick with a tough assignment
				4	57	Lead an assembly team in an automobile plant
				6	86	Lead a large team to design and build a new aircraft
4.A.4.b.3	Training and teaching others	Competence / 03 Methodical abilities	LV	2	29	Give co-workers brief instructions on a simple procedural change
				4	57	Teach a social sciences course to high school students
				6	86	Develop and conduct training programmes for a medical school
4.A.4.b.4	Guiding, directing, and motivating subordinates	Competence / 03 Methodical abilities	LV	2	29	Work occasionally as a backup supervisor
				4	57	Supervise a small number of subordinates in a well-paid industry
				7	100	Manage a severely downsized unit
4.A.4.b.5	Coaching and developing others	Competence / 03 Methodical abilities	LV	2	29	Show a co-worker how to operate a piece of equipment
				4	57	Provide on-the-job training for clerical workers
				6	86	Coach a college athletic team
4.A.4.b.6	Provide consultation and advice to others	Competence / 03 Methodical abilities	LV	1	14	Work in a position that requires little advising of others
				4	57	Recommend a new software package to increase operational efficiency
				7	100	Provide ideas for changing an organisation to increase profitability

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4.A.4.c.2	Staffing organisational units	Competence / 03 Methodical abilities	LV	1	14	Work in a position that has minimal staffing requirements
				4	57	Interview candidates for a sales position and make hiring recommendations
				7	100	Direct a large recruiting and employment programme for a large international manufacturing organisation
4.A.4.c.3	Monitoring and controlling resources	Competence / 03 Methodical abilities	LV	2	29	Work as a housekeeper responsible for keeping track of linens
				4	57	Work as a chef responsible for ordering food for the menu
				6	86	Serve as a financial executive in charge of a large company's budget

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Occupational skills profiles: methodology and application

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Occupational skills profiles describe, in a comprehensive and standardised way, the skill requirements for individual jobs.

The aim of the study is to bridge the information gap on occupational profiles by providing essential characteristics required by the economy, in terms of level and field of education and training, as well as other requirements such as knowledge, skills, competence, occupational interests, and work values.

OSPs have been developed for several purposes: analysing, projecting and forecasting skill needs; determining and measuring skill mismatches in different countries, sectors, or occupations; comparing skill needs across European countries; and determining change over time.

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