Skills mismatch in Operations & Supply Chain Management roles: perceptions from the European Skills, Competences, Qualifications and Occupations database

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Abstract: People skills, competences, attitudes and personality traits constitute the essential factors on which companies lay the foundation for obtaining competitive advantage and superior business performance. Especially in the fields of operations management (OM) and supply chain management (SCM), the quest for the most appropriate hard/soft skills, competences and personal requirements is critical to keep up with the intense competition. For this reason, the efforts towards the description, specification and classification of skills requirements have been intensifying lately among many industries. The most notable example in this context is the "European Skills, Competences, Qualifications and Occupations database" (ESCO), the multilingual classification of occupations within the EU labour market, extending far beyond the OM and SCM domains. The ESCO database aims at providing a framework to connect the relevant stakeholders in the job market, and at improving the matching between people and industry occupations. However, even though the importance of skills requirements in these fields is widely recognized, skills mismatch is often present within companies and dramatically hinders the achievement of operational excellence. Hence, the aim of this paper is to evaluate the skills mismatch for some of the most relevant occupations in the OM and SCM fields – namely: supply chain manager, operations manager – considering the ESCO database specifications and industry requirements. Specifically, the methodology of this contribution examines the key activities for the abovementioned occupations and performs a gap analysis for the jobs' required skills. Our work specifies guidance to improve the ESCO database and to further align it with industry requirements, thus providing useful insights to researchers and practitioners. Furthermore, with this research we establish the foundation for a methodology to assess the skills mismatch (e.g. hard/soft skills, competences, attitudes, personality traits) regarding key jobs' tasks in OM and SCM.

Keywords: Skill mismatch; Operations Management; Supply Chain; Europe; ESCO database

1. Introduction

The success of an organization depends on several crucial factors, which could be either directly or indirectly related to its core business. Among these variables, the importance of Human Resource Management (HRM) practices has been rising over time, being nowadays a major trigger for innovation and workplace satisfaction (Arvanitis *et al.*, 2016; Aslam *et al.*, 2014).

According to Obeidat *et al.* (2018), HRM techniques can be categorised in four different levels: recruitment and selection; performance appraisals; training and development; compensation and reward. In this context, the activity of recruiting and selection should ensure the presence of crucial assets to the organization's processes. Indeed, a correct matching between job vacancies and candidates' skills, competences, attitudes and personality traits represents the foundation for obtaining superior business performances.

However, even though it has been shown that HRM practices are strategic to operational excellence (Fok-Yew *et al.*, 2013), they are yet overlooked. More specifically, the objective of identifying and hiring of the most suitable candidate for a specific job position remains often unaccomplished, thus hindering the achievement of enhanced business performances and the inherent people's career development and growth.

This social phenomenon is labeled as "skills mismatch", whose definition is provided by the paper of Brunello *et al.* (2019): "Skills mismatch at the micro level occurs when workers have a level of skills that is different from what is required for their job.". Due to the economic and social relevance of skill mismatch, its effects have been deeply investigated by both researchers and governmental bodies (Desjardins and Rubenson, 2011; Manacorda and Petrongolo, 1999), along with proposed actions to limit its negative impacts. One of the most notable attempts to reduce skills mismatch is the "European Skills, Competences, Qualifications and Occupations database" (ESCO), the multilingual classification of occupations within the EU labour market. The ESCO database aims at providing a framework to connect the relevant stakeholders in the job market, and at improving the matching between people and industry (European Commission, 2019). Hence,

this database aims at obtaining a primary role in the EU job market during the next years.

Given this background, it is therefore of great interest to evaluate the level of adherence of the ESCO job occupations' requirements and the specifications of the industry. Since the ESCO database has the objective to represent the European reference for occupations skills, our paper aims at proposing a methodology to estimate the alignment/misalignment between the ESCO and industry requirements. For this purpose, our paper leverages on the previous research of D'Orazio *et al.* (2020), which performs an analysis of a set of LinkedIn job descriptions (JDs) in the field of Operations Management (OM) and Supply Chain Management (SCM). Moreover, the authors propose a competency framework – along with a scoring index – and evaluate several clusters of job positions.

Our research hence focuses on two different occupations, namely "operations manager" and "supply chain manager", that are believed to be essential figures in the OM and SCM field. Through a comparison of the insights from the abovementioned research and the key features provided within the ESCO database, it has been possible to assess the degree of observance of industry requirements for the EU database, and to determine policy implications for governmental bodies, researchers and practitioners.

It is worth observing that the JDs are here considered as a valid proxy for outlining industry requirements, since they are directly uploaded from organizations on the LinkedIn portal. Furthermore, note that the terms "skills" and "competencies" are here considered as synonyms. Indeed, according to D'Orazio *et al.* (2020) and Teodorescu (2006), the term competency relates to "skills, knowledge, attributes and behaviors that successful people have" and it is appropriate to evaluate the key characteristics to fit in a specific job position.

The paper is therefore divided into two main parts. In the first part, the skills mismatch issue is introduced, along with the description of the ESCO database. The second part of the paper describes the methodology for comparing the ESCO requirements and the industry specifications, and shows its application.

2. The skills mismatch issue

A great effort has been placed towards the description and specification of skills mismatch in the present literature, due to the wide social and economic impacts of this phenomenon. A notable reference in this context is the paper of Brunello *et al.* (2019), which provides a detailed taxonomy about skills mismatch, reported as follows:

- **Skills mismatch**: at macro level, it refers to the gap between supply and demand for skills, while at micro level it refers to the misalignment between available and required workers' level of skills;
- **Skills shortage:** it is referred to the unavailability of workers with the required skill level, at the standard ongoing rate of pay;
- **Skills surplus:** it occurs when the supply of specific skills is greater than the actual demand;
- **Skills gap:** it refers to the unavailability of specific skills for the actual organization's workforce.

Moreover, the authors underline the economic and social costs generated by skills mismatch: it hampers the business development, limiting corporate investments and affecting labour productivity, and hinders people employability, reducing their opportunity to get the appropriate and desired job. These negative effects are also described within the paper of McGowan and Andrews (2015), with specific reference to inefficient resource allocation.

The theme of skills mismatch in manufacturing has been investigated by several contributions. For example, the paper of Lowe (2015) analyses skills misalignment and related work-force development interventions within the US manufacturing labor market. According to the abovementioned contribution, skill gaps are often overlooked and too much effort is placed towards the development of "college for all" policies. Indeed, competencies-tailored policies should be fostered and encouraged by organizations and governmental agencies to ensure the continuous growth of employees and an appropriate jobs-people matching. A similar analysis is provided by the paper of Weaver and Osterman (2017), which highlights the need for a more tightened interaction between both sides of the job market – supply and demand – to reduce this phenomenon. Other contributions have followed the same research path but in different countries, such as India (Prateek, 2018), South Africa (Heyns and Luke, 2012), Norway (Wessel, 2005), Italy (Monti and Pellizzari, 2015).

Many authors have also provided methodologies to estimate the entity of skills mismatch in a given job market. The most common adopted method among the present literature is the "survey-based approach", whose example is provided by the paper of Pellizzari and Fichen (2017). The authors develop a theoretical methodology to define the level of skills mismatch through an evaluation of the jobs' matching degree, which is then applied to the OECD Survey of Adult Skills (PIAAC). However, when adopting survey-based methods for the assessment, it is essential to further deepen the analysis considering the specific factors and characteristics of the considered organizations (Savšek, 2018). Indeed, the impact of skills mismatch depends on several variables, such as offered wages (Directorate General for Internal Policies, 2015; Monti and Pellizzari, 2015) or labour market conditions (Liu *et al.*, 2016; Oreopoulos *et al.*, 2012).

A different estimation methodology is proposed by the paper of Liu *et al.* (2016), in which the authors evaluate the effect of misalignment between college graduates' skills and industry requirements – particularly in conditions on economic recession – through a mathematical regression approach applied on data from the Norwegian market. They show that those market conditions have a persistent – though declining – negative impact on the probability of mismatch, and consequently on the employees' earnings.

In conclusion, the skills mismatch phenomenon has been gaining attention over the years within the present literature, and its negative economic and social effects are widely recognised. Even though several theoretical methodologies have been proposed to determine the degree to which skills mismatch is related to different job markets, no contribution provides quantitative metrics to determine the mismatch entity. Moreover, specifically considering the EU job market, relevant efforts have been made to standardize the jobs description, supporting geographical mobility and fostering data interchangeability, while poor attention has been paid in the scientific literature towards the evaluation of EU skills mismatch. Hence, this paper follows the abovedescribed path of scientific research, and aims at providing useful insights and perceptions to address the competencies misalignment within the EU market.

3. The European Skills, Competences, Qualifications and Occupations database (ESCO)

The multilingual ESCO classification "identifies and categorises skills, competences, qualifications and occupations relevant for the European labour market and education and training" (European Commission, 2019), with main objectives: to improve communication within the EU labour market; to support geographical mobility in Europe; to improve the exchange and analysis of transparent data.

The database is built around three main pillars, namely:

1. **Occupations pillar:** a set of jobs with similar tasks and duties, where a job comprises a set of tasks and duties to be carried out (the database features 2'942 occupations);
2. **Knowledge, skills and competences pillar:** also known as the "skills pillar", it provides a comprehensive list of skills relevant for the EU market (the database features 13'485 skills). For each occupation, these skills are categorised as "essential" or "optional";
3. **Qualifications pillar:** it gathers data on Member States qualifications, and is compliant with the National Qualification Frameworks (NQFs).

Note that ESCO has been published as Linked Open Data to allow the interchangeability of information among all the relevant stakeholders in the EU labour market.

3.1 Operations and Supply Chain Management occupations

Considering the different occupations provided by the ESCO classification, for the purpose of our research two figures have been considered: supply chain manager, operations manager. It is worth noting that even though the ESCO database provides an occupation labelled as "operations manager", we decided to adopt the occupation labelled as "industrial production manager" for the analysis, since it is more inherent and specific to the manufacturing sector. Therefore, in what follows the occupation "industrial production manager" will be considered as "operations manager". Moreover, in order to carry out a detailed comparison, the analysis will only feature "essential" skills (thus "optional" skills will be excluded).

A description of the considered occupations is reported as in Table 1. Differently, Figure 1 shows the frequency analysis for the most common verbs characterising the skills of both occupations. The verbs "manage" and "analyse" respectively hold approximately 20% and 10% of the total number of occurrences, allowing to observe that these occupations are largely characterised by managerial and analytical tasks.

Occupation description	Skills type	Knowledge, skills and competences
Operations manager	Skill/competence	Adhere to organisational guidelines
	Skill/competence	Adjust production schedule
	Skill/competence	Assess impact of industrial activities
	Skill/competence	Check material resources
	Knowledge	Cleaning industry health and safety
	Skill/competence	Control financial resources
	Skill/competence	Create manufacturing guidelines
	Skill/competence	Define quality standards
	Knowledge	Industrial engineering
	Skill/competence	Liaise with industrial professionals
	Skill/competence	Manage budgets
	Skill/competence	Manage resources
	Skill/competence	Manage staff
	Skill/competence	Manage supplies
	Knowledge	Manufacturing processes
	Skill/competence	Meet deadlines
	Skill/competence	Oversee assembly operations
	Skill/competence	Oversee production requirements
	Skill/competence	Plan health and safety procedures
Supply Chain manager	Skill/competence	Analyse logistic changes
	Skill/competence	Analyse supply chain strategies
	Skill/competence	Analyse supply chain trends
	Skill/competence	Assess supplier risks
	Knowledge	Corporate social responsibility
	Skill/competence	Estimate costs of required supplies
	Skill/competence	Follow company standards
	Skill/competence	Liaise with managers
	Skill/competence	Maintain relationship with customers
	Skill/competence	Maintain relationship with suppliers
	Skill/competence	Manage inventory
	Skill/competence	Manage supplies
	Skill/competence	Order supplies
	Skill/competence	Strive for company growth
	Knowledge	Supplier management
	Knowledge	Supply chain management
	Knowledge	Supply chain principles

Table 1: OM and SCM chosen occupations

Figure 1: verbs frequency analysis

4. Skills alignment assessment methodology

To carry out the skills alignment assessment between the ESCO classification and the industry requirements, a general methodology has been developed. The method is described as follows:

1. **Database selection:** this step requires the selection of databases to perform the skills alignment assessment. For the purposes of our research, the chosen data are the ESCO classification and industry specifications provided by the paper of D'Orazio *et al.* (2020), namely 311 job descriptions extracted from the LinkedIn portal, specifically concerning the occupations of operations manager and supply chain manager;
2. **Data cleaning procedure:** which entails the pre-processing of data and the elimination of eventual outliers for the assessment. In our paper, the ESCO classification data cleaning procedure has been performed deleting all the "optional" skills;
3. **Database content analysis:** this step allows to properly describe the chosen databases, creating a structure that allows their qualitative or quantitative comparison, with the aim of performing the skills alignment assessment. In order to create a shared data structure, this phase requires the choice of two further elements: definition of a framework for skills assessment; content analysis methodology development or selection. In this case, both the ESCO classification and industry requirements have been analysed through adopting the competency framework proposed by D'Orazio *et al.* (2020), and the content analysis has been performed manually;
4. **Identification of gaps and policy implications:** once a common content analysis has been carried out for the different databases, it is possible to evaluate the skills alignment. Through a comparison of the databases' contents, this last step allows to assess the degree skills alignment/misalignment between the chosen data, and to determine policy implications for governmental bodies, researchers and practitioners.

An illustration of the described methodology is reported as in Figure 2.

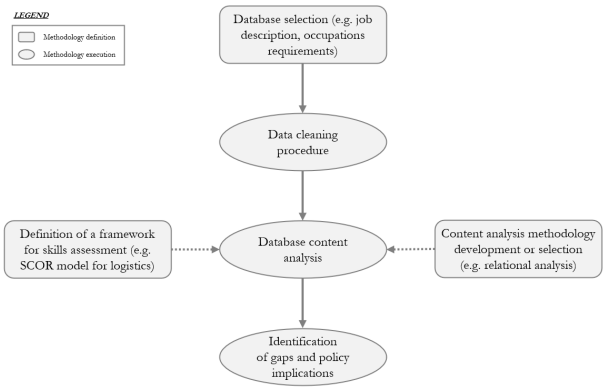

Figure 2: skills alignment assessment methodology

4.1. The competency framework

The proposed framework has been conceived with the aim of identifying and map the skills required within a description of a professional occupation. Moreover, it has been conceived also to support an easier analysis of a job description set.

The framework presents a branched and stratified structure on several levels of generality and competencies details: the levels of the framework represent aggregations, or competence "families". Going down the tree, the competencies inside the lowest levels are more specific and detailed. This structure allows to uniquely classify each competence: a specific competence can thus belong to only one of the categories in the framework, on a specific level.

The framework is formed by three levels. In the first one the "Competency Domains" are defined; each Competency Domain is divided in "Competency Types", and all the Competency Types form the second level; each Competency Type is then divided in "Competency Areas", that form the last level of the framework. Here are briefly described the levels of the framework, for a better detailed description see D'Orazio *et al.* (2020).

In the first level can be found: the set of competencies developed in the previous professional experience of the individual, thus thanks to his training and his work activity; and the set of skills closely related to the personal sphere of the individual, those related to his personality traits, his aptitudes and inclinations. On this basis, two "Competency Domains" are defined as:

- Knowledge Based Competencies (KBC): competences linked to the technical knowledge of the subject matter of interest for the employment of the individual, originating from the individual's background, linked to his work experience or training.
- Personal Competencies (PC): this domain combines the set of skills related to the intrinsic nature of the person, its natural behavioral traits and its way of interpreting reality and relating to it and to others.

The identified Competency Domains have been then detailed defining a level of four competency sub-groups, called "Competency Types", that are:

- SCM Specific Competencies (SCMSC): the set of skills and Knowledge-Based Competences closely related to the SCM domain: knowledge of the processes and practices of the value-added chain and their use to maximize efficiency and exploitation of the resources of the organization.
- Business Generic Competencies (BGC): the set of skills and Knowledge-Based Competencies common to organizational activities that seek to achieve profit through the efficient use of their resources and through the implementation of best practices.
- Individual Competencies (IC): the set of skills and abilities deriving from the resource's personal competencies, in particular those competencies which does not need to be related to the external environment.
- Relational Competencies (RC): the set of skills and abilities deriving from the resource's personal competencies, in particular the ability to relate to the working environment, whether collaborative or competitive.

SCMSC and BGC belong to the Competency Domain KBC, while IC and RC belong to the Competency Domain PC.

Finally, the different Competency Types are divided in overall thirteen Competency Areas, the narrowest and more detailed group of competencies. For the complete description of each Competency Area the reference is D'Orazio *et al.* (2020). Table 2 reports the link between Competency Types and Competency Areas.

Competency Domain	*Competency Type*	*Competency Area*
KNOWLEDGE BASED COMPETENCIES (KBC)	***SCM Specific Competencies (SCMSC)***	*Sourcing and Customer Management*
		Production Planning Management
		Production Executing Management
		Enabling SCM Knowledge
		Logistics Management
	Business Generic Competencies (BGC)	*Generic Business Practices*
		IT and Technical Knowledge
		Finance and Legal Knowledge
		Ethic Principles
PERSONAL COMPETENCIES (PC)	***Individual Competencies (IC)***	*Professional Competencies*
		Traits and Attitudes
	Relational Competencies (RC)	*People Management*
		Social Management

Table 2: competency framework (D'Orazio *et al.*, 2020)

4.2. Analysis method

Professional occupation descriptions in general, or more specifically JDs, may consistently differ one from the other, and vary in detail, which is one of the obstacles for an analysis of the required competencies/skills required (Todd *et al.*, 1995).

Thus, JDs and occupations description have been analysed through deductive content analysis based on the previously proposed framework. Content analysis is used to objectively describe a certain phenomenon (Elo and Kyngäs, 2008), and "precisely the deductive content analysis is used when the structure of analysis is operationalised on the basis of previous knowledge". Using the framework, a method to identify the required skills is defined, relying on an index described in this paragraph.

The collected JDs and occupation descriptions have been examined using content analysis as follows: for each JD, if a competency related to a certain Competency Area is mentioned, the Competency Area has been assigned value 1; 0 otherwise.

The following S index has then been computed:

$$S_{Cc,Sc} = \frac{\left(\sum_{i,j}^{\substack{i \in Cc \\ j \in Sc}} a_{ij}\right)}{Deg\ (Cc) * Deg\ (Sc)}$$

Where:

a_{ij} = 1; 0	as defined before
i	Competency area
Cc	Competency cluster, i.e. a group of Competency areas chosen for the analysis
Deg(Cc)	The number of Competency Areas within a certain Competency Cluster (e.g. Deg(BGC) = 4)
j	Job Description/occupation description
Sc	Stratification cluster, i.e. a specific job position, or a specific experience level required chosen for the analysis
Deg(Sc)	The number of JDs within a certain Stratification cluster (e.g. Deg(Total set) = 311)

This index indicates how much the JD or the occupation description is "specific" (in accordance with the proposed framework) with respect to a given cluster of Competency areas, i.e. how much the company is interested that that set of competencies is present in the individual.

The S index can be calculated on a specific cluster of Competency areas for a specific cluster of JDs.

5. Results and policy implications

The S index has been calculated for the job occupations defined as in the ESCO classification, whose overall results have been compared to the industry requirements as in Figure 3 and in Figure 4. Regarding the overall value, it is straightforward that occupations within the ESCO classification have a higher specificity with respect to the industry JDs. However, the specificity is not equally balanced among the Competency Domain, namely KBC and PC. Indeed, both occupations share the same dynamics: the ESCO classification is more detailed for KBC rather than PC, showing that industry requirements are more concerned about detailing the individual and relational competencies over knowledge ones, while the contrary holds true for the ESCO classification.

This effect could depend on the required effort for the EU governmental body to standardize as much as possible the database of occupations, in order to be applicable in the whole EU labour market. Especially in the Operations and Supply Chain Management fields, competencies related to the specific activity and core business are more standardizable than individual competencies since they are often sector-independent. Differently, the PC are tightly related with the specific industrial sector, hence the lower specificity of the ESCO classification compared to the industry requirements.

This reasoning leads to the observation that, with the aim of filling the identified gap, the ESCO classification could:

- provide further details on the considered occupations, specifying the different PC in relation to a given sector;
- perform a large-scale analysis of industry's JDs (e.g. through the adoption of big data analysis techniques) and identify clusters of competencies to be introduced within the classification.

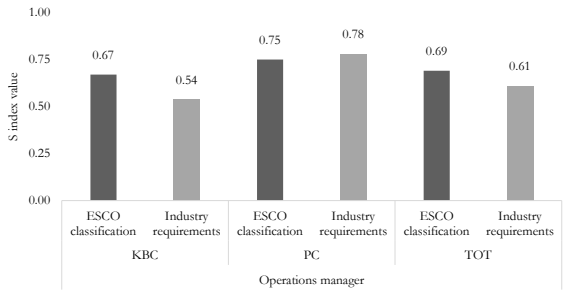

Figure 3: overall S index value (Operations manager)

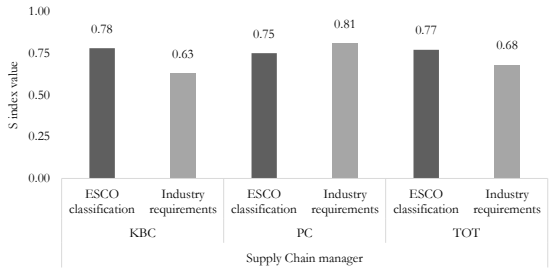

Figure 4: overall S index value (Supply Chain manager)

Successively, the S index has been computed for each Competency Type of the framework for both occupations, and its detailed values are shown as in Figure 5 and in Figure 6. According to these results, the SCMSC are much more detailed within the ESCO classification rather than in the industry JDs, showing that industry JDs tend to avoid an excessive detail for specific competencies. Differently, the BGC does not present significant variations for both the considered occupations, meaning that the level of required generic business competencies is widely acknowledge and standardized among the industry. Hence, the ESCO classification could represent a useful reference for establishing SCMSC and BGC industry requirements within the JDs ("hard skills").

The opposite reasoning applies in relation to the IC and RC. Indeed, with the only exception of IC for the Supply Chain manager occupation, significant differences are observed between the ESCO classification and industry requirements. Specifically, considering the Operations manager occupation, while a higher degree of specificity is present in the industry requirements for IC, the ESCO classification shows a maximum specificity level for the RC. Contrarily, considering the Supply Chain manager occupation, the ESCO classification obtains a lower specificity for the RC compared to the industry JDs. This confirms the perception that personal competencies are more sector-dependent than knowledge-based competencies, and that their standardization does not appear straightforward. Indeed, the observed variation of the S index values for IC and RC for both figures directly depends on the very different requirements in terms of personal competencies of the analysed sectors, ranging from Consumer Goods to Logistics and Transportation sector. This confirms the perceptions that diverse sectors require dissimilar requirements in terms of attitudes and personality traits Hence, in order to be a comprehensive reference for the EU labour market, these results suggest that a greater effort should be placed towards the definition of a classification with higher value of specificity for IC and RC ("soft skills").

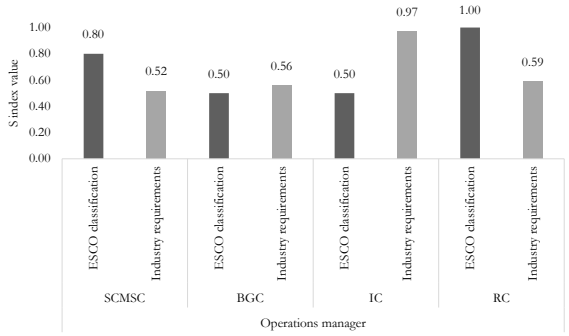

Figure 5: detailed S index value (Operations manager)

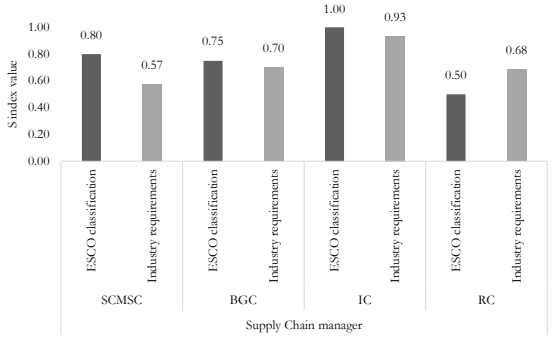

Figure 6: detailed S index value (Supply Chain manager)

6. Conclusions and further developments

This research proposed a methodology to assess the skills alignment of the "European Skills, Competences, Qualifications and Occupations database" (ESCO) with the industry requirements coming from a set of JDs. Specifically, the analysis focused on two relevant occupations from the OM and SCM fields: operations manager and supply chain manager. Moreover, this study leveraged on the previous research of D'Orazio *et al.* (2020), which introduced a competency framework for job posting analysis.

Our research compares the specifications of the ESCO database for the operations manager and supply chain manager, with the identified requirements from a set of 311 JDs extracted from the LinkedIn portal. Moreover, in order to obtain this objective, a general method for evaluating the skills alignment assessment is introduced and discussed. Note that this methodology could either be further expanded to incorporate different analyses, or directly adopted for similar assessment applications.

The main insights obtained from this research regard the applicability and adoption of the ESCO classification within the EU labour market. In this context, while hard skills seem to be largely detailed and could directly be adopted as a reference for industry requirements, soft skills seem to require a further deepening. Indeed, it is recognised that these competencies are less standardizable and more sector-specific than the knowledge-based ones.

Moreover, this research work shows some relevant implications also in the education context. Universities and higher education institutions could adopt the ESCO database as a reference for developing learning programs in line with the industry requirements, to further reduce the gap between industry and education.

However, the huge effort of the European Commission to obtain a comprehensive standardization of the occupations, skills and qualifications should be acknowledged. Hence, the main contribution of the work is the proposal of further areas of development for the ESCO classification, and to lead practitioners and researchers towards undiscovered paths for a more unified and transparent EU labour market.

Authors' statement

This publication uses the ESCO classification of the European Commission.

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