# Vocational Education and Training and Knowledge Intensive Business Services: A Promising Relationship in the Digital Era

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## Abstract

Knowledge intensive business services (KIBS) act as bridges of innovation in the productive fabric. Given this growing importance, the occupational structure and demand for skills in KIBS activities need to be reflected upon. This paper examines the occupational structures of KIBS, looks at the role that vocational training profiles can play within them. The focus of this analysis is the case of the Basque Country, to which the mismatch approach was applied. Beyond merely understanding the current role of vocational education workers, this approach makes it possible to explore the potential of VET graduates in KIBS. Three types of mismatches are studied here: vertical mismatch, horizontal mismatch, and skills mismatch. The results show that the relevance of VET workers varies within the different types of KIBS, being particularly important in T-KIBS. This leads to the conclusion that VET graduates can play a key role in digital transformation processes, both at manufacturing and services companies.

**Keywords:** KIBS; vocational education and training; occupational structure; digitalisation; Industry 4.0; innovation

**Paper type:** Research Article

**Citation:** Albizu M., Estensoro M., Franco S. (2022) Vocational Education and Training and Knowledge Intensive Business Services: A Promising Relationship in the Digital Era. *Foresight and STI Governance*, 16(2), 65–78. DOI: 10.17323/2500-2597.2022.2.65.78

## Introduction

The literature on KIBS has taken as a given that highly qualified workers provide services without clarifying their educational background. It has been assumed, whether explicitly or tacitly, that they are primarily university-educated. At the same time, as a consequence of the new emerging technologies in work processes, new medium-skilled jobs linked to Vocational Education and Training (VET) are rising (Autor, 2015), especially in fields like IT and Industry 4.0 (Becker, Spöttl, 2019; Goller et al., 2021; Spöttl, Windelband, 2021), two key areas of potential development for KIBS in the coming years (Vaillant et al., 2021).

On this basis, this paper disentangles the role of VET workers in KIBS. The focus of the analysis here is the Basque Country's VET system, considered by Cedefop (2019) to be a model of excellence in Europe. The research is conducted on the one hand by considering the share of VET graduates employed in KIBS activities and on the other hand, by analyzing the mismatches between the skills supplied by KIBS employees and their occupations, according to three types of mismatch: vertical, horizontal, and skills. This approach helps one to understand the current role of VET in KIBS and its potential to correct the university bias from which the sector suffers. The case is analyzed using a combination of quantitative (descriptive analysis of secondary data and a survey with KIBS employers carried out by the authors) and qualitative methods (interviews with several KIBS employers). Thus, in order to explore the importance of VET graduates in KIBS, this paper addresses the following research question: are there any vertical, horizontal, or skills mismatches between KIBS occupational demand and the supply of VET graduates? While there are several classifications of KIBS, this paper uses the one established by Miles et al. (2018), who divided KIBS into those related to legal, financial, marketing, and consulting (P-KIBS), those concerning science, engineering, and new technologies (T-KIBS), and those centered on cultural and creative activities (C-KIBS) (Table 1).

Consequently, the paper contributes to two strands in the literature. The first is related to examining the occupational structure of KIBS and the internal nature of this sector (Consoli, Elche, 2010, 2013; Miles et al., 2019) by focusing on its employees' educational background and, more particularly, on the role of vocational education in KIBS, which was previously unexplored. The second contribution, based on the conclusions related to the research question, is connected to the emergence of new medium-skilled profiles as a consequence of the rise of new technologies associated with digitalization and Industry 4.0 (Becker, Spöttl, 2019; Spöttl, Windelband, 2021).

## Theoretical and Analytical Framework

### *KIBS as a driver of innovation in the digital era*

Ever since the seminal publication by Miles et al. (1995) brought the relationship between KIBS and innovation to the fore, this topic has continued to receive noteworthy attention in the literature. As economies develop, there is an increasing demand for more sophisticated knowledge inputs and for private suppliers who can offer specialized knowledge, such as KIBS (Consoli, Elche, 2013; Den Hertog, 2000; Muller, Zenker, 2001). KIBS are typically described as "bridges of innovation" (Wood, 2009) since they fulfill an essential strategic function in firms' competitiveness by providing knowledge (Antonelli, 1998; Corrocher, Cusmano, 2014; Czarnitzki, Spielkamp, 2003; Muller, Doloreux, 2009). Through interactive customization andcollaboration processes between customers and suppliers, KIBS develop ad hoc solutions (Bettencourt et al., 2002; Cabigiosu, Campagnolo, 2019; Landry et al., 2012; Miles, 2008). While these processes could be carried out remotely through new technologies nowadays, face-to-face contact and communication are crucial (Chichkanov et al., 2021). And their outcomes, which become both technological and non-technological innovations (Amara et al., 2009; Muller, Zenker, 2001), have a high impact on the productive performance of the customer. The role of KIBS in boosting innovation appears to be particularly important in manufacturing regions (Corrocher, Cusmano, 2014; Savic, 2016; Wyrwich, 2018).

Most of today's current regional development strategies that include smart manufacturing as a priority also involve developing a strong KIBS sector (De Propris, Bailey, 2020). However, the innovative propensity of KIBS is not limited to the manufacturing sector; they can be providers of innovation, especially in ICT, in the service sector, including KIBS themselves (Cabigiosu, 2019; Kamp, Sisti, 2018). This paper follows Miles et al. (2019) when arguing that it is essential to study the occupational structure of KIBS to be able to reflect on the future of employment in this sector. Likewise, Consoli and Elche (2013) pointed out that this analysis is useful for understanding the internal structure of KIBS, as well as the competences and knowledge they demand. And according to Cabigiosu (2019), KIBS have to rethink the different professional roles, occupations, and skills needed to make effective use of the increasing opportunities offered by the new technologies. Such roles are unlikely to be homogeneous and will depend more upon the type of activity undertaken.

### *Vocational education and training, innovation and KIBS*

KIBS are nurtured with high-skilled workers (Freel, 2006; Den Hertog, 2000), yet their qualifications are often not specified. In many cases, whether tacitly or explicitly, it has been assumed that KIBS employ-

ees have a university background. Proof of this is the large number of articles that relate KIBS to universities (Jacobs et al., 2014; Lee, Miozzo, 2019; Pinto et al., 2015). These works contend that universities are their main workforce supplier and can also act as collaborators within regional innovation systems that feed back into their capacity to acquire and operationalize the knowledge upon which they base their business model. Moreover, they can even serve as incubators that generate KIBS (Koschatzky, Stahlecker, 2006). Given the importance that the literature has placed on KIBS as boosters of innovation for other companies, the explanation as to why KIBS and VET have not been linked so far may be related to a reductionist view of the innovation economy. In general, and particularly within the literature stream of regional innovation systems, the importance of VET is still largely ignored (Navarro, 2014; Porto, Doloreux, 2018; Moso-Díez, 2020) and the fact that firms' ability to apply knowledge and technologies depends on both their high-skilled and medium-skilled workers is lost from sight (Retegi, Navarro, 2018). Indeed, many key support functions, commonly associated with vocational education, are carried out by technical staff in areas such as design, product development, and improvement of production processes (Tether et al., 2005; Toner, Woolley, 2016). Along these lines, Cedefop (2014) showed that in countries with strong apprenticeship systems, highly skilled employees are complemented by medium-skilled technical workers, thus improving a country's productivity and innovation capacity. Furthermore, remaining at the technological forefront will involve relying on a different and specific combination of human capital inputs to achieve growth, where university education will still be crucial for the more specialized tasks of implementing technology and innovation, and medium-level vocational training will be increasingly necessary to complement this work (Manca, 2012). For instance, the VET workforce is key in the deployment of Industry 4.0 and ICT (Becker, Spöttl, 2019; Spöttl, Windelband, 2021; Goller et al., 2021).

Nonetheless, few studies have established any direct links between KIBS and vocational training. The research carried out by Eurofund (2006) opened the door by drawing attention to the impact of medium-skilled workers in the creation of practical solutions for KIBS. Consoli and Elche (2010) went a step further, arguing that vocational skills will gain importance within KIBS because of the need to simultaneously adapt and effectively use the emerging technologies. Moreover, the analysis of the occupational structure of KIBS conducted by Miles et al. (2019) used the ISCO classification (International Standards Classification of Occupations) to examine the evolution of the occupational structures of KIBS and to identify different trends associated with professional support work (ISCO 3 and ISCO 4), such as the declining ratio of those groups compared to professionals (ISCO 2) within KIBS. These ISCO occupational categories, according to ILO (2012), are linked to vocational studies. Another exception is the study by Marttila et al. (2008) which explored the role of Finnish polytechnic schools as providers of KIBS. SMEs were found to be their main customers, with innovation activities more based on practical solutions to specific problems than advances in science. However, none of these contributions directly focus on the presence of employees with VET studies within KIBS. In this regard, this paper contributes by connecting the occupational structure of KIBS to the educational background of employees, seeking to identify any possible imbalances or mismatches that may exist and examining their relevance in relation to their core activities.

Table 1. **KIBS Typologies according to the NACE Classification**

| KIBS type | NACE code | Activities |
|---|---|---|
| P-KIBS | 69 | Legal and accounting activities |
| | 70 | Head office and business management consultancy activities |
| T-KIBS | 62 | Computer programming and consultancy and related activities |
| | 71 | Architectural and engineering activities; technical testing and analysis |
| | 72 | Scientific research and development |
| C-KIBS | 73 | Advertising and market research |
| | 74 | Other professional, scientific, and technical activities |

*Source:* (Miles et al., 2018).

### *The mismatch approach for understanding the role of VET in KIBS*

The mismatch adjustment framework makes it possible to determine which function is currently performed by people with VET in KIBS, as well as the one they should perform, avoiding the bias towards workers with a university background. This can enhance firms' productivity because, when individuals are well matched to their occupations, the knowledge and skills that are acquired through education are optimally utilized on the labor market (Somers et al., 2019). As underlined by Green (2016) and McGuinness et al. (2018), there are three main types of mismatches: the vertical mismatch, the horizontal mismatch, and the skill mismatch.

- The first type of mismatch occurs when the individual's qualifications either exceed or fall short of what is required for the job. In the first case, the individual is overqualified and, in the latter, underqualified. This type of mismatch is referred to as "vertical mismatch" (Chevalier, 2003; McGuinness, 2006; Quintini, 2011).
- The second type of mismatch, known as "horizontal mismatch" (Somers et al., 2019; Robst, 2007a), occurs when the occupation held by an employee is not related to his or her field of study. This type of imbalance is also called 'field-of-study mismatch'.

- The third type of mismatch is referred to as the "skills mismatch" or "skills gap" and describes the situation in which the employer believes that a worker does not possess the adequate competences to successfully implement his or her current tasks and functions. According to McGuinness and Ortiz (2016), the literature on firm-level skills mismatch is less developed than other sorts of mismatch.

## Methodology

This paper examines the case of the Basque Country (Spain) which is particularly relevant for this study for several reasons. The region is one of the most industrialized in Europe and has been considered an interesting example to use for the analysis of industrial policy (Navarro, Sabalza, 2016).[1] Moreover, within the frame of the regional Smart Specialisation Strategy, smart manufacturing and KIBS are viewed as priorities for regional competitiveness. Finally, surveys of graduates in the Basque Country provide a highly valuable source of information at the regional level that allows the educational background of recent graduates employed in KIBS to be investigated in greater detail.

The methodological approach combines quantitative and qualitative research methods. The quantitative analysis starts with exploring the educational background, occupational structure, and vertical mismatch in Spanish KIBS, as well as the extent of horizontal mismatch in Basque KIBS, all based on the secondary sources presented below. The results from a primary survey are combined with a qualitative approach through interviews with KIBS employers to analyze the skills mismatch and the relevance of VET workers within KIBS.Using microdata from the 2019 Spanish Labour Force Survey (LFS), the role of VET workers within KIBS is studied by comparing KIBS educational background with the rest of economic activities. The Spanish LFS was used again to examine the occupational structure of KIBS and how it compares with the rest of economic activities, based on the International Standard Classification of Occupations (ISCO). The Spanish LFS uses the National Classification of Occupations (CNO), a Spanish adaptation of the ISCO. Both are the same in the one-digit classification, with slight differences between the two-digit occupational categories. We have chosen to present the results using ISCO codes because they are well known internationally and can be compared with other territories. The focus is on the occupations that are considered more relevant for KIBS. According to Miles et al. (2019), the first three levels of the ISCO (ISCO-1: management occupations; ISCO-2: technicians and professionals, both scientific and intellectual; and ISCO-3: support technicians and professionals) correspond to occupations whose main tasks include knowledge-intensive activities. The occupations included in the fourth category (ISCO-4, accounting, administrative and office occupations) can also perform knowledge-intensive tasks but to a lesser extent.

To analyze the vertical mismatch, the correspondence table (see Table 2) has been adapted. This tool matches the occupational levels with the levels of education as organized by the International Standard Classification of Education (ISCED). The levels where VET is present have been divided in two to identify clearly where

Table 2. **Occupational and Educational Level Correspondence**

| ISCO categories | ISCED categories | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3-1 | 3-2 | 4 | 5-1 | 5-2 | 6 | 7 | 8 |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |

**ISCO codes**
ISCO-1: Managers
ISCO-2: Professionals
ISCO-3: Technicians and Associate Professionals
ISCO-4: Clerical Workers
ISCO-5: Services, Sales Workers
ISCO-6: Skilled Agricultural Workers
ISCO-7: Craft and Related Trades Workers
ISCO-8: Plant Machine and Operators and Assemblers
ISCO-9: Elementary Occupations

**ISCED Codes**
ISCED 0: Early childhood education
ISCED 1: Primary Education
ISCED 2: Lower secondary education
ISCED 3-1: Medium-level VET
ISCED 3-2: Other upper secondary qualifications
ISCED 4: Post-secondary non-tertiary education
ISCED 5-1: Higher VET
ISCED 5-2: Other short-cycle education
ISCED 6: Bachelor's or equivalent level
ISCED 7: Master's or equivalent level
ISCED 8: Doctoral or equivalent level

**Skills in the job and educational level**

Correctly matched
Under-educated
Over-educated

*Source:* Adapted from ILO (2012). See also: https://dev-ilostat.pantheonsite.io/258-million-workers-in-the-world-are-over-educated-for-their-jobs/ accessed 15.03.2020.

[1] See also: http://en.eustat.eus/estadisticas/tema_473/opt_0/temas.html, accessed 14.01.2022.

Table 3. **Correspondence between KIBS' NACE Activities and VET Fields of Knowledge**

| KIBS type | NACE code | VET field of knowledge |
|---|---|---|
| P-KIBS | 69 | Administration and Management |
| | 70 | Administration and Management |
| T-KIBS | 62 | Information and Communication Technology |
| | 71 | Construction and Civil Work; Mechanical Manufacturing |
| | 72 | Chemistry; SSC |
| C-KIBS | 73 | Administration and Management; Trade and Marketing |
| | 74 | Administration and Management; Image and Sound; Textiles, Clothing Industry and Leather |

*Source:* Extracted from INCUAL (2014)..

it stands. According to this correspondence table, the ISCO-2 occupational category refers to university education, while the ISCO-3 and ISCO-4 categories, considered more technical occupations, are linked to vocational education and training. ISCO-3 corresponds to higher VET and ISCO-4 corresponds to medium-level VET along with other types of education. ISCO-1 occupations are filled by people with both university and higher vocational education levels (ISCED categories 5-8). By computing the share of people according to educational level in each occupation in the KIBS sector, the level of vertical mismatch can be observed. In particular, the ISCO-3 and ISCO-4 occupations filled by university graduates indicate a mismatch on the labor market due to overqualification.

The analysis of the horizontal mismatch is based on the classification developed by the Spanish Qualifications Institute (INCUAL, 2014) in which the Spanish VET fields of knowledge, also known as professional branches[2], are connected with the appropriately matched NACE codes (Table 3). Given this reference, the annual survey conducted by the Basque Employment Service on all graduates from VET[3] has been used. The survey, which offers information about the activities (at the NACE 2-digit level) of the companies where the graduates are employed, makes it possible to identify the field of knowledge and the occupation (ISCO 2-digit level) of VET graduates employed in each of the KIBS. Using the surveys from the 2015-2019 period, with a total of 1,805 graduates working in KIBS, their fields of knowledge and occupations can be examined to assess whether their qualifications and the job they hold correspond with what they are expected to be and, hence, to determine the share of qualifications that are horizontally matched.

Finally, the skill mismatch is examined to obtain a complete picture of the role and importance of the tasks performed by vocationally trained people within KIBS, combining descriptive analysis from a primary survey and qualitative analysis from semi-structured interviews. To understand this potential gap, a survey was conducted with 36 KIBS employers. This survey was launched within a research project in collaboration with the Bilbao City Council and Basque KIBS. The Bilbao City Council has made KIBS a priority in Bilbao's Smart Specialisation Strategy. The survey included seven different sections (see Box 1). Furthermore, ten semi-structured interviews[4] were carried out with KIBS employers.

## Results

### *Analysis of KIBS occupational and educational structure*

KIBS employ 7% of the workers in the Basque Country, which is the same percentage as in Spain and the EU 27.[5] The analysis of the educational background of people employed in KIBS shows that university graduates do the majority of jobs in all types of KIBS, more so than the average in all industries. This is especially the case in P-KIBS (73%) and T-KIBS (71%) (See Figure 1), while university-educated employees in the whole of the economy reach 31%, a substantially lower percentage than in KIBS.

Based on this first approach, it can be concluded that KIBS are a type of activity where employees mostly have a university background. Yet, despite this high percentage of profiles with university studies, Figure 1 shows that vocationally-trained people also account for a considerable percentage within KIBS; specifically, 16% in P-KIBS, 19% in T-KIBS, and 23% in C-KIBS. Except in the latter case, these percentages are smaller than in the whole of the economy. This is mainly due to the lower presence of workers with medium-level voca-

[2] The fields of knowledge, also known as professional branches, are the set of qualifications into which the Spanish National System For Qualifications and Vocational Education and Training are structured. There are 26 different fields of knowledge and these are: Physical and Sports Activity; Administration and Management; Agriculture; Graphic Arts; Arts and Crafts; Trade and Marketing; Construction and Civil work; Electricity and Electronics; Energy and Water; Mechanical Manufacturing; Hospitality and tourism; Personal Image; Image and Sound; Food Industry; Extraction Industry; Information and Communication Technology; Installation and Maintenance; Wood, Furniture and Cork ; Maritime and Fishing Industry; Chemistry; Health; Security and Environment; Sociocultural and Community Services; Textiles, Clothing Industry and Leather; Transport and Vehicles Maintenance; and Glass and Ceramics.

[3] This yearly survey is carried out with vocationally-trained people a year after their graduation. It presents data by employment status, sex, region, industry, and occupation. Microdata has been used for this paper, but general information can be found at the following link: https://www.lanbide.euskadi.eus/estudios-estadisticas/#stats5_clStats, accessed 27.02.2022.

[4] As specified by Singh (2008), such interviews start with structured questions and their possible responses, which can then evolve into unstructured or probing questions leading to different answers.

[5] Within the EU, the country, with the highest percentage of workers in KIBS is Sweden with 11%, followed by Luxembourg and Finland, both with 10%. The countries with the lowest share of workers in KIBS are Romania employing the 3% of the workforce, and Hungary and Bulgaria with a 5%.

**Box 1. KIBS Employers' Survey and Semi-Structured Interview Script**

**1.Description of the company/organization**
- What is the legal nature of the company?
- How many people are employed at the company (including the employer)?
- What is the company's business activity? [I]

**2. Education of the workforce**
- How many employees in the workforce have completed UNIVERSITY STUDIES (diploma, degree, master's degree, etc.)?
- How many employees have a HIGHER VET qualification?
- How many employees have a MEDIUM-LEVEL VET qualification?
- How many employees have completed OTHER STUDIES?
- How many types of jobs in the company are held by people with a VET qualification?

**3. VET jobs [II]**
- Field of knowledge of the person with a VET qualification
- What is the position? (marketing technician, clinic analysis technician, IT technician...)
- Do you consider the KNOWLEDGE/ SKILLS acquired in VET ADEQUATE for the job the employee has to do? (Please answer from 0 to 10 with 0 being «very unsuitable» and 10 being «totally suitable»).*
- Is there any particular SKILL OR KNOWLEDGE that you think should be part of VET that the worker DOES NOT HAVE?
- Do you think there is any particular SKILL OR KNOWLEDGE that will be KEY in the NEXT ten YEARS that is currently unavailable?
- Do you think there is any TECHNOLOGY / SOFTWARE that will be KEY in the NEXT ten years that should be studied at VET institutions?
- To what extent is there the possibility to GROW PROFESSIONALLY (job promotion, salary, etc.) within the company from this position (with 0 being «remote» and 10 being «very strong»).*
- To what extent do you consider this job RELEVANT for the COMPANY'S GROWTH? (with 0 being «not relevant for the company's growth» and 10 being «totally relevant»).*
- Does your company have more VET jobs?

**4. Companies with no employees with a VET qualification [III]**
- Why are there no employees with VET studies in the company?
- Do you consider that any of the positions in your company could be filled by a person with VET?
- Which position could he/she occupy?

**5. VET**
- Do staff, in general, participate in training courses?
- What type of training is provided?
- What type of training is considered most important?
- Which training providers are used?

**6. Dual VET [IV]**
- Do you know what Dual VET is?
- Do you have Dual VET apprentices?**
- Do you consider that they generate added value in the company? To what extent?**

**7. VET Ecosystem**
- Have you had any vocational contact with a VET institution?
- What was the reason for this contact?

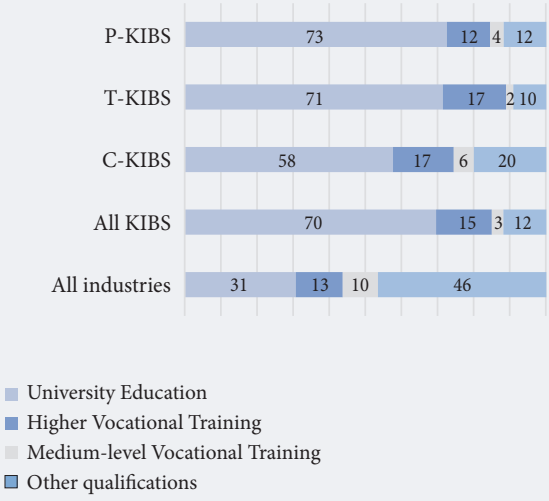
Notes:
[I] This question was absent in the questionnaire for semi-structured interviews.
[II] In the survey questionnaire, this section was completed for each type of job carried out by a VET worker at the company. For the questions marked by *, the part of the quesion in brackets was absent in the questionnaire for semi-structured interviews
[III] This section was absent from the questionnaire for semi-structured interviews.
[IV] The questions marked by ** were added for the goals of the semi-structured interviews.

*Source:* authors.

tional training, thus confirming that even within VET, higher qualifications are preferred when all industries are considered. Personnel with other qualifications, all of which are lower, represent a much smaller share in all types of KIBS than in the economy as a whole. Figure 2 shows that the predominant occupational level is ISCO 2 (Professionals).

Nevertheless, employees in ISCO 3 (technicians and associate professionals) and ISCO 4 (clerical workers), which, as mentioned above, are the levels mainly associated with vocational studies, also account for a significant percentage, with 39% in both P-KIBS and T-KIBS and 43% in C-KIBS. In T-KIBS and C-KIBS, technicians (ISCO 3) account for a higher percentage than clerical workers (ISCO 4), but the opposite is the case in P-KIBS, where the percentage of clerical workers (ISCO 4) is higher. Technicians (ISCO 3) are linked to higher VET qualifications and clerical workers (ISCO 4) to medium-level VET. Consequently, the tacit assumption that KIBS are provided only by university graduates becomes somewhat more nuanced when observing the results in Figure 2. The combined

**Figure 1. KIBS Educational Structure in Spain by Type of Qualification (2019)**




*Note:* Calculated as annual averages from quarterly data.
*Source:* Spanish Labour Force Survey (INE).

presence of occupations linked to VET backgrounds (technicians and clerical workers) is much lower in the rest of the region's economic activities.

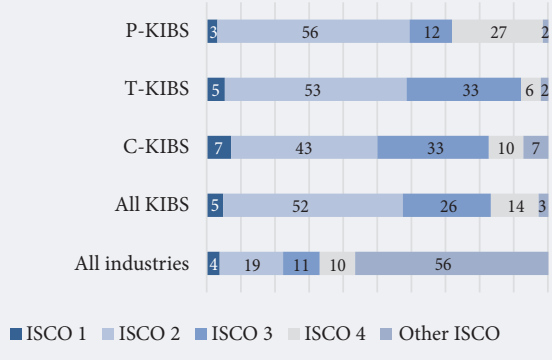
### *Vertical mismatch*

In order to explore vertical mismatches, and following the correspondence table adapted from Gammanaro (2020) and ILO (2012) (Table 2), the share of employment has been computed by educational background in ISCO levels 3 and 4, and is shown in Table 4. It can be observed that, for technicians (ISCO 3), the level of employees who are correctly matched is higher in all KIBS than in all industries (36% vs 28%), while the opposite happens for clerical workers (ISCO 4). However, for either type of occupation, the extent of overqualification is 5 percentage points higher in all KIBS than in other industries, indicating that overqualification is more prevalent in this sector than in the rest of the economy. By type of KIBS, and starting with P-KIBS, it can be seen that the level of overqualification for technicians (ISCO 3) is quite close to that of all KIBS. Likewise, there are fewer technicians that are correctly matched because the level of underqualification is higher (35% in P-KIBS vs 25% in all-KIBS). This is, in fact, quite similar to the level for all industries (37%). Given that according to Figure 2, the share of employment in this occupation is quite similar in P-KIBS (12%) and all industries (11%), we can conclude that there are no significant differences between P-KIBS and the rest of the economy for this occupation. However, when it comes to clerical workers (ISCO 4), who account for 27% of the P-KIBS workforce, which is significantly higher than in the whole economy and the average of all KIBS, the percentage of overqualification is even greater than in all KIBS reaching 66%. This includes 30% of workers with a higher VET background. With regards to T-KIBS, the occupational level that accounts for the second highest share of employment after professionals (ISCO 2) is that of technicians (ISCO 3) (Figure 2). While 38% of them are found to be overqualified, in between the levels of all KIBS and all industries, only 19% are underqualified.

Therefore, T-KIBS is the sector with the highest level of correctly matched employees (42%) in this type of occupation. In the case of clerical workers, the level of overqualification, at 62%, is quite similar to that of all KIBS, but only 18% have higher VET qualifications, as compared to 26% in all KIBS or 22% in all industries. Finally, in C-KIBS, where 33% of the workforce are technicians (Figure 2), the level of overqualification is the highest among all activities reaching 45%, while only 23% are correctly matched by higher VET graduates (see Table 4). On the contrary, for clerical workers, the level of overqualification (48%, with 18% higher VET graduates) is the lowest among all activities, and, consequently is the activity where the level of correctly matched workers in this occupational level is the highest. This indicates that all the types of KIBS suffer from vertical mismatch in the occupations associated with VET and, therefore, the capacity to provide KIBS with VET workers is greater than currently. In the case of P-KIBS, it is more prominent in clerical occupations as they account for 27% of its workforce, and a large proportion of the positions (2 out of 3) are filled by workers with either higher VET or university qualifications, where medium-level VET or other less advanced qualifications would have sufficed.

Meanwhile, in T-KIBS and C-KIBS, the mismatch is more relevant in technician occupations. Whereas the level of overqualification (38%) in this occupation in T-

**Figure 2. KIBS Occupational Structure in Spain by Occupational Category (ISCO) (2019)**




*Note:* Calculated as annual averages from quarterly data.
*Source:* Spanish Labour Force Survey (INE).

KIBS is more similar to the rest of the economy (35%) than in other KIBS, it is relevant because it constitutes a larger proportion of its workforce (33% in T-KIBS vs 11% in all industries). C-KIBS technicians, 33% of its workforce (Figure 2), present the highest level of overqualification (46%). On the contrary, clerical workers present the lowest (48%). In C-KIBS, 45% are found to be overqualified, while only 23% are correctly matched by higher VET graduates (see Table 4). The level of overqualification is quite similar for clerical workers (48%), with 18% higher VET graduates, and half of the workers correctly matched, including 14% with a medium-level VET background.

While the above has focused on vertical mismatches and the occupations considered to be matched with a VET educational background, it could also be analyzed whether VET workers are in fact employed in such activities or whether they undertake occupations for which they are considered to be either overqualified or underqualified. This is shown in Table 5, where it can be observed that Medium VET graduates are highly matched in P-KIBS (in a similar way to what happens in all industries), and substantially underqualified for their occupations in T-KIBS and C-KIBS, mainly employed in ISCO-3 occupations. Regarding higher VET profiles, they are much more correctly matched in T-KIBS than in the rest of KIBS and in all industries. On the contrary, higher VET graduates in P-KIBS are significantly overqualified, mainly employed as clerical workers. This raises the question of whether they are really carrying out tasks for which they are overqualified and should be done by medium level VET workers or whether their tasks require a higher level of qualification and should, in fact, be considered as ISCO 3, but are incorrectly classified as ISCO 4. Concerning C-KIBS, what is significant is the high level of underqualification, with 33% of the higher VET workforce working as professionals (ISCO 2).

### *Horizontal mismatch*

This section analyzes the level of horizontal mismatch by presenting, on the one hand, the fields of knowledge that recent Basque VET graduates employed in KIBS have studied and, on the other hand, the occupations they hold. Following INCUAL's (2014) correspondence table presented in Table 3, the shaded cells in each of the NACE activities in Table 6 represent the activities that are horizontally matched, disaggregated by occupational level at a single-digit level.

Appendix 1 includes more disaggregated details at ISCO 2-digit level.[6] As indicated in the table, the matching of the knowledge and professional skills they acquire during their educational/training period varies depending on the type of KIBS, and substantial differences can be seen in this respect. Regarding P-KIBS, graduates that are correctly matched reach 77% in legal and accounting activities (NACE 69). The main occupations they hold, more than 90%, are directly related to clerical work (ISCO 43, 41, 42, 34, 44, 33 and 24). In head office and business management consultancy activities (NACE 70), the level of

**Table 4. Vertical Mismatch in ISCO 3 and ISCO 4 Occupations in Spain, 2019 (%)**

| ISCO codes | KIBS types | ISCED codes | | | | | | | | | | Skills mismatching degree | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ISCED-1 | ISCED-2 | ISCED-3-1 | ISCED-3-2 | ISCED-4 | ISCED-5-1 | ISCED-5-2 | ISCED-6 | ISCED-7 | ISCED-8 | Underqualified | Matched | Overqualified |
| ISCO-3 | P-KIBS | 1 | 5 | 4 | 26 | 0 | 26 | 0 | 14 | 25 | 0 | 35 | 26 | 39 |
| | T-KIBS | 0 | 3 | 4 | 13 | 0 | 42 | 0 | 17 | 20 | 1 | 19 | 42 | 38 |
| | C-KIBS | 0 | 7 | 6 | 18 | 0 | 23 | 0 | 21 | 24 | 0 | 32 | 23 | 46 |
| | All KIBS | 0 | 4 | 6 | 15 | 0 | 35 | 0 | 18 | 20 | 1 | 25 | 36 | 40 |
| | All-Industries | 1 | 12 | 6 | 18 | 0 | 28 | 0 | 15 | 20 | 0 | 37 | 28 | 35 |
| ISCO-4 | P-KIBS | 1 | 5 | 11 | 17 | 0 | 30 | 0 | 17 | 19 | 0 | 1 | 33 | 66 |
| | T-KIBS | 0 | 11 | 7 | 19 | 0 | 18 | 1 | 18 | 24 | 0 | 0 | 38 | 62 |
| | C-KIBS | 2 | 12 | 14 | 24 | 0 | 18 | 0 | 11 | 19 | 0 | 2 | 50 | 48 |
| | All KIBS | 1 | 7 | 11 | 18 | 0 | 26 | 0 | 16 | 20 | 0 | 1 | 36 | 62 |
| | All-Industries | 1 | 13 | 10 | 20 | 0 | 22 | 0 | 16 | 18 | 0 | 1 | 42 | 57 |

*Note:* see Table 2 for the ISCO and ISCED codes legend, as well as for color codes.

*Source:* Spanish Labour Force Survey (INE).

[6] Given to the volume limitations for this print-oriented version of the paper, the Appendix 1 is available at the separate file via: https://foresight-journal.hse.ru/data/2022/05/16/1823721366/Appendix%201.docx

**Table 5. Vertical Mismatch of VET Graduates in Spain, 2019 (%)**

| ISCO codes | ISCED 3-1 Medium-level VET | | | | | ISCED 5-1 Higher-level VET | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P-KIBS | T-KIBS | C-KIBS | All KIBS | All-Industries | P-KIBS | T-KIBS | C-KIBS | All KIBS | All-Industries |
| ISCO-1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 4 | 2 | 3 |
| ISCO-2 | 0 | 1 | 16 | 5 | 1 | 4 | 8 | 33 | 11 | 5 |
| ISCO-3 | 12 | 62 | 34 | 33 | 7 | 27 | 81 | 44 | 59 | 23 |
| ISCO-4 | 79 | 21 | 25 | 47 | 10 | 67 | 6 | 11 | 24 | 18 |
| ISCO-5 | 0 | 1 | 7 | 2 | 38 | 0 | 0 | 3 | 1 | 21 |
| ISCO-6 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 |
| ISCO-7 | 0 | 8 | 5 | 4 | 18 | 0 | 3 | 4 | 2 | 15 |
| ISCO-8 | 0 | 0 | 4 | 1 | 10 | 0 | 0 | 0 | 0 | 7 |
| ISCO-9 | 6 | 4 | 7 | 6 | 12 | 1 | 0 | 2 | 0 | 6 |
| Underqualified | 15 | 65 | 53 | 40 | 9 | 4 | 8 | 33 | 11 | 5 |
| Matched | 79 | 31 | 41 | 54 | 78 | 28 | 82 | 48 | 61 | 26 |
| Overqualified | 6 | 4 | 7 | 6 | 12 | 68 | 9 | 19 | 28 | 68 |

*Note:* see Table 2 for the ISCO and ISCED codes legend, as well as for color codes.

*Source:* Spanish Labour Force Survey (INE).

correctly matched graduates is lower at 38%. Nonetheless, even taking into consideration that the match is not perfect, most of the working graduates belong to VET fields of knowledge that might be considered related or transversal, such as IT and communications or trade and marketing. If those activities were to be considered matched, the percentages would be over 75%. In this type of activity, VET graduates hold a greater range of occupations and, in fact, the occupation that employs a higher number of graduates is ISCO 35 (Information and communication technicians). In any case, the occupations related to clerical work are prevalent accounting for 49% (ISCO 41, 43, 42, 33 and 24).

Concerning T-KIBS, computer programming, consultancy and related activities (NACE 62) have recruited mostly graduates from the ICT professional field of knowledge (77%), who are correctly matched. Remarkably, this type of activity has recruited more VET graduates (754) between 2014 and 2019 than any other type of KIBS, concretely 42% of the total of VET graduates employed. A total of 72% of them work as information and communications technicians (ISCO 35) or information and communications technology professionals (ISCO 25) that account for 9% of the graduates within this activity. Most of those that are not horizontally matched come from the related area of electricity and electronics and also work in ISCO 35, ISCO 25, or ISCO-4 occupations, with few exceptions, mainly working as electrical and electronic trades workers (ISCO-74) and thus have occupations that are related to their studies.

In architectural and engineering activities, technical testing and analysis (NACE 71), 40% of the graduates are correctly matched but, as in P-KIBS, related or transversal VET fields of knowledge are present, some of them connected to manufacturing activities like electricity and electronics or transport and vehicles maintenance. The main occupation held by the VET graduates are science and engineering associate professionals (ISCO 31) that account for 50% of the total occupations. This is followed by both health associate professionals (ISCO 32) and metal, machinery and related trade workers (ISCO 72), accounting for 7% respectively. Science and engineering professionals account for 6%.

In scientific research and development (NACE 72), while only 28% of VET graduates seem to have qualifications that match the activity (all specialized in chemistry), there is a related field of knowledge (health) with a large percentage of graduates. Health is field of knowledge divided into two main branches, one focused on personal care and assistance and the other on technical laboratory assistance, the latter is highly related to the activity of scientific research. The main occupations are technical and closely linked to the activity (ISCO 31 and 33). Yet, some IT technicians (ISCO 35) and clerical workers (ISCO 43) are present. Finally, the percentage of correctly matched employees in C-KIBS is substantially lower, reaching 21%. In NACE 73, this share is 29% and in NACE 74, it is particularly low, only amounting to 18%. Likewise, it can be highlighted that the fields of knowledge of VET graduates in C-KIBS are quite diverse. Finally, in NACE 74 some occupations held by VET graduates such as ISCO 92 (Cleaners) or ISCO 59 (Protective services workers) are far from being associated with the core activities carried out in C-KIBS.

**Table 6. Horizontal Mismatch in Recent Basque VET Graduates (2014-2019) Employed in KIBS, Disaggregated by Occupation at ISCO 1-Digit Level**

| NACE code | ISCO code | Occupation | | | | | | | | | | | | | | | | | | | | | | VET Graduates | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | Total | By occupation per activity (%) | Matched (%) |
| 69 | ISCO-3 | 0 | 10 | 0 | 0 | 4 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 11 | 42 |
| | ISCO-4 | 0 | 156 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 0 | 3 | 0 | 6 | 0 | 0 | 183 | 83 | 85 |
| | Other ISCO | 1 | 4 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 13 | 6 | 31 |
| | TOTAL | 1 | 170 | 0 | 0 | 13 | 1 | 1 | 0 | 1 | 4 | 0 | 0 | 0 | 15 | 4 | 0 | 0 | 0 | 4 | 0 | 6 | 0 | 0 | 220 | 100 | 77 |
| 70 | ISCO-3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 14 | 38 | 21 |
| | ISCO-4 | 0 | 10 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 15 | 41 | 67 |
| | Other ISCO | 0 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 | 22 | 13 |
| | TOTAL | 0 | 14 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 37 | 100 | 38 |
| | P-KIBS | 1 | 184 | 0 | 0 | 17 | 1 | 2 | 0 | 1 | 5 | 1 | 0 | 0 | 27 | 4 | 0 | 0 | 0 | 8 | 0 | 6 | 0 | 0 | 257 | 100 | 72 |
| 62 | ISCO-3 | 0 | 7 | 0 | 6 | 1 | 0 | 53 | 1 | 5 | 2 | 0 | 12 | 0 | 476 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 569 | 75 | 84 |
| | ISCO-4 | 0 | 19 | 0 | 0 | 1 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 31 | 4 | 13 |
| | Other ISCO | 0 | 2 | 0 | 2 | 1 | 0 | 30 | 0 | 3 | 0 | 0 | 11 | 0 | 103 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 153 | 20 | 67 |
| | TOTAL | 0 | 28 | 0 | 8 | 3 | 0 | 87 | 1 | 8 | 3 | 0 | 23 | 0 | 583 | 3 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 754 | 100 | 77 |
| 71 | ISCO-3 | 0 | 9 | 4 | 1 | 1 | 30 | 26 | 1 | 50 | 0 | 0 | 0 | 1 | 9 | 15 | 0 | 0 | 20 | 7 | 5 | 0 | 0 | 15 | 194 | 63 | 52 |
| | ISCO-4 | 0 | 33 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 40 | 13 | 8 |
| | Other ISCO | 0 | 2 | 2 | 2 | 1 | 5 | 20 | 3 | 12 | 2 | 0 | 1 | 0 | 4 | 6 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 8 | 73 | 24 | 26 |
| | TOTAL | 0 | 44 | 6 | 3 | 3 | 35 | 46 | 4 | 65 | 2 | 0 | 1 | 1 | 14 | 21 | 0 | 0 | 22 | 8 | 7 | 2 | 0 | 23 | 307 | 100 | 40 |
| 72 | ISCO-3 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 7 | 1 | 0 | 0 | 0 | 8 | 1 | 0 | 0 | 38 | 38 | 3 | 0 | 0 | 1 | 105 | 77 | 36 |
| | ISCO-4 | 0 | 10 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 10 | 0 |
| | Other ISCO | 0 | 0 | 0 | 1 | 2 | 0 | 2 | 1 | 3 | 0 | 1 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 17 | 13 | 0 |
| | TOTAL | 0 | 11 | 0 | 1 | 5 | 0 | 10 | 1 | 10 | 1 | 1 | 2 | 0 | 11 | 1 | 0 | 0 | 38 | 40 | 3 | 0 | 0 | 1 | 136 | 100 | 28 |
| | T-KIBS | 0 | 83 | 6 | 12 | 11 | 35 | 143 | 6 | 83 | 6 | 1 | 26 | 1 | 608 | 25 | 1 | 2 | 60 | 50 | 10 | 3 | 0 | 25 | 1197 | 100 | 62 |
| 73 | ISCO-3 | 0 | 0 | 0 | 1 | 11 | 0 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 21 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 43 | 40 | 26 |
| | ISCO-4 | 0 | 4 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 13 | 12 | 38 |
| | Other ISCO | 0 | 2 | 0 | 11 | 13 | 0 | 2 | 0 | 0 | 2 | 1 | 4 | 0 | 5 | 2 | 2 | 0 | 1 | 3 | 0 | 2 | 1 | 1 | 52 | 48 | 29 |
| | TOTAL | 0 | 6 | 0 | 13 | 25 | 1 | 4 | 0 | 0 | 3 | 1 | 9 | 0 | 26 | 3 | 3 | 0 | 1 | 5 | 0 | 6 | 1 | 1 | 108 | 100 | 29 |
| 74 | ISCO-3 | 0 | 0 | 1 | 6 | 0 | 1 | 2 | 0 | 6 | 0 | 0 | 3 | 0 | 4 | 11 | 0 | 0 | 2 | 3 | 2 | 0 | 0 | 0 | 41 | 17 | 7 |
| | ISCO-4 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 25 | 10 | 88 |
| | Other ISCO | 7 | 12 | 6 | 10 | 3 | 1 | 17 | 0 | 16 | 4 | 5 | 5 | 1 | 11 | 16 | 4 | 1 | 0 | 33 | 1 | 21 | 1 | 2 | 177 | 73 | 10 |
| | TOTAL | 7 | 33 | 7 | 16 | 3 | 2 | 19 | 0 | 24 | 4 | 5 | 8 | 1 | 15 | 27 | 4 | 1 | 2 | 36 | 3 | 22 | 2 | 2 | 243 | 100 | 18 |
| | C-KIBS | 7 | 39 | 7 | 29 | 28 | 3 | 23 | 0 | 24 | 7 | 6 | 17 | 1 | 41 | 30 | 7 | 1 | 3 | 41 | 3 | 28 | 3 | 3 | 351 | 100 | 17 |
| | TOTAL KIBS | 8 | 306 | 13 | 41 | 56 | 39 | 168 | 6 | 108 | 18 | 8 | 43 | 2 | 676 | 59 | 8 | 3 | 63 | 99 | 13 | 37 | 3 | 28 | 1805 | 100 | 56 |

*Note:* see Table 2 for the ISCO and ISCED codes legend.

Occupations: 1 — Physical and Sports Activity; 2 — Administration and Management; 3 – Agriculture; 4 — Graphic Arts; 5 — Trade and marketing; 6 — Construction and Civil work; 7 — Electricity and Electronics; 8 — Energy and Water; 9 — Mechanical manufacturing; 10 — Hospitality and tourism; 11 — Personal image; 12 — Image and Sound; 13 — Food Industry; 14 — Information and Communication Technology; 15 — Installation and Maintenance; 16 — Wood, Furniture and Cork; 17 — Maritime and Fishing Industry; 18 – Chemistry; 19 – Health; 20 — Security and Environment; 21 — Sociocultural and Community Services; 22 — Textiles, Clothing Industry and Leather; 23 — Transport and Vehicles Maintenance.

*Source:* Lanbide VET graduate survey (2014-2019). https://www.lanbide.euskadi.eus/estudios-estadisticas/#stats5_clStats, accessed 19.04.2021.

While the analysis seems to indicate that the level of horizontal mismatch varies between different types of KIBS, it also casts some doubts about the accuracy of the correspondence table. This suggests that some fields of knowledge (such as ICT) might be considered transversal to almost all activities and that certain activities (such as creative ones) could benefit from incorporating graduates from diverse fields of knowledge.

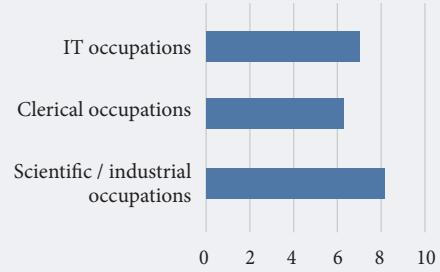
### *Skills mismatch*

The survey and semi-structured interviews with employers shed light on the functions and the tasks performed by vocationally trained people and their relevance concerning the core activities of firms, i.e., those that bring value to customers. In the survey, the profiles of the VET workers were first defined (position, field of knowledge, and VET level). The occupations were grouped into three categories: clerical, IT, and scientific/industrial.[7]

As can be seen from the results in Figure 3, clerical occupations show the most significant skills mismatch, followed by IT occupations. Meanwhile, scientific/industrial occupations, strongly related to the installation and maintenance, and draftsman fields, stand out as the ones closest to the employers' expectations

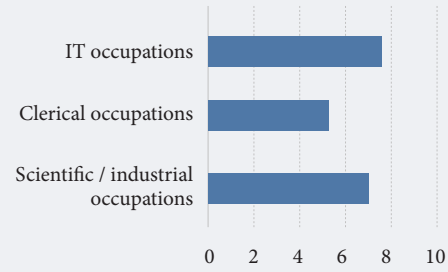
[7] A specific question was asked to be able to compute the skills mismatch: Do you consider that the knowledge/skills acquired in VET are suitable for the work they have to do? Please answer from 0 to 10, with 0 being "very unsuitable" and 10 "totally suitable".

Figure 3. **Average Level of Suitability of VET Acquired Skills by Occupational Category**




*Source:* Authors' own survey given to KIBS employers.

Figure 4. **Average Level of Relevance of Jobs Undertaken by VET Graduates by Occupational Category**




*Source:* Authors' own survey given to KIBS employers.

with regards to competences. The employers asserted during the interviews that IT occupations involve programming and computer system management tasks in different areas (full stack development, cloud computing, big data, cybersecurity, among others) where it is particularly difficult to keep up to date with what is new in the field. Likewise, in this evolving working environment, the attitudinal disposition was highlighted as a key factor when it comes to a worker's performance. In this regard, employers said that skills such as the ability to adapt to change as well as to acquire new knowledge are becoming particularly relevant to KIBS. Finally, according to employers, one evident skill gap can be found in English language skills, which do not seem to be mastered by VET graduates in comparison to their university-educated colleagues.

### *The role of VET workers within KIBS*

In order to explore the relevance of VET workers, the survey asked the following question to KIBS employers: To what extent do you consider this job to be relevant for the growth of the company?[8] The results presented in Figure 4 show that IT occupations and scientific/industrial occupations are considered equally relevant in relation to the core activities performed in KIBS. The added value generated by clerical occupations is clearly lower since they do not participate directly in KIBS' main productive activities. This is in line with what was observed in Figure 4, which illustrates that the type of occupation carried out by people with VET in clerical profiles is, for the most part, ISCO 4. According to Miles et al. (2019), this occupational level involves lower cognitive tasks than required in other levels like ISCO-3 (Technicians).

The interviewed employers confirmed that the technological profiles are currently providing the greatest added value to the KIBS sector. Indeed, these types of profiles are becoming increasingly important for certain companies. Strikingly, several employers reported that they employed VET graduates as IT technicians because of the lack of university graduates, who are very difficult to recruit due to their high demand on the labor market. The employers asserted that they *"have discovered"* that the knowledge and skills of VET profiles are remarkable, and they are able to perform tasks that had been carried out by university graduates until that moment. Moreover, some employers even pointed out that vocationally trained people can be promoted within the firm to the same level as university graduates once given the appropriate in-house training, specifically in the Big Data field. Hence, certain tasks performed in this sector could be optimized under the principle of complementarity between workers with different educational backgrounds.

## Conclusions

The literature on KIBS has pointed out that these types of services are mainly provided by highly skilled workers, usually university graduates. However, as this paper has demonstrated, the role VET graduates play in the sector cannot be overlooked. The data shows that despite the significant percentage of workers with VET training within KIBS, they are under-represented due to a mismatch problem. A vertical mismatch has been detected in the two occupational categories associated with VET qualifications: technicians (ISCO 3) and clerical workers (ISCO 4). This level of mismatch can be related to the whole Spanish labor market but KIBS present singular results, especially in P-KIBS and T-KIBS. The extent of overqualification indicates that some university graduates are being employed in occupa-

[8] The answers were measured from 0 to 10, with 0 being "not relevant for the company's growth" and 10 being "totally relevant".

tions suited for VET graduates and, therefore, the share of VET graduates could be potentially higher. Similarly, overqualification also affects different VET levels, in that some higher VET graduates are employed in clerical occupations that could be undertaken by medium-level VET graduates. Likewise, overqualification may coexist with underqualification, with technician occupations being carried out by medium-level VET workers. These results indicate differences among the various types of KIBS: P-KIBS tend to recruit clerical workers while T-KIBS and C-KIBS recruit mainly technicians. This coincides with other studies in the literature which underline the internal heterogeneity of KIBS (Consoli, Elche, 2010, 2013; Pina, Tether, 2016). As to the horizontal mismatch analysis, overall, P-KIBS and T-KIBS are found to be properly matched, especially if considering not only the fields of knowledge directly linked to them but also related or transversal ones. In particular, certain economic activities like computer programming, consultancy and related activities (NACE 62) and legal and accounting activities (NACE 69) are highly matched. Conversely, C-KIBS present a considerable horizontal mismatch where, moreover, the range of occupations carried out by VET graduates is broader and, in some cases, even unrelated. As a general conclusion, related to all sorts of KIBS, a future research topic could be to refine the fields of knowledge that are best suited for them. Regarding the skills mismatch, the survey shows that the best-matched occupations as far as VET graduates are concerned are those belonging to IT and scientific/industrial areas, while a mismatch is detected in the case of clerical occupations. In terms of relevance, once again IT and the scientific/industrial occupations are deemed particularly important as they are involved in the core activities of KIBS firms. On the contrary, clerical workers are not considered to be instrumental in those activities. These conclusions are reinforced by the opinion of the employers. According to them, VET graduates in IT and scientific/industrial occupations are playing crucial roles that are not only highly complementary to those of university graduates in the development and implementation of technological solutions but could even replace them. Likewise, the need for skills that allow VET graduates to adapt to an evolving work environment has been raised. Therefore, the role of VET graduates varies according to the type of KIBS: in both P-KIBS and C-KIBS, it is found to be less important, whereas in T-KIBS, it is more relevant. Notably, the IT and scientific/industrial profiles associated with VET stand out.

These conclusions open opportunities for further discussion and suggest future research topics related to the role of VET graduates in the current digital transition era where the application of new technologies in economic productive processes is a growing tendency. On the one hand, technological profiles related to ICT are in demand. This profile appears to be particularly important for the deployment of knowledge-intensive solutions, both to the industrial and services sector (including KIBS themselves) in areas such as cybersecurity, big data, and cloud computing. Given the growing demand for such profiles and how critical they are (Castellaci et al., 2020), being aware of the capacity of graduates with vocational training can benefit the productivity of companies that until now have tended to hire people with university profiles. This also has implications for the skills provision system that can train new learners, through VET, in emerging areas of employment in fields of knowledge related to current ones but with the potential for development in new and emerging areas of knowledge.

The findings in this paper illustrate that this first profile can be offered by VET graduates and reinforces the argument of Autor (2015), who suggests that a significant stratum of medium-skilled jobs combining specific vocational skills with foundational middle-skill levels of literacy, numeracy, adaptability, problem-solving, and common sense will be essential in the coming decades. As Cabigiosu (2019) states, the rapid evolution and proliferation of ICT technologies represents not only a considerable opportunity for KIBS but also a challenge for firms trying to make effective use of these technologies. Having teams that are made up of VET graduates together with university graduates could be an answer to such challenges.

As to the limitations of this work and further research opportunities, the paper presents a study conducted using the specific case of the Basque Country. Given that VET systems differ substantially across countries and regions in Europe, future research could include other cases. Moreover, another limitation comes from the methodological approach. Due to the novelty of the topic and the difficulty in finding reliable sources for an in-depth analysis of the nature of KIBS from an educational perspective, this paper has adopted an exploratory and descriptive approach. Nevertheless, sufficient evidence has been gathered to affirm that the role of VET in KIBS is of growing relevance in areas such as IT and Industry 4.0, which opens new avenues for this promising relationship to be further examined.

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