



Brussels  
EMPL.E.1

## MEMBER STATES WORKING GROUP ON ESCO

### Plenary meeting

15 March 2025, 9:30, Brussels

### ESCO note on updates to the skills pillar

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## **Purpose of this document**

The purpose of this document is to inform the Member States Working Group on the developments and updates concerning the ESCO classification. This note covers specifically the topic of the updates to the skills pillar in ESCO.

The first part of the note gives an update on the work regarding skills co-occurrence and the related skills clustering, which will be covered and discussed in the next MSWG meeting set for 14<sup>th</sup> of March 2025, in Brussels.

During the skills co-occurrence and clustering work, several observations were made that contributed to the strategy for ESCO, which includes a more fundamental and comprehensive restructuring for ESCO, based on sound heuristics. The second part of the note therefore gives a practical introduction to the concept of a layered ontology which is envisioned to be one of the foundations for ESCO in the future.

## **1. STATE OF PLAY OF THE WORK ON SKILLS CLUSTERING**

During the November 2024 ESCO MSWG <sup>1</sup>, the Commission presented the progress towards the development of a new system for clustering ESCO skills. This alternative hierarchy aims to improve the user experience by making navigation within the classification more intuitive, and to serve various use cases such as skill recommendation, matching, or job and course recommendation.

The following sections summarise the methodology for this project, present the outcome of applying the methodology, and discuss the consultation of the new data structures.

### **1.1. Methodology**

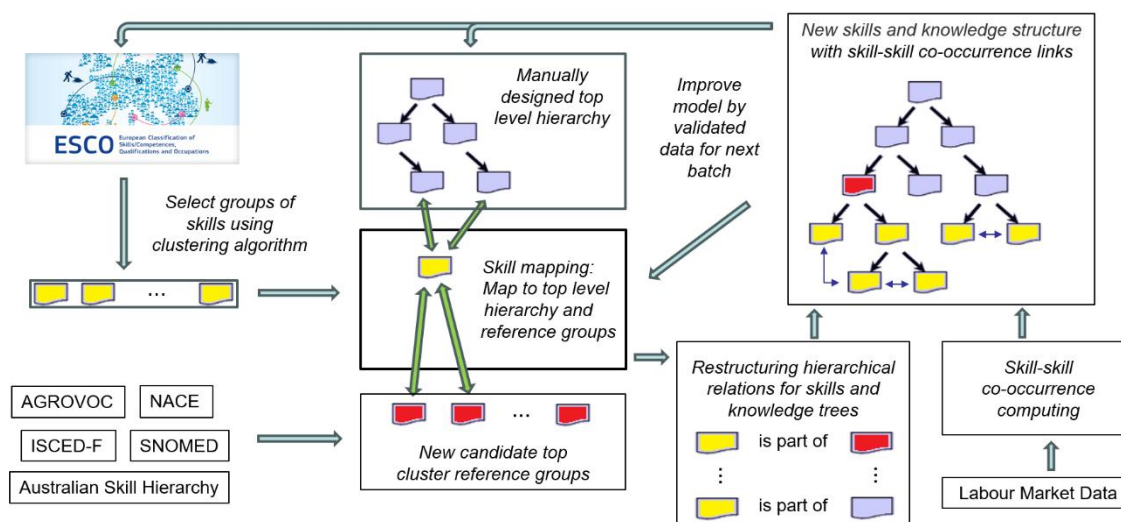
The methodology for establishing an alternative skills clustering is based on a human-in-the-loop approach that combines ontological design principles with data science methods. *Figure 1* summarises the methodology that consists of the following stages:

- Design of a top-level hierarchy based on ontological design principles.
- Manual allocation of individual skills to the top-level hierarchy assisted through data science techniques.
- Skills co-occurrence analysis to understand which skills are reflected together in labour market data.

The outcome of this process is a sector-driven skills hierarchy with all ESCO skills allocated to one of the skills clusters from the top-level hierarchy, supplemented with additional co-occurrence relations. The co-occurrence links allow to interpret links between related skills from (distinct) clusters.

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<sup>1</sup> <https://esco.ec.europa.eu/en/26th-esco-mswg-meeting-0>



**Figure 1:** Overview of the process followed for developing an alternative hierarchy for skills.

## 1.2. Outcome 1: Alternative skills hierarchy

Since the MSWG meeting in November 2024, the methodology has been applied to further develop the top-level hierarchy and allocate all ESCO skills in this structure. The resulting top-level hierarchy consists of 7 levels. *Table 1* provides an overview of the domains that are part of the first level and summarises the number of skills clusters and percentage of skills located underneath each top category.

Alternative hierarchy top-level skills cluster	Number of underlying skills clusters	Percentage of underlying skills
<i>Academic and scientific research and development</i>	28	6 %
<i>Accommodation, tourism and food services</i>	7	2 %
<i>Agriculture, forestry, fisheries and veterinary</i>	26	5 %
<i>Architecture, planning and engineering</i>	16	2 %
<i>Arts, entertainment and recreation</i>	33	9 %
<i>Business operations, administration and auditing</i>	13	6 %
<i>Construction</i>	19	3 %
<i>Education and training</i>	12	3 %
<i>General/non-industry specific skills</i>	0	1 %
<i>Health</i>	29	8 %
<i>Information and communication technologies</i>	34	6 %
<i>Legal sector, finance and accounting</i>	12	4 %

<i>Libraries, archives, museums and other cultural activities</i>	3	1 %
<i>Manufacturing and retail</i>	170	26 %
<i>Mining and quarrying</i>	1	1 %
<i>Public services and social work</i>	12	3 %
<i>Transportation, logistics and storage</i>	14	8 %
<i>Utilities</i>	13	3 %
<i>Wellbeing and personal services</i>	7	2 %

**Table 1:** Highest level (i.e. level 1) of the top-level hierarchy with corresponding child skills clusters and percentage of allocated skills.

A summary of the number of skills clusters that are part of the different levels of the top-level hierarchy is presented in Table 2.

<b>Hierarchical level</b>	<b>Number of skills clusters</b>
<i>Level 1</i>	19
<i>Level 2</i>	115
<i>Level 3</i>	159
<i>Level 4</i>	111
<i>Level 5</i>	29
<i>Level 6</i>	31
<i>Level 7</i>	4

**Table 2:** Number of skills clusters for each of the 7 levels of the top-level hierarchy.

The alternative hierarchy groups skills based on sectors. Table 3 illustrates this approach by contrasting it with the existing skills hierarchy, by looking at skills from the existing hierarchical groups *S2.4.1 – Gathering information from physical or electronic sources*, *S2.5.1 – Measuring dimensions and related properties* and *S4.1.0 – Developing objectives and strategies*.

<b>Current hierarchy skills cluster</b>	<b>ESCO skill preferred term</b>	<b>Alternative hierarchy skills cluster</b>
<i>S2.4.1 – Gathering information from physical or electronic sources</i>	<i>synthesise research publications</i>	<i>Support activities for academic and scientific research</i>
	<i>collect cyber defence data</i>	<i>Cyber security</i>

	<i>collect client fitness information</i>	<i>Sports for wellbeing</i>
	<i>undertake employee screening</i>	<i>Human resources and employment activities</i>
	<i>manage mine site data</i>	<i>Support activities for mining and quarrying</i>
	<i>evaluate social work program's impact</i>	<i>Social work</i>
<i>S2.5.1 – Measuring dimensions and related properties</i>	<i>measure the human body for wearing apparel</i>	<i>Wearing apparel</i>
	<i>measure trees</i>	<i>Forestry</i>
	<i>draw up artists' measurements</i>	<i>Wearing apparel</i>
	<i>measure pollution</i>	<i>Support activities for construction</i>
	<i>measure precise food processing operations</i>	<i>Manufacture of food products</i>
	<i>measure the impact of specific aquaculture activity</i>	<i>Aquaculture</i>
	<i>measure yarn count</i>	<i>Manufacture of textiles</i>
	<i>determine property boundaries</i>	<i>Topography and land surveying</i>
<i>S4.1.0 – Developing objectives and strategies</i>	<i>develop non-hazardous waste management strategies</i>	<i>Waste management</i>
	<i>create soil and plant improvement programmes</i>	<i>Carrying out gardening activities</i>
	<i>develop health and safety strategies in mining</i>	<i>Occupational health and safety</i>
	<i>develop physiotherapy services</i>	<i>Provide medical treatment according to method</i>
	<i>identify fitted source for heat pumps</i>	<i>Steam and air conditioning supply</i>
	<i>create an airport master plan</i>	<i>Airport planning</i>
	<i>develop an animal handling strategy</i>	<i>Tending animals</i>
	<i>determine event objectives</i>	<i>Event management</i>

**Table 3:** Comparison of existing skills hierarchy and alternative skills grouping

Table 3 shows that existing skill group S2.4.1 – *Gathering information from physical or electronic sources* contains skills such as *evaluate social work program's impact*, *collect cyber defence data* and *undertake employee screening*. These skills are allocated to the new skills clusters *Social work*, *Cyber security* and *Human resources and employment activities*, respectively. This example illustrates that the existing hierarchy groups skills also based on the underlying transversal activity (e.g. collecting information), thereby placing less emphasis on the sector specific context. The alternative hierarchy addresses this by explicitly grouping the skills by sector such that it reflects closer how workers and employers conceive the skills in the labour market.

### 1.3. Outcome 2: ESCO skill co-occurrences

The Commission presented in the November 2024 ESCO MSWG the process to compute ESCO v1.1.2 skill co-occurrences based on a sample of 20 million multilingual online job advertisements as collected by Eurostat within the context of the Web Intelligence Hub project <sup>2</sup>. The process was performed for all ESCO skills, excluding skills part of the language hierarchy or the transversal skills hierarchy, resulting in a total of 13,454 concepts. It resulted in skill pairs (Skill1, Skill2), where each skill pair has a co-occurrence score defined as:

$$co - occurrence (Skill1, Skill2) = \frac{\text{number of online job advertisements with Skill1 and Skill2}}{\text{number of online job advertisements with Skill1}}$$

The co-occurrence score ranges from 0 to 1 where higher values correspond to two skills being more often present in the same online job advertisements. Only skills pairs with co-occurrence larger than or equal to 0.2 were retained, resulting in a total of 59,846 pairs.

Table 4 summarises the proportion of ESCO skills that were observed as Skill1 and Skill2. Almost 80% of all ESCO skills have other co-occurring skills based on the analysis. Around 60% of all ESCO skills are a co-occurring skill for another skill. These statistics indicate that co-occurrence statistics are available for a very significant part of all ESCO skills.

	Number (percentage) of unique skills
<i>ESCO</i>	13,454 (100%)
<i>Co-occurrence Skill1</i>	10,674 (79%)
<i>Co-occurrence Skill2</i>	8,204 (61%)

**Table 4:** Coverage of observed Skill1 and Skill2 with respect to all 13,454 skills not part of the language or transversal skills hierarchy.

<sup>2</sup> <https://cros.ec.europa.eu/landing-page/web-intelligence-network>

Table 5 illustrates that 58% of all co-occurring skill pairs have a co-occurrence value between 0.2 and 0.4, while 42% is within the range 0.4 – 1.0. Examples of co-occurring skill pairs with co-occurrence in the range 0.2 – 0.4 are (*VBScript, operate relational database management system*) and (*diagnose genetic diseases, clinical biology*). Examples from the group with larger co-occurrences values are (*ensure compliance with railway regulation, railway framework legislation*) and (*add slabs to ceramic work, ceramic ware*). These examples show that a larger co-occurrence often means the two skills share a specific and important aspect.

Co-occurrence	Number (percentage) of co-occurring skill pairs	Co-occurring skill pair
$0.2 \leq X < 0.4$	34,517 (58%)	<i>VBScript</i> <i>operate relational database management system</i>
		<i>diagnose genetic diseases</i> <i>clinical biology</i>
		<i>create moving images</i> <i>Adobe Photoshop Lightroom</i>
		<i>ingredients for beer production</i> <i>modern brewing systems</i>
		<i>natural language processing</i> <i>machine learning</i>
$0.4 \leq X$	25,329 (42%)	<i>ensure compliance with railway regulation</i> <i>railway framework legislation</i>
		<i>add slabs to ceramic work</i> <i>ceramic ware</i>
		<i>enterprise risk management</i> <i>risk management</i>
		<i>produce guitar components</i> <i>types of guitars</i>
		<i>repair electric bicycles</i> <i>bicycle mechanics</i>

**Table 5:** Number and share of skill pairs by co-occurrence score group and corresponding examples.

The alternative hierarchy, as described in Section 2.1, provides the basis to serve multiple use-cases, e.g., improved browsing of the taxonomy or statistical reporting. In addition,

skills co-occurrences can support use-cases such as skill recommendation and job recommendation, which require additional information that is not fully captured in the new hierarchical structure. Co-occurrence indicates that there is some sort of relation between two skills, but it does not specify whether this relationship is hierarchical or another type of relation. With hierarchical relations alone it is not possible to contextualise skill concepts in every possible way.

Table 6 presents a statistical summary that measures to which extent the co-occurrence relations and the alternative hierarchy relations differ from each other. This analysis is performed by computing for each co-occurring skill pair the level of their lowest shared parent concept in the hierarchy (i.e. lowest common ancestor). When the lowest shared parent of two co-occurring skills is deeper in the hierarchy (e.g. level 3 and beyond), the co-occurrence and alternative hierarchy are more aligned in terms of information content. When the lowest shared parent is higher in the alternative hierarchy (e.g. level 1 or 2), the information represented by the co-occurrence and grouping in the alternative hierarchy is more different. For example, 28% and 16% of all co-occurring skills have their lowest shared parent on level 1 and level 2 of the alternative hierarchy, respectively. On the other hand, 24% and around 30% of co-occurring skills have their lowest shared parent on level 3 or level 4 – 9 in the hierarchy. This indicates that the alternative hierarchy and co-occurrence information have a different nature and complement each other.

Alternative hierarchy level of lowest common ancestor for co-occurring pair	Percentage of co-occurring skill pairs
1	28 %
2	16 %
3	24 %
4	20 %
5	7 %
6	2 %
7	1 %
8	0.1 %
9	0.01 %

**Table 6:** Summary statistics for level of lowest common ancestor for all co-occurrence pairs.

To illustrate the difference in nature between the hierarchical structure and co-occurrence pairs, Table 7 provides examples of co-occurring skill pairs that have their lowest shared skill cluster on level 1 (i.e. part of the 28% as depicted in Table 6). All these examples are in a different part of the alternative hierarchy from the top-level on.

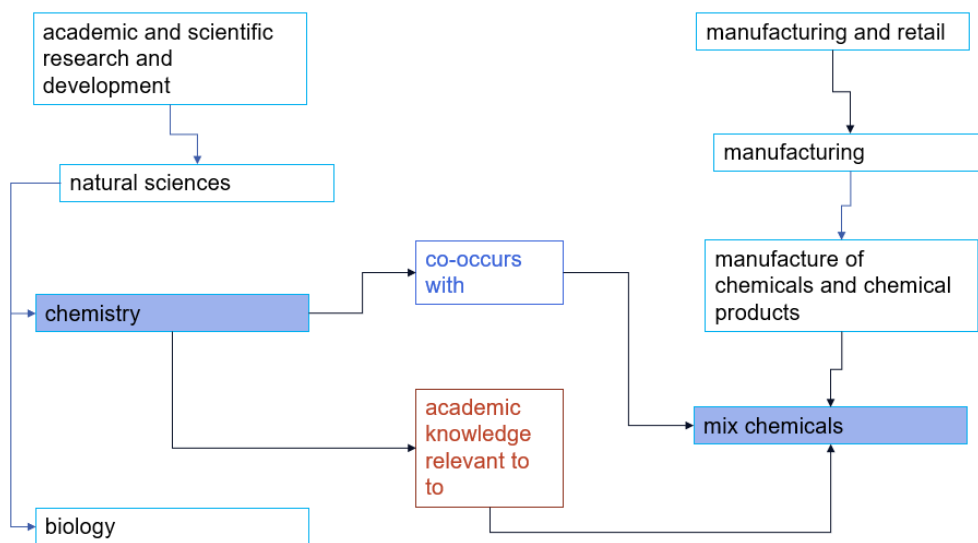
Co-occurring skill pair	Alternative hierarchy skills cluster
<i>purchase supplies</i>	<i>Procurement</i>
<i>accounting</i>	<i>Legal sector, finance and accounting</i>
<i>mix chemicals</i>	<i>Manufacture of chemicals and chemical products</i>
<i>chemistry</i>	<i>Natural sciences</i>
<i>assess railway operations</i>	<i>Rail transport</i>
<i>railway law</i>	<i>Body of law</i>
<i>train staff to reduce food waste</i>	<i>Workplace learning</i>
<i>food waste monitoring systems</i>	<i>Software for specific industries and occupations</i>
<i>control tree diseases</i>	<i>Forestry</i>
<i>maintain landscape site</i>	<i>Carrying out gardening activities</i>
<i>perform lectures</i>	<i>Education science</i>
<i>conduct public presentations</i>	<i>Business communication</i>
<i>biosecurity related to animals</i>	<i>Tending animals</i>
<i>biosecurity</i>	<i>Support activities for health</i>
<i>bookkeeping regulations</i>	<i>Accounting</i>
<i>office software</i>	<i>Digital tools for collaboration and productivity</i>
<i>extinguish fires</i>	<i>Fire services</i>
<i>conduct fire safety inspections</i>	<i>Occupational health and safety</i>
<i>manage land resources permits</i>	<i>Urban planning</i>
<i>environmental legislation</i>	<i>Body of law</i>

**Table 7:** Co-occurring skill pairs and corresponding skills cluster.

The following examples explore this difference between co-occurrence and alternative clustering or hierarchy in more detail. At the same time, these examples also illustrate how this exercise, based on data science, is the stepping stone towards the implementation of the longer-term vision for ESCO where additional information is added through ontological relations between concepts.

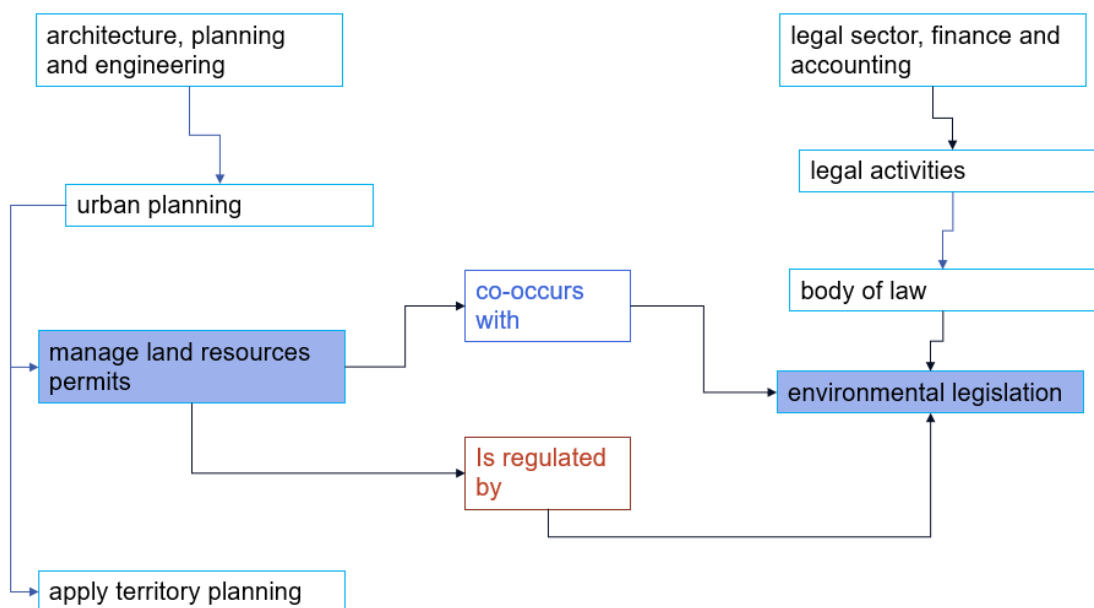
**Chemistry example:** The concept *chemistry* co-occurs with *mix chemicals*. The reason these two concepts are not located in the same skills clusters tree is because *chemistry* is an area of knowledge that is relevant to a variety of areas such as manufacturing, agriculture, mining, and utilities. The longer-term strategy for ESCO envisions to add an

ontological relation specifying that *chemistry* is an area of knowledge that is relevant to *mix chemicals*.



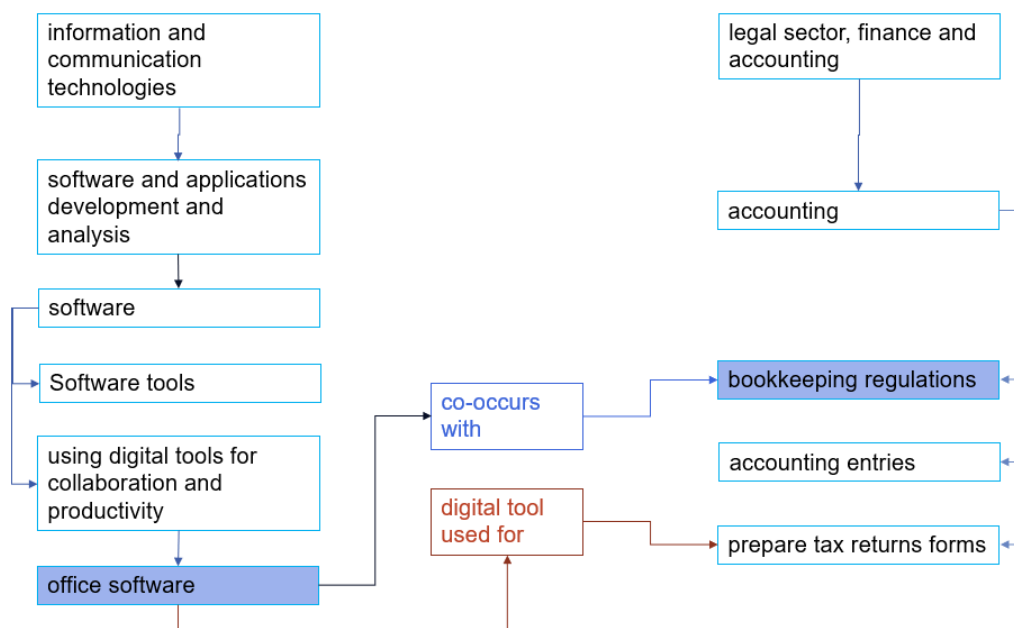
**Figure 2:** Chemistry versus mix chemicals.

**Environmental legislation example:** The concept *environmental legislation* co-occurs with *manage land resources permits*, which is an area of *urban planning*. The two concepts are not assigned to the same skills clusters tree because *environmental legislation* is relevant for a wide variety of industries such as utilities, agriculture, manufacturing, and transportation as well as urban planning. The longer-term strategy for ESCO envisions to add an ontological relation specifying that *environmental legislation* is an area of *body of law* that regulates *urban planning* (which includes *manage land resources permits*).



**Figure 3:** Environmental legislation versus manage land resources permits.

**Office software example:** The concept *office software* co-occurs with *bookkeeping regulations*. The concepts are not assigned to the same skills clusters tree because *office software* is a software tool that is relevant to all industries. In this instance, there is no direct semantic relationship between *office software* and *bookkeeping regulations*. However, the longer-term strategy for ESCO envisions to capture the co-occurrence indirectly, by representing the relation that exists between *office software* and other narrower terms of *accounting*, such as for example *prepare tax returns forms*.



**Figure 4:** Office software versus bookkeeping regulations.

#### 1.4. Consultation

The Commission launched the consultation of the alternative skills hierarchy and skills co-occurrence data on 26 February 2025. The consultation is expected to end by 15<sup>th</sup> May 2025 and includes twelve registered participants listed below.

Organisation/Company name	Organisation type	Country
APIROPLUS Solutions Ltd.	Private Sector Company	Cyprus
Arbetsformedlingen (Swedish Public Employment Agency)	Public Employment Service	Sweeden
Clarifiet	Private Sector Company	Denmark
Danish Agency for Labour Market and Recruitment	Public Employment Service	Denmark
European Commission	Public Employment Service or other Public Authority	Belgium
European Commission, DG HR	Public Employment Service or other Public Authority	Belgium
Finnish National Agency for Education	Public Employment Service or other Public Authority	Finland
Lightcast	Private Sector Company	Italy
Palacky University Olomouc	Education Provider	Czech Republic
Saipem	Private Sector Company	Italy
VDAB	Public Employment Service	Belgium
XOBOL	Private Sector Company	Greece

*Table 8: List of participants for the Skills Clustering consultation*

The primary objective is to assess the usability of the proposed structure by engaging with ESCO implementers. Specifically, the focus will be on gathering feedback on whether the alternative structure and co-occurrence data meets the needs of various ESCO use cases, such as intuitive navigation, skill recommendation, statistical reporting, and job or course recommendation. Testing organisations are tasked with the analysis of the usability of the new structure in their core businesses and to provide feedback on the structure and granularity as well as on the applied methodology. The goal of the consultation is not to validate the allocation of individual skills in the hierarchy or individual co-occurring skill pairs.

A table with the alternative hierarchy (i.e. top-level hierarchy and allocated skills) was provided to the participants (*Figure 9*). Each line of the consultation file represents the path from the top-level of the hierarchy to the allocated ESCO skill:

- **Identifier Level X:** Identifier of skills cluster or allocated ESCO skill on level x
- **PT Level X:** Preferred term of the skills cluster or allocated ESCO skill on level x

Identifier Level 1	PT Level 1	Identifier Level 2	PT Level 2
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/03b9b491-fc9b-4868-914a-bf7cd47b5041">http://data.europa.eu/esco/skill/03b9b491-fc9b-4868-914a-bf7cd47b5041</a>	create solutions to problems
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/089bab26-a854-40fb-8c04-5be4693315a">http://data.europa.eu/esco/skill/089bab26-a854-40fb-8c04-5be4693315a</a>	integrate strategic foundation in daily performance
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/08e2ff26-88ff-47b5-9d37-d19ace01b075">http://data.europa.eu/esco/skill/08e2ff26-88ff-47b5-9d37-d19ace01b075</a>	manage feedback
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0b071b01-4b40-4936-9d6d-d8c5609481b4">http://data.europa.eu/esco/skill/0b071b01-4b40-4936-9d6d-d8c5609481b4</a>	identify support mechanisms to develop your professional practice
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0b144726-21c2-46ed-8d13-c03d27f61604">http://data.europa.eu/esco/skill/0b144726-21c2-46ed-8d13-c03d27f61604</a>	perform multiple tasks at the same time
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0c606377-fbd6-4f66-b700-ba4524670b73">http://data.europa.eu/esco/skill/0c606377-fbd6-4f66-b700-ba4524670b73</a>	screen clients
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0e161427-3369-47c0-8669-9e226207f6d0">http://data.europa.eu/esco/skill/0e161427-3369-47c0-8669-9e226207f6d0</a>	discern written communication
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0e21e183-e787-4f23-a240-93b416c088c2">http://data.europa.eu/esco/skill/0e21e183-e787-4f23-a240-93b416c088c2</a>	maintain personal hygiene standards
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/0f46a403-9606-465f-8247-8ae975ff4f35">http://data.europa.eu/esco/skill/0f46a403-9606-465f-8247-8ae975ff4f35</a>	communicate verbal instructions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/1835a7c1-600e-4b16-a0af-fb4f7d8a77b9">http://data.europa.eu/esco/skill/1835a7c1-600e-4b16-a0af-fb4f7d8a77b9</a>	develop personal skills
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/194c05ed-253c-485a-8bfc-0c8de1aaafda">http://data.europa.eu/esco/skill/194c05ed-253c-485a-8bfc-0c8de1aaafda</a>	follow work schedule
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/1ba59ce0-7fec-434b-8d5c-9b275250a26c">http://data.europa.eu/esco/skill/1ba59ce0-7fec-434b-8d5c-9b275250a26c</a>	prepare presentation material
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/1dea2f3a-857c-4fc3-b1f8-d5f2015c46a9">http://data.europa.eu/esco/skill/1dea2f3a-857c-4fc3-b1f8-d5f2015c46a9</a>	give instructions to staff
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/23ac233d-84ad-4517-b0f5-8ca19ba2614e">http://data.europa.eu/esco/skill/23ac233d-84ad-4517-b0f5-8ca19ba2614e</a>	monitor developments in field of expertise
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/26a6e6d2-1c9a-4d7e-8c04-5ba16d1f53da">http://data.europa.eu/esco/skill/26a6e6d2-1c9a-4d7e-8c04-5ba16d1f53da</a>	greet guests
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/3035be48-c249-453f-bf11-cb27219448b8">http://data.europa.eu/esco/skill/3035be48-c249-453f-bf11-cb27219448b8</a>	deal with challenging work conditions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/3035be48-c249-453f-bf11-cb27219448b8">http://data.europa.eu/esco/skill/3035be48-c249-453f-bf11-cb27219448b8</a>	deal with challenging work conditions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/30b1f3e1-1586-4d41-aa02-e2ab201b5164">http://data.europa.eu/esco/skill/30b1f3e1-1586-4d41-aa02-e2ab201b5164</a>	handle paperwork
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/38788a64-6271-40ff-9e0b-5644c38322ff">http://data.europa.eu/esco/skill/38788a64-6271-40ff-9e0b-5644c38322ff</a>	consultation methods
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/3a876d1c-3dd5-45ed-9a27-47cbe466ce7">http://data.europa.eu/esco/skill/3a876d1c-3dd5-45ed-9a27-47cbe466ce7</a>	ensure information transparency
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/414332e4-8347-4771-b947-65bd38014620">http://data.europa.eu/esco/skill/414332e4-8347-4771-b947-65bd38014620</a>	use consulting techniques
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/4659e742-7568-4b16-86df-57cb66fd926e">http://data.europa.eu/esco/skill/4659e742-7568-4b16-86df-57cb66fd926e</a>	provide input to collaborators to guide their work
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/48391ec6-42ba-4093-acf4-c7673b0c07f4">http://data.europa.eu/esco/skill/48391ec6-42ba-4093-acf4-c7673b0c07f4</a>	process commissioned instructions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/4932c6e3-f6c7-49bf-bf66-f8508237054f">http://data.europa.eu/esco/skill/4932c6e3-f6c7-49bf-bf66-f8508237054f</a>	comply with schedule
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/4b3c8605-819d-4b38-83fc-f23663e78dc9">http://data.europa.eu/esco/skill/4b3c8605-819d-4b38-83fc-f23663e78dc9</a>	consultation
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/4e7b2c61-aa42-404c-995f-32281b18923">http://data.europa.eu/esco/skill/4e7b2c61-aa42-404c-995f-32281b18923</a>	have spatial awareness
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/50ab7296-bc34-4cb1-9fdb-7cf7b6f80f9c">http://data.europa.eu/esco/skill/50ab7296-bc34-4cb1-9fdb-7cf7b6f80f9c</a>	maintain work standards
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/512d6a9d-d55f-4042-a565-4a929731d8e3">http://data.europa.eu/esco/skill/512d6a9d-d55f-4042-a565-4a929731d8e3</a>	prepare work instructions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/54d68400-9da3-4077-a7ee-52e68b390e6f">http://data.europa.eu/esco/skill/54d68400-9da3-4077-a7ee-52e68b390e6f</a>	follow written instructions
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/56ec990-3e5b-475f-88e4-2c209f5625b3">http://data.europa.eu/esco/skill/56ec990-3e5b-475f-88e4-2c209f5625b3</a>	work with different target groups
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/59429f7f-8b95-4094-b1cf-97cbb556f03d">http://data.europa.eu/esco/skill/59429f7f-8b95-4094-b1cf-97cbb556f03d</a>	participatory decision-making
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/59ad10b1-67f1-4dd4-ad1f-1fd6f8bc2fb">http://data.europa.eu/esco/skill/59ad10b1-67f1-4dd4-ad1f-1fd6f8bc2fb</a>	show professional responsibility
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/5a927fad-462e-4d54-ae12-97df6ca45762">http://data.europa.eu/esco/skill/5a927fad-462e-4d54-ae12-97df6ca45762</a>	exercise self-control
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/5b394ba8-5d40-40d9-b771-5df6e9ac436">http://data.europa.eu/esco/skill/5b394ba8-5d40-40d9-b771-5df6e9ac436</a>	perform technical tasks with great care
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/5efec19d-ac8a-4608-b824-f8c438a8dfe">http://data.europa.eu/esco/skill/5efec19d-ac8a-4608-b824-f8c438a8dfe</a>	monitor recommendation follow-up
SC.1	general / non industry specific skills	<a href="http://data.europa.eu/esco/skill/5fa6cd2f-9bab-4afa-a184-2d2f1401b770">http://data.europa.eu/esco/skill/5fa6cd2f-9bab-4afa-a184-2d2f1401b770</a>	write meeting reports

*Figure 5: Consultation file for alternative skills hierarchy.*

Similarly, a table with co-occurrence statistics was provided (*Figure 10*):

- **Skill1 URI:** URI of ESCO skill 1
- **Skill1 PT:** Preferred term of ESCO skill 1
- **Skill2 URI:** URI of ESCO skill 2
- **Skill2 PT:** Preferred term of ESCO skill 2
- **Co-occurrence score:** Co-occurrence (skill 1, skill 2)

Skill URI	Skill PT	Skill URI	Skill PT	Co-occurrence
<a href="http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab">http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab</a>	manage musical staff	<a href="http://data.europa.eu/esco/skill/a672418c-0188-409e-80b6-51041400201">http://data.europa.eu/esco/skill/a672418c-0188-409e-80b6-51041400201</a>	supervise musicians	0.7161172161172161
<a href="http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab">http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab</a>	manage musical staff	<a href="http://data.europa.eu/esco/skill/a0317bcb-d620-41ee-963a-6985b5391cf">http://data.europa.eu/esco/skill/a0317bcb-d620-41ee-963a-6985b5391cf</a>	conduct musical ensembles	0.4468964468964469
<a href="http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab">http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab</a>	manage musical staff	<a href="http://data.europa.eu/esco/skill/339165c-0002-4702-91a6-ca4722e682f">http://data.europa.eu/esco/skill/339165c-0002-4702-91a6-ca4722e682f</a>	advise music groups	0.4255189255189255
<a href="http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab">http://data.europa.eu/esco/skill/0005c151-5b5a-4a66-8aac-60e734beb1ab</a>	manage musical staff	<a href="http://data.europa.eu/esco/skill/8992fa08-51a2-4436-b23b-c3532577113">http://data.europa.eu/esco/skill/8992fa08-51a2-4436-b23b-c3532577113</a>	supervise music pedagogy	0.26556776556776557
<a href="http://data.europa.eu/esco/skill/00064735-8fad-454b-90c7-ed858cc9932">http://data.europa.eu/esco/skill/00064735-8fad-454b-90c7-ed858cc9932</a>	supervise correctional procedures	<a href="http://data.europa.eu/esco/skill/d4a0744a-508b-4a3e-97a5-ad1fc7f55e6e">http://data.europa.eu/esco/skill/d4a0744a-508b-4a3e-97a5-ad1fc7f55e6e</a>	correctional procedures	0.93872180451127819
<a href="http://data.europa.eu/esco/skill/00064735-8fad-454b-90c7-ed858cc9932">http://data.europa.eu/esco/skill/00064735-8fad-454b-90c7-ed858cc9932</a>	supervise correctional procedures	<a href="http://data.europa.eu/esco/skill/8012658f-58a3-4a39-a28b-84a7431ee51e">http://data.europa.eu/esco/skill/8012658f-58a3-4a39-a28b-84a7431ee51e</a>	contribute to the formulation of correctional procedures	0.8872180451127819
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/7c4bb41a-9b5a-472c-888a-9c58bb4e2a0d">http://data.europa.eu/esco/skill/7c4bb41a-9b5a-472c-888a-9c58bb4e2a0d</a>	ensure defendants	0.2229323082706789
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/1a080b07-406e-4a2e-b316-fc7662e6e2d">http://data.europa.eu/esco/skill/1a080b07-406e-4a2e-b316-fc7662e6e2d</a>	ensure compliance with railway regulation	0.4325966850828729
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/aae0e0be-d6f5-4355-8fed-460963306445">http://data.europa.eu/esco/skill/aae0e0be-d6f5-4355-8fed-460963306445</a>	railway law	0.3994475138121547
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/22ca7fd1-46a0-473a-b79f-a8ac955a319a">http://data.europa.eu/esco/skill/22ca7fd1-46a0-473a-b79f-a8ac955a319a</a>	railway framework legislation	0.36906077348066296
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/01903b64-4892-4bc4-b67d-894dd97905fb">http://data.europa.eu/esco/skill/01903b64-4892-4bc4-b67d-894dd97905fb</a>	comply with railway safety standards	0.3441989950276243
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/c6b09a0-96c5-4334-bc64-c529c314d1ac">http://data.europa.eu/esco/skill/c6b09a0-96c5-4334-bc64-c529c314d1ac</a>	enforce railway safety regulations	0.28066298342544435
<a href="http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95">http://data.europa.eu/esco/skill/0007bdc2-dd15-4824-b7d6-416522c46f95</a>	control compliance of railway vehicles regulations	<a href="http://data.europa.eu/esco/skill/4b8670a1-3cd4-4c1d-bd1e-8b9a0e1c29ba">http://data.europa.eu/esco/skill/4b8670a1-3cd4-4c1d-bd1e-8b9a0e1c29ba</a>	rail infrastructure	0.2580110497237669
<a href="http://data.europa.eu/esco/skill/00090cc1-1c72-439e-a4e0-19a67901bfc">http://data.europa.eu/esco/skill/00090cc1-1c72-439e-a4e0-19a67901bfc</a>	identify available services	<a href="http://data.europa.eu/esco/skill/4b30b5-2297-4bba-85b1-d0f696a92db8">http://data.europa.eu/esco/skill/4b30b5-2297-4bba-85b1-d0f696a92db8</a>	operate railway vehicles	0.2370165746863535
<a href="http://data.europa.eu/esco/skill/000b1e4-890b-4b66-be05-05eac3641724">http://data.europa.eu/esco/skill/000b1e4-890b-4b66-be05-05eac3641724</a>	perform toxicological studies	<a href="http://data.europa.eu/esco/skill/70ab677-5781-40f5-9198-d984a34310f">http://data.europa.eu/esco/skill/70ab677-5781-40f5-9198-d984a34310f</a>	characteristics of services	0.2129130434782608
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/bf00a96-807c-492f-bed2-267224ba7bc7">http://data.europa.eu/esco/skill/bf00a96-807c-492f-bed2-267224ba7bc7</a>	toxicology	0.1985435435435435
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/dff0087d-25e4-40b1-979e-32fd2445438">http://data.europa.eu/esco/skill/dff0087d-25e4-40b1-979e-32fd2445438</a>	conduct research on food waste prevention	0.7378640776699029
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/3939c67d-d045-4e0b-b951-b862a072c0a2">http://data.europa.eu/esco/skill/3939c67d-d045-4e0b-b951-b862a072c0a2</a>	develop food waste reduction strategies	0.7176375404530745
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/dacaeb5-5d85-43e0-9adb-7c82a4f53189">http://data.europa.eu/esco/skill/dacaeb5-5d85-43e0-9adb-7c82a4f53189</a>	design indicators for food waste reduction	0.559870501618123
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/2879e86-037a-49ed-ba73-6f7d766223e">http://data.europa.eu/esco/skill/2879e86-037a-49ed-ba73-6f7d766223e</a>	dispose food waste	0.4053398058252427
<a href="http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123">http://data.europa.eu/esco/skill/0011466db-035e-4b52-83a3-ed8771e0c123</a>	train staff to reduce food waste	<a href="http://data.europa.eu/esco/skill/c29fedc5-033b-4389-b110-29b6db00cd1">http://data.europa.eu/esco/skill/c29fedc5-033b-4389-b110-29b6db00cd1</a>	food waste monitoring systems	0.22635721682847899
<a href="http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d">http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d</a>	apply diplomatic principles	<a href="http://data.europa.eu/esco/skill/1cc252f1-e91a-4186-a221-caa715195fd7">http://data.europa.eu/esco/skill/1cc252f1-e91a-4186-a221-caa715195fd7</a>	dispose non-food waste within the food industry	0.21116504834812807
<a href="http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d">http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d</a>	apply diplomatic principles	<a href="http://data.europa.eu/esco/skill/75752e2ca-8934-45d3-8e52-3877d37329d">http://data.europa.eu/esco/skill/75752e2ca-8934-45d3-8e52-3877d37329d</a>	show diplomacy	0.9676417613812807
<a href="http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d">http://data.europa.eu/esco/skill/0023e7a5-43da-4b68-bee3-726e21f986d</a>	apply diplomatic principles	<a href="http://data.europa.eu/esco/skill/42c573f1-6335-45ca-b0a4-91ca03b178d1">http://data.europa.eu/esco/skill/42c573f1-6335-45ca-b0a4-91ca03b178d1</a>	diplomatic principles	0.7976523197319597
<a href="http://data.europa.eu/esco/skill/0029e497-3dc3-408e-a902-bc0a2b2a831">http://data.europa.eu/esco/skill/0029e497-3dc3-408e-a902-bc0a2b2a831</a>	lead police investigations	<a href="http://data.europa.eu/esco/skill/7391341e-407a-40a6-b684-2e934db77652">http://data.europa.eu/esco/skill/7391341e-407a-40a6-b684-2e934db77652</a>	make diplomatic decisions	0.4786028134277374
<a href="http://data.europa.eu/esco/skill/0029e497-3dc3-408e-a902-bc0a2b2a831">http://data.europa.eu/esco/skill/0029e497-3dc3-408e-a902-bc0a2b2a831</a>	lead police investigations	<a href="http://data.europa.eu/esco/skill/5996d5a6-1100-4138-b157-e82240b437e">http://data.europa.eu/esco/skill/5996d5a6-1100-4138-b157-e82240b437e</a>	assist police investigations	0.47340485601355164
<a href="http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c">http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c</a>	develop energy saving concepts	<a href="http://data.europa.eu/esco/skill/c83f0b2b-6cd2-46af-b1f1-d31c8360426">http://data.europa.eu/esco/skill/c83f0b2b-6cd2-46af-b1f1-d31c8360426</a>	perform covert investigations	0.2319594500282333
<a href="http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c">http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c</a>	develop energy saving concepts	<a href="http://data.europa.eu/esco/skill/e38f95be-b67d-42c5-8301-c16c40008ee">http://data.europa.eu/esco/skill/e38f95be-b67d-42c5-8301-c16c40008ee</a>	energy efficiency	0.7203791469194315
<a href="http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c">http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c</a>	develop energy saving concepts	<a href="http://data.europa.eu/esco/skill/c4e9d00-bdd4-42d7-83a5-2c1316467c2">http://data.europa.eu/esco/skill/c4e9d00-bdd4-42d7-83a5-2c1316467c2</a>	energy	0.657338500130392
<a href="http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c">http://data.europa.eu/esco/skill/0037c821-2898-4919-b96e-7ed1c089554c</a>	develop energy saving concepts		develop energy policy	0.4833008084750488

Figure 6: Consultation file for ESCO skill co-occurrences.

## 2. ESCO AND LAYERED ONTOLOGIES

### 2.1. Introduction

One of the main goals for the future of ESCO is to transform the classification into an advanced ontology based on sound ontological principles and heuristics. To this end, and as a first step, this note introduces the concept of layered ontologies into ESCO and establishes the differences between a data model and an ontology within the ESCO classification. However, this analysis on ontology layers will not be presented in the March 2025 MSWG, and instead will be subject of a dedicated focus meeting due to its significance and impact.

An ontology and a data model not only serve distinct purposes but adhere to different design principles as well. However, currently there is no clear separation between what parts of the ESCO model are a data model, and which parts are an ontology.

The transition of what is currently called ‘ESCO Taxonomy’ into a domain ontology requires further terminological clarification. It will no longer be accurate to use terms such as ‘taxonomy’, ‘terminology’ or ‘vocabulary’ for describing ESCO. Defining the several meanings that the term ‘ontology’ can have is relevant because the boundaries between what is modelled in the ‘ESCO Model’ vs the ‘ESCO Taxonomy’ will become more blurred.

### 2.2. Definition of a data model

A data model is a structured, conceptual representation of data elements and the relationships between them, within a specific system or application; addresses the logical and physical organisation of data. The focus is on how data is organised, stored and retrieved. Data models define entities, attributes, and relationships for organising and managing data in a way that supports the needs of a particular context, such as a database

or information system. Unlike ontologies, which aim to describe the meaning and interconnections of concepts as they exist in reality, data models are more concerned with the technical aspects of data management.

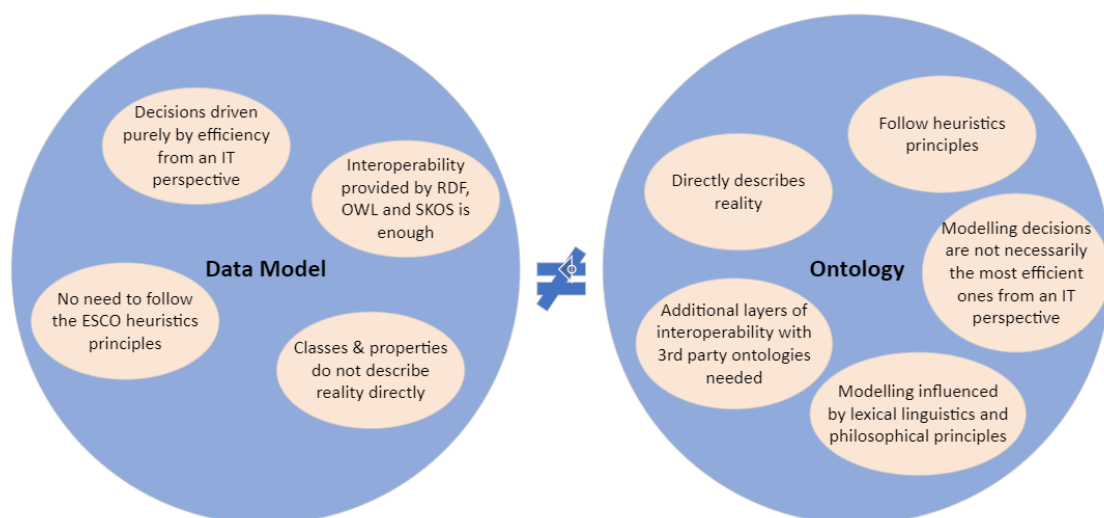
The ESCO data model is not required to adhere to the heuristics developed for the ESCO ontology, such as ontological realism, as it is not concerned with describing reality. An analysis of potential IT solutions will be conducted to determine the most efficient approach for classes and properties that are exclusively part of the data model layer.

### 2.3. Definition of ontology

An ontology is a representational artifact designed to capture the meaning of concepts and the relationships between them as a representation of reality (ontological realism); in the case of ESCO this is the European labour market. It serves as a formal, explicit specification of a conceptualisation; it provides a clear and unambiguous description of the concepts and their interconnections, intended to be shared and understood by a community of users. Unlike data models, which focus on the organisation of data, ontologies are concerned with representing the actual entities within a domain and their inherent relationships, rather than the strings or data that reference those entities.

The concept of ‘ontology’ is grounded in both ‘applied ontology’ and ‘philosophical ontology’. In applied ontology, the focus is on the science of meaning, where the meaning of concepts is expressed through formal logic and articulated in a way that aligns with the language and needs of a specific business or domain. An ontology includes a taxonomy (a hierarchical classification of entities) as a fundamental component, and it extends to include defined classes and the relationships among them.

Classes and properties that belong to the ‘ESCO ontology layer’ need to follow the established ESCO heuristics, as they constitute a representational artifact that makes an objective representation of reality machine-readable..

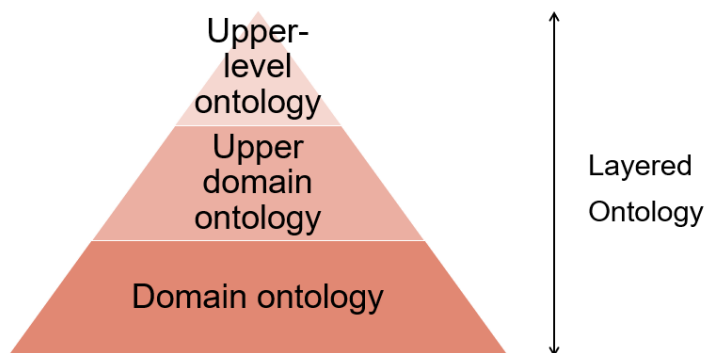


*Figure 7: Differences between a data model and an ontology in the context of ESCO*

## 2.4. Layered ontologies

A layered ontology is a method of structuring an ontology by dividing it into distinct layers, each representing a different level of abstraction or specificity. This hierarchical organisation enhances the management, extension, and reuse of the ontology. In a layered ontology, the layers are typically organised from the most abstract concepts at the top to the most specific, domain-dependent concepts in the middle, and user-specific layers in the bottom. This layered approach offers advantages in the work of ESCO:

- Different heuristic principles can be applied to each layer.
- Each layer can be developed, maintained, and updated independently.
- New layers can be added to the ontology as needed without disrupting the existing structure.



*Figure 8: Illustration of a layered ontology*

## 2.5. Upper level / top-level ontologies

A top-level ontology is a domain-neutral ontology that defines the most general and fundamental concepts applicable across all fields of knowledge. These ontologies are designed to provide a broad, abstract conceptualisation of the world by including universal categories such as "object," "process," "space," and "time." These concepts are independent of any specific domain or problem, making top-level ontologies key for ensuring consistency and coherence across various domain ontologies.

While a domain ontology organizes and makes sense of data within a particular field, a top-level ontology provides a universal structure that supports the organisation and integration of multiple domain ontologies.

In the context of ESCO, plans for reusing any specific top-level ontologies are still under discussions. Top level ontologies will be highly relevant for the development of ESCO's domain layer ontology, and it might be mapped (even if partially) to one or more upper ontologies. Concepts from top level ontologies are also being used by ESCO for creating methodologies for measuring granularity of concepts.

## 2.6. Upper-domain ontology

Upper-domain ontologies are an extension of domain ontologies. They model domains of reality that are not as general as upper-level ontologies, but that are still very general and relevant for different domains. In the context of ESCO this layer is useful for concepts such as skills, knowledge, activities, and occupations, which are not general enough for being a part of an upper-level ontology but constitute the top-level architecture for ESCO and should be distinguished from the remaining elements that belong to the domain layer.

## 2.7. Domain ontology

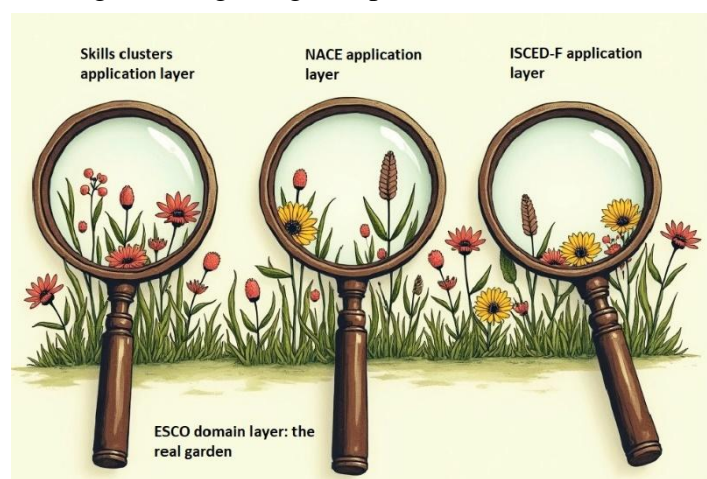
A domain ontology is an ontology that provides a shared and structured representation of the concepts, relationships, and knowledge within a specific domain or subject area. It offers a common point of reference, enabling a consistent understanding of what data elements represent in the real world within that domain.

A domain ontology is tailored to a delineated portion of reality, in ESCO's case the European labour market. Each domain ontology consists of a taxonomy (hierarchical relations) together with other types of relationships such as "part\_of" or "has\_functionality." In this way, a domain ontology goes beyond a simple classification or terminology, providing a detailed and controlled representation of the entities, classes, and relationships relevant to the domain. This is the vision for ESCO taxonomy in the long term.

## 2.8. Application layer of an ontology

An application layer of an ontology is a specialised layer created to address a specific use case within a particular context or domain. Unlike top-level or domain ontologies, which aim to provide a broad or objective representation of knowledge, application ontologies are tailored to solve particular problems, or perform tasks. As they are not intended to model an objective description of reality, they should therefore be a part of the ESCO data model instead of the ESCO ontology.

The application layer of an ontology reuses portions of existing top-level or domain ontologies, integrating the parts that are relevant to the specific application. In ESCO

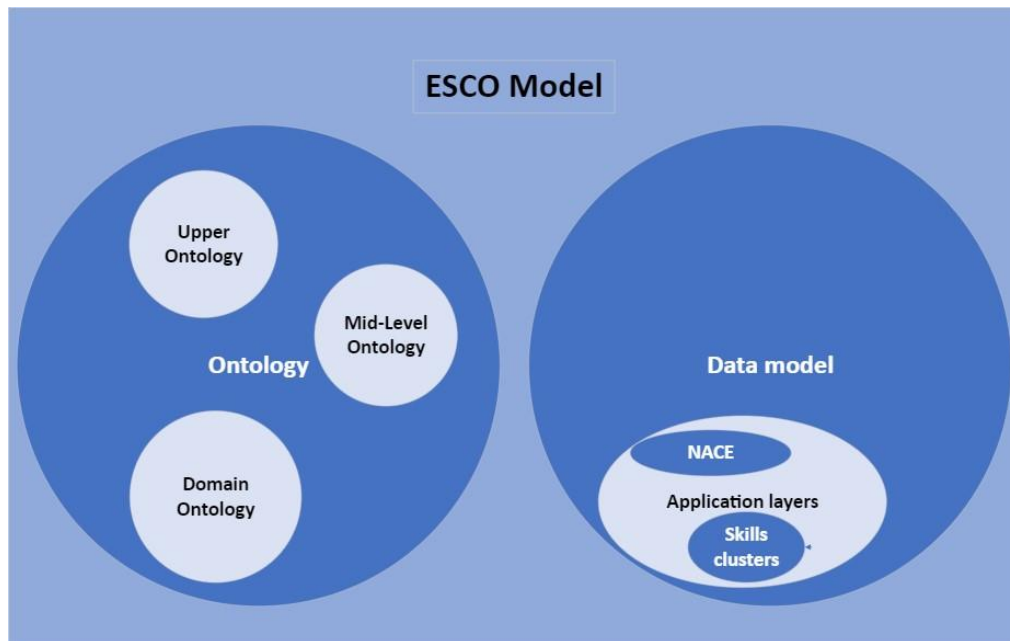


example for this would be the skills clusters application layer, that unites knowledge and skills concepts, or the mapping of ESCO to NACE. Once the skills pillar is restructured according to the principles of ontological realism, the current ISCED-F architecture for knowledge concepts will continue existing as an application layer.

*Figure 9: Interaction between a domain ontology and an application layer*

## 2.9. Conclusion

This analysis helped distinguish the several layers that constitute the ESCO model. The differences between which classes and properties of the ESCO model belong to the data model layer or the ontology layer are now clearer, as well as the different functionalities and design principles that are applicable to each of the ontology layers of ESCO.



*Figure 10: Representation of the layers of the ESCO model*